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Evaluating the Impact of School Nutrition Programs

Final Report

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Abstract

This study develops estimates of the efficacy of school nutrition programs in improving a broad range of dietary outcomes by comparing the nutritional status of students and their families during the school year with the status when school is out. The study finds evidence that children who have a School Breakfast Program (SBP) available consume a better overall diet, consume a lower percentage of calories from fat, are less likely to have a low intake of magnesium, and are less likely to have low serum levels of vitamin C and folate. For every outcome examined, SBP availability either promotes better outcomes or at the least does not promote worse outcomes. The results of this study suggest that the availability of an SBP has beneficial effects for children. This report describes the study's broad evaluation of the SBP and the National School Lunch Program (NSLP). The study used the National Health and Nutritional Examination Survey III (NHANES III)—a nationally representative data set that contains detailed information on food consumption, a complete clinical exam, and a laboratory report for respondents.

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Summary

School nutrition programs represent a sizeable share of the United States' food and nutrition programs. Despite their size, relatively few studies have attempted to uncover the causal impact of school nutrition programs, and the studies that exist often suffer from methodological shortcomings. For example, some studies rely on selection models without exclusion restrictions (e.g., Devaney and Fraker 1989; Long 1990), and other studies use instrumental variables with low predictive power (e.g., Gordon, Devaney, and Burghardt 1995). More recently, Bhattacharya and Currie (2001) use a difference-in-difference methodology that addresses the endogeneity of program participation. Their methodology relies on the insight that children will receive these programs only when school is in session.

We contribute to the school nutrition program evaluation literature along two dimensions. First, we explicitly lay out our strategy to obtain causal estimates of the school nutrition programs that extends methods used in Bhattacharya and Currie (2001). Second, we undertake a broad and systematic evaluation of the programs examining numerous nutritional outcomes, including several that do not rely on potentially error-ridden self reports.

We use the National Health and Nutritional Examination Survey (NHANES) III for our evaluation. These data are nationally representative and contain detailed information on food consumption, a complete clinical exam, and a laboratory report for respondents, as well as information about income, family structure, and participation in school nutrition programs.

Our results suggest that the availability of a school breakfast program (SBP) has beneficial effects for children. For example, we find evidence that children who have a SBP available consume a better overall diet, consume a lower percentage of calories from fat, are less likely to have a low intake of magnesium, and are less likely to have low serum levels of vitamin C and folate. For every outcome we examine, a SBP either promotes better outcomes or at the least does not promote worse outcomes. Contrary to our expectations, these effects are most consistently observed for children from relatively high income families. One interpretation of these results is that when a SBP is available, students substitute a relatively high quality school meal for a relatively low quality home meal.

In principle, there is no reason to think that the effects of a SBP would confine itself to participating children—for some families meal programs could serve as an in-kind transfer. Such transfers could affect family budgeting and may affect nutritional choices of all family members, not just children. Previous studies, which have focused only on children, may have overlooked an important impact of the school nutrition programs. Thus, we also present some results on the impact of SBP availability on other household members. Our findings provide some evidence that school breakfast programs have important effects on adult diets in families that have school-bound children.

Finally, we briefly examine the impact of the national school lunch program (NSLP) on the dietary outcomes of children. Our results indicate that the NSLP has little impact on children's diet, but we present evidence that these results are not as reliable as our school breakfast results.

1. Introduction

School nutrition programs represent a sizeable share of the United States' food and nutrition programs.[1] As a proportion of federal expenditures (see Table 1), school nutrition programs were the second largest nutrition programs in 1999, just less than half the size of the Food Stamps program and twice as large as the Supplemental Program for Women, Infants, and Children (WIC). The school nutrition programs are subject to periodic re-authorization.[2]

Despite their size, relatively few studies have attempted to uncover the causal impact of school nutrition programs, and the studies that exist often suffer from methodological shortcomings. For example, some studies rely on selection models without exclusion restrictions (e.g., Devaney and Fraker 1989; Long 1990), and other studies use instrumental variables with low predictive power (e.g., Gordon, Devaney, and Burghardt 1995). More recently, Bhattacharya and Currie (2001) use a difference-in-difference methodology that addresses the endogeneity of program participation. Their methodology relies on the insight that children will receive these programs only when school is in session.

We contribute to the school nutrition program evaluation literature along two dimensions. First, we explicitly lay out our strategy to obtain causal estimates of the school nutrition programs that extends methods used in Bhattacharya and Currie (2001). Second, we undertake a broad and systematic evaluation of the programs examining numerous nutritional outcomes, including several that do not rely on potentially error-ridden self reports.

We use the National Health and Nutritional Examination Survey (NHANES) III for our evaluation. These data are nationally representative and contain detailed information on food consumption, a complete clinical exam, and a laboratory report for respondents, as well as information about income, family structure, and participation in school nutrition programs.

Our results suggest that the availability of a school breakfast program (SBP) has beneficial effects for children. For example, we find evidence that children who have a SBP available consume a better overall diet, consume a lower percentage of calories from fat, are less likely to have a low intake of magnesium, and are less likely to have low serum levels of vitamin C and folate. Importantly, these findings are for the mean impact of the availability of SBP, which averages over those students who do and do not participate. For every outcome we examine, a SBP either promotes better outcomes or at the least does not promote worse outcomes. Contrary to our expectations, these effects are not concentrated among the poorest households. One interpretation of these results is that when a SBP is available, students substitute a relatively high quality school meal for a relatively low quality home meal. However, the differences across income groups are often not statistically significant, and thus, we offer this interpretation cautiously.

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[1] See Currie (2003) for an overview of food and nutrition programs in the United States.

[2] For example, the Agriculture, Nutrition and Forestry Committee of the United States Senate held hearings in March and April of 2003 for the drafting of the re-authorization of the Child Nutrition Act.

In principle, there is no reason to think that the effects of a SBP would confine itself to participating children—for some families meal programs could serve as an in-kind transfer. Such transfers could affect family budgeting and may affect nutritional choices of all family members, not just children. Previous studies, which have focused only on children, may have overlooked an important impact of the school nutrition programs. Thus, we also present some results on the impact of SBP availability on other household members. Our findings provide some evidence that school breakfast programs have important effects on adult diets in families that have school-bound children.

Finally, we briefly examine the impact of the national school lunch program (NSLP) on the dietary outcomes of children. Our results indicate that the NSLP has little impact on children's diet, but we present evidence that these results are not as reliable as our school breakfast results.

Overall, the results should be interpreted with some caution because of how the data collection methodology interacts with our research design. Specifically, the data were collected in such a way as to make geography highly collinear with season, implying that geography is also a confounding factor. It is unclear whether our identification strategy can accommodate the large differences caused by geography.

2. Background

Both the School Breakfast Program (SBP) and the National School Lunch Program (NSLP) provide nutritionally balanced, low-cost meals to children each school day. Both programs are administered by the United States Department of Agriculture (USDA) through its Food and Nutrition Service (FNS). Participating school districts receive a cash and commodity subsidy for each meal they serve, and in turn, they serve meals which must meet minimum dietary standards. In this section, we describe these programs in some detail, and we review the literature that has evaluated them.

2.1. National School Lunch Program (NSLP)[3]

The NSLP was established by the National School Lunch Act in 1946 in response to nutrition deficiency-related health problems identified among young men being drafted during World War II.[4] Perhaps this is why the legislation governing the program states that, "It is declared to be the policy of Congress, as a measure of national security, to safeguard the health and well-being of the Nation's children and to encourage the domestic consumption of nutritious agricultural commodities and other food... [through] school lunch programs" (U.S. Congress, 2000). As this language suggests, a primary goal of the program is to provide meals that include minimum daily requirements of key nutrients. A secondary purpose was the disposal of agricultural surplus (Currie 2003).

Changes to the program over the past 20 years include attempts to alter meal guidelines in order to provide healthier meals and reduce waste, as well as to decrease emphasis on surplus commodity use. Other changes include the development of the "Offer vs. Serve" option, which allowed schools to be reimbursed for lunches in which students were offered all five components of the school lunch meal pattern, as long as students chose at least three components.[5]

The Food and Nutrition Service of USDA oversees administration of the program through local state agencies (usually departments of education). In turn, the state agencies provide technical assistance to local school food authorities, who provide assistance to individual schools. Children are eligible to receive free lunches if their family income is less than 130 percent of the poverty line and reduced-price lunches if their family income is between 130 percent and 185 percent of the poverty line. The schools may charge only up to $0.40 for a reduced-price lunch.

[3] Information on NSLP is available from the USDA/FNS website at http://www.fns.usda.gov/cnd/Lunch/default.htm. Unless otherwise noted, the information from this section comes from the NSLP Fact Sheet (http://www.fns.usda.gov/cnd/Lunch/AboutLunch/NSLPFactSheet.htm), participation totals (http://www.fns.usda.gov/pd/slsummar.htm), and budgetary totals (http://www.fns.usda.gov/pd/cncosts.htm).

[4] Prior to the National School Lunch Act, school lunch programs operated in some school districts on a temporary basis. This Act made school lunch programs a permanent program available nationwide.

[5] The five elements were one serving of a meat or meat alternate, two servings of vegetables, fruit and/or juice, one serving of bread or bread alternate, and one serving of milk.

The program provides a flat per meal subsidy to participating schools, as long as the meals conform to program guidelines. The subsidy depends on the income of the students served. For the 2003-2004 school year, the subsidies were $2.19 per free meal, $1.79 per reduced price meal, and $0.21 for a full price meal.[6] Additionally, schools receive commodities for use in school lunches. These commodity subsidies are available regardless of the incomes of the students served.

In FY 2001, an average of 27.5 children ate lunch each school day through the NSLP, with an average of 12.9 million children (47 percent) receiving free lunches, 2.6 million receiving reduced-price lunches (9 percent), and 12.0 million (44 percent) receiving full-price lunches at school. The cash reimbursement totaled $5.6 billion. Currently, the NSLP operates in almost 100,000 public and non-profit private school and residential child care institutions.

In 1994, Congress passed the Healthy Meals for Healthy Americans Act which required the Department of Agriculture to develop a new menu planning system to help schools meet specific nutrient standards set out in the Dietary Guidelines for Americans. Now, rather than choosing a specific number of items from a list, schools can use whatever portions and combinations of food they wish in order to meet these guidelines.[7] In response to the Act, USDA has also implemented the School Meals Initiative for Healthy Children to provide nutrition education to both children and food service staff (Hamilton and Fox 2000). USDA is also working to improve the nutritional quality of commodities distributed to NSLP schools by, for example, reducing the sodium in canned vegetables and offering low-fat beef patties.

2.2. School Breakfast Program (SBP)[8]

The SBP was established in 1966 as a pilot program to provide categorical grants to schools to serve breakfast to the nutritionally needy. While the designation of nutritionally needy was not defined, schools that were first considered for the program included those located in poor areas or where children had to travel a long distance to get to school. Over the next several years, the program was expanded and changed to a per-meal reimbursement. In 1975, the SBP was made permanent, and continued to emphasize providing breakfast to low-income children. To encourage low-income schools to participate, the program offers a severe need payment. To be considered a severe need school, the school must show that the regular breakfast reimbursement rate per meal is insufficient to cover the costs of the school's breakfast program. The school must also show that the 40 percent or more of lunches served to students at the school

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[6] Reimbursement rates are higher in Alaska and Hawaii.

[7] The guidelines for school lunches include: (1) the provision of one-third of the recommended dietary allowances of protein, calcium, iron, vitamin A and vitamin C; (2) the provision of the lunchtime energy allowances for children; and (3) the applicable recommendations of the 1990 Dietary Guidelines for Americans which include eat a variety of food, limit total fat to 30% of calories, limit saturated fat to less than 10 % of calories, a diet low in cholesterol, and moderate use of salt and sodium.

[8] Information on SBP is available from the USDA/FNS website at http://www.fns.usda.gov/cnd/Breakfast/Default.htm. Unless otherwise noted, the information from this section comes from the SBP Fact Sheet (http://www.fns.usda.gov/cnd/breakfast/AboutBFast/bfastfacts.htm), participation totals (http://www.fns.usda.gov/pd/sbsummar.htm), and budgetary totals (http://www.fns.usda.gov/pd/cncosts.htm).

in the second preceding school year were served free or at a reduced price. Just as with the NSLP, the breakfasts that are served must meet minimum dietary requirements.[9]

In FY 2001, an average of 7.79 million children ate school breakfast daily, which is up from participation of 1.82 million children in 1975. The cash payments for this program in FY 2001 were $1.5 billion. The SBP is currently available in more than 78,000 public schools or non-profit schools of high school grade or under, and residential child care institutions.

The eligibility requirements for free and reduced-priced meals are the same as those for the NSLP. In FY 2001, an average of 5.80 million participants (74 percent) received a free breakfast daily, 0.67 million participants (9 percent) received a reduced price breakfast daily, and 1.32 million participants (17 percent) received a full-price breakfast daily. School food programs get reimbursed from the USDA for each breakfast served that meets program requirements. Currently, programs are reimbursed $1.20 for each free breakfast, $0.90 for each reduced-price breakfast, and $0.22 for each full price breakfast served.[10] Schools are reimbursed an additional $0.23 for free and reduced-price breakfasts if they qualify for severe-need payments.

2.3. Evaluation Literature

Several studies have examined the impact of SBP (Wellisch et al. 1983; Devaney and Fraker 1989; Burghardt, Devaney, and Gordon 1995; Gleason 1995; Devaney and Stuart 1998; Gleason and Suitor 2001).[11] These studies have focused on two questions: (a) does SBP increase the likelihood that children eat breakfast? (b) does SBP have positive impacts on the nutritional outcomes of children? Surprisingly, these studies have reached contradictory conclusions about the first question. While some found that SBP increases breakfast eating, other found that SBP decreases it and still others found no effect (Wellisch et al. 1983; Devaney and Fraker 1989; Burghardt, Devaney, and Gordon 1995; Gleason, 1995; Devaney and Stuart 1998; Gleason and Suitor 2001). Some of these studies have recognized that identifying the impact of SBP is difficult—a simple comparison of outcomes for children participating with those not participating will not give an adequate answer because participation is not randomly assigned. These same reasons also make obtaining an answer to the second question difficult. Some have found that SBP participants have higher intake of some vitamins but lower intake of others. One study finds that SBP is associated with a higher breakfast dietary intake of percentage of calories from fat and saturated fat (Burghardt, Devaney and Gordon 1995).

The NSLP studies have focused on the impact on nutritional outcomes, again with mixed results. Many studies find that NSLP participation is associated with both positive outcomes such as increased protein, vitamin A, and calcium and negative outcomes such as higher

[9] These guidelines include: (1) the provision of one-fourth of the Recommended Dietary Allowance for protein, calcium, iron, Vitamin A, Vitamin C and calories, and (2) the applicable recommendations of the Dietary Guidelines for Americans which recommend that less than 30 percent of an individual's calories come from fat and less than 10 percent from saturated fat.

[10] Reimbursement rates are higher in Alaska and Hawaii.

[11] See Gleason and Suitor (2001) and Levedahl and Oliveira (1999) for more detailed reviews of the programs and the literature that has analyzed them.

percentages of calories from fat and saturated fat (Wellisch et al. 1983; Akin et al. 1983; Burghardt, Devaney, and Gordon 1995; Gleason and Suitor 2001).

Three studies have used explicit statistical techniques (beyond simple regression) in an attempt to obtain causal estimates of program participation.[12] Devaney and Fraker (1989) evaluate the SBP and find that participation positively affects breakfast intakes of calcium and magnesium and negatively affects breakfast intakes of cholesterol and iron. They use a selection bias model to estimate their results, but they have no exclusion restrictions to identify their participation equation. Consequently, whether their estimates are unbiased depends upon functional form assumptions that easily may be incorrect (Wooldridge 2002). Gordon, Devaney, and Burghardt (1995) evaluate the impact of SBP and NSLP on nutrient intake using an instrumental variables approach to handle the endogeneity of the participation decision; that is, their estimates rely on a variable that quasi-randomly assigns students to participating or not participating in a SBP.[13] However, they report that their first stage does not predict participation well, which amounts to a failure of quasi-randomization.[14] Not surprisingly, their results that are adjusted for endogenous participation do not differ much from their unadjusted results.

Bhattacharya and Currie (2001) estimate the effect of participation in school nutrition programs on selected nutritional outcomes of adolescents using a difference-in-difference methodology to address the endogeneity problem. Specifically, they rely on the insight that eligible children will receive the subsidized meals only when school is in session. They compare the changes across school being in session for those eligible (the first difference) to those who are not eligible (the second difference) to obtain an estimate of the impact of the program. They find that school nutrition programs cause students to consume higher quality diets—which means more fruits and vegetables and less fatty foods. However, they find little effect of the programs on nutritional outcomes like anemia and low serum vitamin levels. One exception to this latter finding is that, among children who are eligible for reduced-priced meals, they find that school nutrition programs lead to fewer children with high cholesterol levels.

There are several criticisms that apply to some or all of these studies. First, many of the studies that examine the 24-hour impact of program participation rely on dietary recall data to estimate dietary quality such as the intake of vitamin A. Such calculations require accurate dietary recall and accurate analysis of the likely contents of food. Even when these quantities are accurately obtained, one must still face the problem that nutrient intakes can vary considerably from day to day even in well-nourished populations.

Second, all of the studies have recognized that any evaluation is difficult given that program participation and program availability (for SBP) are jointly determined, but few have dealt with this problem convincingly. In fact, many of the SBP studies find the counterintuitive result that

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[12] Akin, Guilkey, and Popkin (1983) use a switching regression model to allow the behavior of poor and non-poor children to differ in obtaining their results. However, such a model does not allow for program participation to be endogenous within the income groups, and thus we do not consider it here.

[13] The instruments they use include the price of lunch, indicators for the price for which the student qualifies, the available alternatives to school lunch measured by an indicator for vending machines or school store, and the school's food characteristics measured by an indicator for *a la carte* service availability.

[14] See Bound, Jaeger, and Baker (1995) for a discussion regarding the problems with weak instruments.

SBP reduces the likelihood that children eat breakfast. It seems more likely that such an outcome is not causal, but rather an artifact of statistical methods that fail to account fully for endogenous participation. Namely, it is possible that the children who are most likely to participate are the same children whose households face the severest constraints.

Finally, none of the previous studies have considered the impact of SBP and NSLP on the household. If the programs free up household resources that could be redirected towards other household members, such as younger children or adults, then the true impact of the programs will have been understated.

In this study, we use explicitly address each of these drawbacks. First, our data includes nutritional information that is based on actual serum levels rather than dietary recall information. Second, we rely on an explicit and transparent identification strategy to uncover the causal impacts of the programs. Third, our data allows us to examine the impact of the programs on other household members.

3. The Data

3.1. The NHANES III

We rely on the National Health and Nutrition Examination Survey (NHANES) III. The NHANES III is a nationally representative survey that was conducted between October 1988 and October 1994 and included nearly 34,000 respondents, aged 2 months and over. The NHANES III collects much of the usual information found in household surveys, such as demographics (e.g., age, gender, education), income (e.g., labor income and government program participation), and self-reported health (e.g., diseases and functional status). The survey also collects information on dietary intake and substantial health information not normally found in surveys such as data from a physical exam conducted by doctors (e.g. blood and urine tests). One of the primary contributions of this report is that we use measures of nutrition that are based on these exams, which provide more objective measurements of nutritional adequacy than self-reported data can.

The survey over-samples blacks, Mexican-Americans, younger children, and older persons to assure adequate representation and includes weights to make the sample nationally representative. We present weighted results for all of the analyses in the body of the report, and present unweighted results for some of the key analyses in the appendix.

3.2. Measure of Nutrition

One of the substantial benefits of using the NHANES III is that it allows us to examine multiple nutritional outcomes, including some based on physical exams and clinical laboratory data. We briefly describe these measures here and provide additional details in the appendix.

Previous evaluations of SBP have examined whether offering school breakfast increases the probability of children eating breakfast. This is an important outcome because children who skip breakfast are thought to be less able to learn. We examine the impact of the SBP on the likelihood of eating breakfast by relying on a question that asks the frequency an individual eats breakfast in which the available responses are categorical (never, every day, some days, rarely, and weekends only). Similar questions are not available in the NHANES III for lunch consumption.

A common method of collecting nutritional information in surveys is to ask respondents to recall what they ate. In the NHANES III, respondents are asked what they ate in the past twenty-four hours (midnight to midnight) and how many times they ate various foods in the past month. Nutrient values are then calculated based on the respondent's account of the types of foods and amounts that were eaten. We use several measures of dietary intake based on the 24-hour recall, all of which were computed by the NHANES and are on the publicly-available data files.

Our first measure based on the dietary recall data is a summary measure of overall dietary quality called the Healthy Eating Index (HEI). The index has 10 components including grains, vegetables, fruits, meat, total fat, cholesterol and sodium. The latter categories such as total fat, cholesterol, and sodium are based on a recipe analysis of the reported food intake. Each component is scored between 0 and 10 (a perfect score is 100), and intakes that fall between the criteria for scores of 0 and 10 are scored proportionally. The principal drawback of the HEI is that it does not penalize a diet that is high in empty carbohydrates from sweets. See Kennedy et al. (1995) for more details on the index.

We also rely on several nutritional measures that are based on a recipe analysis of the dietary recall data. These measures include total caloric intake, percent calories from fat, and percent calories from saturated fat. In addition, we construct indicator variables for whether an individual had low magnesium intake or low zinc intake.

Finally, we rely on several measures that are drawn from physician examination data, which include blood and urine tests. These measures include serum levels of vitamin A, vitamin C, vitamin E, folate, and cholesterol. For each measure, we create variables that indicate whether a respondent has deficient serum levels (excessive in the case of cholesterol). We use cut-off values for abnormal serum levels that are based upon standard medical textbook definitions. Additionally, we construct an indicator variable for anemia based on standard laboratory tests (based on hematocrit and hemoglobin levels); anemia is a condition that is often caused by insufficient iron intake and by chronic disease.

There are significant benefits to using these blood measures. Blood tests can provide solid, objective evidence of an inadequate diet when properly interpreted. These measures are not susceptible to recall bias as is the dietary recall data. However, the relationship between micro-nutrient intake and blood levels of these nutrients is complicated because the body can store some vitamins and minerals for extended periods of time. The appendix provides additional details on the various measures.

3.3. Sample Descriptive Statistics

For our primary analysis sample, we select individuals from the NHANES who are 5 to 16 years old, who are currently attending school or on vacation from school, whose parents responded to a question regarding whether school lunch and school breakfast were available, who answered the dietary questionnaire, and who participated in the physical exam. Based on these criteria, we obtain a sample of 4,841 children.[15]

Table 2 provides the basic tabulations for the children by school nutrition program eligibility, determined by the income-to-poverty ratio (IPR). A fairly large share of children comes from families who do not provide income information. We place the children without income information in a separate group.

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[15] We begin with 6,423 children in the appropriate age group and who are enrolled in school. We then lose 1,224 children who did not provide a physical exam, 230 additional children for whom dietary recall information was not available, and 128 additional children for whom the requisite school questions (whether school was in session and whether meal programs were available) were not answered.

We do not have complete data for all 4,841 children in this remaining sample. The question regarding breakfast consumption is not asked about children over 11 years old. Vitamin C levels are not provided for children under 6 years old. Some additional laboratory test data are simply missing. For all of the analysis reported below, we use all available data. So that the potential for missing data problems can be assessed, we provide sample sizes for all regression results.

The descriptive statistics exhibit many well-known patterns. For example, the proportion of the population who are non-Hispanic white increases with income, while the proportion of the population who are non-Hispanic black and Hispanic decreases with income. In addition, a SBP is more likely to be available to children from poorer families: 67.3 percent of children from families with income below 130 percent of the poverty line report having a SBP available, 59.0 percent of children in from the middle income category, and 40.6 percent of children from the higher income category. Thus, the targeting of the SBP appears to be at least somewhat successful.

The dietary recall outcomes generally do not exhibit a simple, monotonic relationship by family income, although the children from higher income families tend to have better outcomes. For example, higher income children have a healthier diet, as measured by the HEI score, the percent of calories from fat and from saturated fat. The exam outcomes also generally suggest that the higher income children are better off. For example, their rates of vitamin A deficiency, anemia and hypercholesterolemia (that is, high cholesterol) are lower than corresponding rates for poorer children.

There are some children in the NHANES III sample who do not have a recorded family income (see the last column of Table 2). The results suggest children from such families are fairly poor. The distribution of race and the proportion of these families who receive Food Stamps are more like the corresponding quantities for poor children, though these children are actually less likely to have a SBP available at their school.

4. The Evaluation Methodology

4.1. The Conceptual Framework

We begin with a simple utility maximization model, in which the calories of food consumed by the child must be purchased. Under standard assumptions, an Engel curve can be derived that traces out the optimal caloric intake with respect to income.[16] We draw the stylized Engel curve in Figure 1 suggesting that the curve will become quite flat, perhaps even at relatively low income levels. Quite simply, the flatness recognizes that there are limits to desired calories. To the extent that individuals are below the income level where caloric intake is appreciably flat, then the introduction of a school nutrition program will cause the caloric intake to increase. The mechanism for this beneficial effect is that school nutrition programs represent an in-kind income transfer.

To gauge the potential effects of the program, suppose we value the school breakfast at the USDA reimbursement rate of $1.12 for those families receiving free meals, which implies that the SBP represents a monthly transfer of about $25 for each child receiving free breakfasts. If this additional income were multiplied by a realistic marginal propensity to consume calories for the child, then we might expect a very modest income effect of the program.

Such a calculation could underestimate the impact of school nutrition programs for several reasons. First, to the extent that families participate in many other in-kind nutrition programs (Food Stamps, WIC, etc), then the poorest families might be spending very little of their own money on food. In such cases, a family might not have the opportunity to transfer their own food spending, implying that the entire school nutrition subsidy could purchase additional calories for the child.[17] Second, due to cooking habits or packaging constraints, households might not marginally change their food preparation behavior with the introduction of school nutrition programs, also implying that the entire school nutrition subsidy could purchase additional calories for the child.

Third, this simple model ignores the fact that not all calories are equal, but rather calories vary with respect to quality and price. For example, some calories are replete with vitamins and minerals, while other calories come with few nutrients and perhaps even negative attributes such as high saturated fats. Similarly, calories also vary tremendously in price, particularly when the purchase price and the time cost of preparation are considered. Such a complication can greatly change the relationship depicted in Figure 1. For example, many studies have found that the poor are more likely to be obese than the non-poor in the United States. This alternative relationship is often understood as high fat, empty calories being relatively inexpensive when compared to high quality, nutrient-rich calories.

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[16] See Deaton (1997) for a useful textbook treatment.

[17] Specifically, families might be at a corner solution regarding food expenditures in which the total in-kind food transfer that the family receives is greater than the level of food expenditures the family would choose if the in-kind transfers were paid in cash.

One implication of such concerns is that it can be useful to monitor many facets of a child's diet. For example, even if school nutrition programs have little effect on the quantity of calories that are consumed, the programs could still be substituting for relatively nutrient-poor calories at home. In such cases, the impact of the program would not be observed in measures of the quantity of food intake but rather in measures related to the quality of the diet. In fact, it is possible that an impact will be more easily observed in the quality of the diet if the underlying relationship with income is monotonic (as depicted in Figure 1) or if the income level at which the relationship becomes appreciably flat is higher.[18]

The second implication of such concerns is that the impact of the school nutrition program need not operate only through an income effect as described at the outset. Rather, positive impacts of the program would be available to all those who eat breakfast at school whenever the food eaten at school is of better quality than the food eaten at home. This impact will be observed regardless of whether the breakfasts are subsidized for a particular child and regardless of whether the school-provided meal is nutritiously good as measured by some objective dietary guideline. Given the conclusion in Bhattacharya and Currie (2001) that diets for children are often nutritiously poor, the scope for meal substitution effects may be large.

4.2. The Identification Strategy

We are interested in measuring the causal impact of NSLP and SBP on nutritional outcomes. Consider the SBP program.[19] As many previous researchers have noted, directly comparing students with SBP available to those without does not measure the true causal impact of SBP availability. Quite simply, those who have SBP available are likely to differ along many dimensions from those who do not. Differences in nutritional and other outcomes between the two groups will reflect both the causal impact of the program and the underlying differences between the two groups. For example, Table 2 shows that school breakfast is much more likely to be available to children in poor families and these children have systematically worse diets when compared to children from relatively high income families.

If we could observe everything that makes these two groups different, we could statistically adjust for these differences by estimating a regression model. However, such a method will always be subject to the criticism that we do not observe many of the important differences between the groups, and these remaining differences could confound regression results.

Our strategy to circumvent this problem rests with the simple observation that most school systems are not in session year around, and thus students do not receive the nutrition program year around. Therefore, we could imagine comparing students' diets while school is in session (and thus NSLP and/or SBP is available) to their diets while school is not in session. If the only thing that changes between these periods is the availability of school nutrition programs, then that difference would be the causal impact of the program.

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[18] In the appendix, we plot the relationship between various measures of nutritional outcomes and the poverty-to-income ratio for the children in our sample (ages 5 to 16) and adults age 18 to 34. The relationship between income and nutrition outcomes, particularly at lower incomes levels, varies across the various nutrition outcomes.

[19] Our discussion in this section focuses on SBP, but the reasoning about identification carries directly over to NSLP.

Such an identification strategy would only identify the causal impact of NSLP and SBP on outcomes that could reasonably change within a few months. For example, we would be able to identify the causal impact of the programs on dietary quality and vitamin deficiencies that depend on frequent consumption, but we could not identify the causal impact of school nutrition on longer-term outcomes such as school achievement and obesity. With respect to the outcomes we consider here, vitamin A, vitamin C, and folate are water soluble and are not stored long-term in the body. On the other hand, vitamin E is not water soluble and is stored longer in the body. Thus, it is more likely that we will be able to identify a causal impact on vitamin A, vitamin C, and folate with our identification strategy.

In practice, schools tend not to be in session during the summer months, and our identification strategy would assign all summer/non-summer differences in outcomes to be the causal impact of the program. However, it is conceivable that other things may vary by season. For example, if the opportunity cost of food is cheaper in the summer, either because food could be grown or food prices are lower, then dietary outcomes could be better during the summer regardless of real programmatic effects. Similarly, activity levels could vary by season, also affecting the clinical measures. Any such seasonal variation would confound our estimation procedure, leading us to underestimate the effect of the programs.

A good solution to this problem exists for evaluating the availability of the SBP. In particular, the SBP program is not as widely available as the NSLP program (see Table 2). The children for whom SBP is not available can provide important information regarding the variation that exists in various outcomes (for example, serum measures of vitamin deficiencies) between school being in session and not in session. Thus, we can use a difference-in-difference methodology in which we compare the outcomes for individuals across winter and summer to obtain direct estimates of the seasonal effects. By comparing the two differences, we obtain the causal impact of the nutrition program.

Table 3 demonstrates the basic identification strategy. We divide the sample into groups based on whether a SBP is available and whether school is in session. It is clear that the children with SBP available are relatively disadvantaged in that they have a lower income-to-poverty ratio and they are more likely to receive Food Stamps. Again, this finding implies that simply comparing the behavior of individuals for whom a SBP is available with those who do not would mislead us about what would happen if SBP were made available.

To illustrate the difference-in-difference strategy, consider the HEI score. For children with SBP available, they have a healthier diet when school is in session versus when school is not in session (63.0 vs. 60.9). This difference is consistent with SBP improving the diets of children. Interpreting this change directly is difficult, however, because it is unclear how diets change across seasons (which is coincident with school being in session). To gauge this underlying effect, we examine the variation among children for whom SBP is not available. The change among this group (63.6 vs. 64.7) goes in the opposite direction and is consistent with the notion that healthy food is relatively cheaper during the summer when school is not in session. A difference-in-difference strategy implies that impact of the SBP program on the HEI score is 3.2 [= (63.0 - 60.9) - (63.6 - 64.7)]. That is, the causal effect of SBP is to improve the dietary quality of children by 3.2 HEI points. We present this estimate in the last column in Table 3, and statistical tests suggest that the difference-in-difference estimate is significant at the 0.05 level.

Turning to the other outcomes in Table 3, we find that the SBP improves the dietary outcomes for children, though not all of the improvements are statistically significant. The outcomes that are statistically significantly improved at the 0.1 level include the HEI score, the total calorie consumption from fat, the probability of a low serum level of vitamin C, and the probability of a low serum level of folate.

This identification strategy does not account for at least one seasonal confounding factor, the Summer Food Service Program (SFSP).[20] The Summer Food Service Program provides free nutritious meals and snacks to children in low-income areas during the summer months when school is not in session. The caseload of the SFSP is small relative to the NSLP or SBP. In the summer of 1999, the program served nearly 2.1 million children per day compared to 26.9 million children per day who participated in the NSLP and 7.8 million who participated in the SBP. Because the number of children participating in this program is relatively small, we do not believe that the existence of this program importantly affects our results. However, to the extent that it does, it will tend to bias our results toward not finding any impact because some children still receive a treatment (that is, a meal from the SFSP program) in the summer.

This identification strategy also limits us to examining the impact of SBP availability rather than SBP participation. Quite simply, our strategy allows us to take into account that SBP is more likely to be available to poor students (see Table 2), but it does not allow us to take into account who chooses to participate. To the extent that some students who have SBP available choose not to participate, the impact of SBP availability will be smaller than the impact of SBP participation. The impact of SBP availability is still of interest to policymakers because policymakers can only mandate that the program be made available, not mandate that students must participate.

[20] Information on SFSP is available from the USDA/FNS website at http://www.fns.usda.gov/cnd/Summer/Default.htm.

5. Regression Results for Evaluating the School Nutrition Programs

In this section, we present the regression results for evaluating the school nutrition programs. We first present results for the SBP program, and then we consider the sensitivity of our results. Finally, we turn to the implications of our SBP results for evaluating the NLSP program.

5.1. Evaluating SBP Availability

For our main analysis, we implement this difference-in-difference strategy in a regression framework. A regression allows us to take into account observable differences, such as age, gender, race, and income, between our difference-in-difference groups. To the extent that the identification strategy is contaminated, the regression can potentially adjust for remaining observable confounding factors. In addition, to the extent that we can control for other important determinants of the outcomes, the regression framework will improve the precision of our estimates relative to the difference-in-difference results.

We evaluate the impact of SBP availability with the regression

(1) $$Outcome_i = \alpha + sbav_i\beta_1 + inschool_i\beta_2 + sbav_i * inschool_i\beta_3 + X_i\gamma + \varepsilon_i$$

where $sbav_i$ is an indicator variable for school breakfast being available, $inschool_i$ is an indicator variable for school being in session, and X_i is a vector of other important control variables. The coefficient on the interaction $sbav_i$ and $inschool_i$ (i.e., β_3) measures the causal impact of program, the regression analog of the difference-in-difference estimates presented in Table 3. The other control variables include age (indicators for each age), male, race (indicators for Hispanic, non-Hispanic black, and "other race"), income (indicators for $5,000 increments and for greater than $50,000), household size, and geography (a complete set of interactions between urban and the four census regions). For simplicity, we use ordinary least squares for all models, regardless of whether the dependent variable is continuous or dichotomous.[21]

For all the results in this section, the regressions account for the complex sample design of the NHANES. Specifically, we use information on the strata, primary sampling units, and weights provided by the NHANES for the regressions.[22] These methods implicitly account for the fact that our sample contains multiple children from some households. We examine the sensitivity of our results to accounting for the complex survey design in the appendix.

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[21] Using ordinary least squares with a dichotomous dependent variable (a linear probability model) can lead to difficulties, especially when one is interested in computing predicted probabilities. Because are interests throughout are on marginal effects and for the sake of simplicity, we choose to ignore the dichotomous nature of our dependent variable. We have estimated logit models (results not presented here) and all of our substantive conclusions remained the same.

[22] The NHANES documentation suggests that such methods should be used. We implement these methods by using the "survey commands" in STATA, identifying the underlying selection probabilities, strata, and primary sampling units.

We present the results for the dietary recall measures in Table 4 and the exam measures in Table 5. The regression results largely mirror those presented in Table 3. The availability of SBP generally has positive impacts on nutrition-related outcomes, with statistically significant impacts on improving dietary quality (as measured by the HEI), the percent of total calories from fat, and rates of vitamin C, vitamin E, and folate deficiencies. For example, SBP availability increases the HEI by 3.89, an amount that represents a 6 percent increase of the population mean HEI, and reduces the prevalence of children being low of vitamin C by 7 percentage points, an amount that is twice as large as the population prevalence. Both of these results are statistically significant at the 0.01 level.

Impacts by Income Group

Equation 1 measures the mean impact across all income groups, but there are substantive reasons to expect the impact to vary across the groups. First, the subsidy the children receive varies across groups. Breakfasts are free for children from families with income less than 130 percent of the poverty line and are limited to cost less than $0.30 for children from families with income between 130 and 185 percent of the poverty line. Children from relatively high income families could still benefit because of a small subsidy to their meals. Second, there is a potential additional effect for all children who participate to the extent that school breakfasts are substituting for breakfasts that might have otherwise been consumed at home. Such a substitution effect will vary depending on the quality of the meal that would otherwise be consumed at home, which in turn likely depends on family income.

To examine how the impact of SBP varies by income, we define four different income groups based on the income-to-poverty ratio. These groups correspond to the programmatic rules regarding subsidies. We define the low income group as the children who are in households with an income-to-poverty ratio of less than 130 percent of the poverty line, the medium income group with an income-to-poverty ratio between 130 and 185 percent of the poverty line, and the higher income group with an income-to-poverty ratio greater than 185 percent of the poverty line. We also define an unknown group for those who did not respond to the income question.

Based on the four income groups, we estimate the model,

$$
\begin{aligned}
Outcome = {} & \beta_1 sbav * low + \beta_2 inschool * low + \beta_3 sbav * inschool * low \\
& + \beta_4 sbav * medium + \beta_5 inschool * medium + \beta_6 sbav * inschool * medium \\
& + \beta_7 sbav * high + \beta_8 inschool * high + \beta_9 sbav * inschool * high \\
& + \beta_{10} sbav * unknown + \beta_{11} inschool * unknown + \beta_{12} sbav * inschool * unknown \\
& + \beta_{13} X + u
\end{aligned} \tag{2}
$$

The impact of SBP availability is measured by the interactions as before (that is, the coefficients β_3, β_6, β_9, and β_{12}). We note two things about this model. First, we include the same specification for the other regressors for this model as we did for equation 1. Second, we include interactions with a complete set of income dummy variables to facilitate comparison of these coefficients with those from equation 1—they are on the same scale.

Tables 6 and 7 present the equation 2 regression results. Recall that the significant overall impacts of the SBP were on dietary quality (measured by HEI score) and the percent of total calories attributed to fat (see Table 4). The results from Table 6 suggest that the impacts on dietary quality and the total calories attributed to fat are most consistently observed for the higher income group, not for the low income group. Similar patterns are apparent in Table 7 in that the overall significant impacts on vitamin C and folate are driven by the high and unknown income groups.

Taken at face value, these results are somewhat surprising. Recall that a school nutrition program is expected to affect the poor groups through an income effect (based on the subsidized meal) that is not supposed to be present for the non-poor. Although all income groups could potentially benefit from the meal substitution effect, we expected to find a larger meal substitution effect among the poorer groups. Quite simply, we would have thought that the poorer individuals would have had a lower quality diet at home.

One potential explanation for our results is that children from higher income families are better able to take advantage of the potential benefits of SBP. For example, it is possible that children across the income distribution are provided a relatively unhealthy breakfast. When SBP is available, the higher income parents may be more likely to have the flexibility to ensure their children are at the program and better able to monitor what the children eat. In addition, it is important to note that the "high income" group still contains households with quite modest income because the cut-off for the group is only 185 percent of the poverty line.

These results also allow us to observe what would happen if we were to use the higher income group as a differencing group, as Bhattacharya and Currie (2001) did. Such a strategy identifies the additional impact of SBP availability to the poorer groups over and above those impacts on higher income groups. In other words, such a strategy ignores any meal substitution impacts on higher income children. However, our results suggest that there exist effects among the higher income groups, and thus such an identification strategy would underestimate the impact on poorer children.

5.2. The Sensitivity of the SBP Availability Results

The results thus far are fairly striking. We have exploited a transparent identification strategy, and we find that the availability of SBP has a significant impact on several outcomes. In this subsection, we examine the sensitivity of our results.

Limiting the Variation in Income

A difference-in-difference strategy is dependent upon a linearity assumption. To the extent that the underlying impacts are linear or to the extent that the underlying impacts are non-linear and the underlying changes are small, our identification strategy will identify the true impact of SBP availability. Because we have not specified an underlying theory that tells us the functional form of the various relationships, we must be cautious whenever large underlying differences exist.

As is apparent in Table 3, there are large differences in income between the schools where SBP is available and where it is not available. Although we are controlling for income fairly flexibly (indicator variables for $5,000 bands up to $50,000, as well as an indicator for income over $50,000 and income unknown), it is possible that these controls are not sufficient to make the underlying groups comparable. We believe that income is an important determinant of dietary outcomes, and indeed our results in the previous section suggest that the impacts of SBP vary by income group. To ensure that these results are not driven by underlying non-linearities, we present some results where we restrict the variation in income to provide evidence about whether such concerns are driving our conclusions.

In Table 8, we repeat the key regressions in Tables 4 through 7, but drop individuals with more than $40,000 in annual household income from the sample.[23] The results look similar to the previous results. There are still significant impacts on several outcomes (HEI score, percent of calories from fat, low vitamin C levels, and low vitamin E levels), and the results are still generally driven by impacts among children from medium and relatively high income families.

Seasonal Variation in the NHANES

One of the key aspects of our identification strategy is that, among the individuals who have SBP available, some receive breakfast and some do not due to school being in session. As we discuss in Section 4, one of the major confounding factors to this strategy is that schools systematically tend to be out of session during the summer months and dietary outcomes could be related to season. For example, fresh fruits or vegetables may be cheaper during the summer (either because of increased availability in stores or because of the opportunity to have gardens) or exercise may be easier. Our strategy aims to overcome seasonal confounders by using those individuals without school breakfast available to identify the true, underlying seasonal variation in diet. However, to the extent that such seasonal variation is large, the differencing strategy may not fully account for the differences.[24]

One aspect of seasonal variation that we can examine directly is food prices. Figure 2 plots the percent change in the Food component of the CPI-U (not seasonally adjusted) between adjacent months for the period January 1993 through December 2002. The heavy black line is the mean change in the index. There is some systematic variation in food prices across the year. For example, there is a large decline in the mean change between January and February, as well as little overlap in the distribution of changes between January and February. However, there does not appear to be too much systematic variation by season. Figure 3 presents the same information for monthly changes in the Fresh Fruit and Vegetables component of the CPI-U. This figure suggests more seasonal variation in prices: three of the four low growth months are during the summer (June, July, and August). However, we do not interpret these differences to be so large as to make the differencing strategy infeasible.

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[23] The NHANES collects information on income with one question, asking about total family income, that places families into brackets. Thus, we are forced to impose the income restriction in nominal terms across the six survey years rather than real terms.

[24] Importantly, a difference-in-difference strategy is also dependent upon a linearity assumption. To the extent that the underlying impacts are linear or to the extent that the underlying impacts are non-linear and the underlying changes are small, our identification strategy will identify the true effect.

A potentially more problematic source of seasonal variation exists in the NHANES due to its survey design. Specifically, to accomplish its vast undertaking of data collection, the NHANES survey relies on fully equipped medical clinics, a Mobile Examination Center (MEC), that are housed in the back of tractor trailers.[25] An MEC is then transported to each of the data collection sites. Thus, data collection is limited by the number and transportation time of the MECs. Because of this constraint, the NHANES takes far longer to collect a nationally representative sample then most other surveys. For example, the NHANES III was in the field for six years, with the first three years producing a nationally representative sub-sample and the last three years producing a nationally representative sub-sample.

Due to the actual data collection schedule of the NHANES, a further seasonality issue is introduced into the data. Table 9 presents a cross-tabulation of the number of children interviewed by season and census region. The interviewing pattern implies a strong correlation between season and geography. In fact, almost no interviews took place in the South census region (plus Texas) during the summer. To the extent that diets differ across regions, then the NHANES data collection process introduces an additional confounding factor into our analysis.

The potential difficulties of the interviewing schedule can be observed in Table 3. To the extent that the same types of places were visited over the calendar year, then the demographic characteristics should not vary by school being in session. However, individuals are much more likely to be Hispanic when school is in session, regardless of whether or not SBP is available. Although our difference-in-difference identification strategy could net out these underlying differences between the groups as well, such large differences are potentially problematic.

In Table 10, we repeat the regressions from Table 8, except we exclude children born in the South and West. Although the precision of the estimates is much less, presumably because of the smaller sample sizes, many of the point estimates are quite similar. For example, we still find overall impacts on low vitamin C and low vitamin E, and the results are still largely driven by individuals in the higher income groups.

5.3. Evaluating the National School Lunch Program

The difference-in-difference identification strategy that we have used to examine the impact of the SBP relied on two premises: school is not in session year around and the SBP is not available in many places. The latter premise is not true for the NSLP. As can be observed in Table 2, NSLP is available for over ninety percent of the children across all four income groups.

In our proposal to the USDA, we acknowledged a different identification strategy would be necessary because of NSLP's widespread availability and discussed several alternatives. The most promising alternative was to use higher income children as the differencing group to identify the underlying seasonal variation in diet. However, this strategy relies on the assumption that the NSLP program has no effect on the higher income children. Taken at face value, our results thus far invalidate this assumption in that we observe an impact of the SBP on

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[25] For more information about the MEC, see the special section on the NHANES website: http://www.cdc.gov/nchs/about/major/nhanes/mectour.htm.

the children of higher income families, and in fact, these are the children for whom we primarily observe an impact. We have little reason to speculate that the NSLP would be any different.

Regardless, it is instructive to examine results for the NSLP. Table 11 presents the basic difference-in-difference results (analogous to Table 3) for the impact of NSLP availability in which we use the identification strategy originally proposed. Specifically, the first two columns compare the outcomes for children who have free NSLP available, distinguishing between those children who are in school and those children who are not in school. This comparison ideally would allow us to hold everything else constant about the children (such as socio-economic status and community characteristics), except some children currently receive NSLP because school is in session and some do not because school is not in session.[26] For example, the results in Table 11 would suggest that the overall dietary quality is better for poor children when they are in school (an HEI score of 63.3) than when they are out of school (an HEI score of 62.7). However, there could also be important seasonal variation in dietary quality that could confound this comparison. If we were to maintain that there were no impacts of NSLP on the children from relatively high income families, then the seasonal variation would suggest the dietary quality is higher when school is out (an HEI score of 64.5) then when school is in session (an HEI score of 63.6). The difference-in-difference estimator then implies that free lunches through the NSLP has an impact of 1.5 [= (63.3 – 62.7) – (63.6 – 64.5)] on the HEI score.

Overall, the results in Table 11 are weak and mixed.[27] The availability of free lunches appears to improve dietary outcomes for some measures (higher HEI score, lower calories, less prevalence of low zinc intake and low vitamin C level), but it appears to harm dietary outcomes for many other measures (increased calories from fat and saturated fat and increased prevalence of low vitamin A, E, folate, anemia, and high cholesterol). However, only one of these impacts is statistically significant (increased prevalence of low vitamin E levels), but this relationship is weak and implausible in that vitamin E is unlikely to change over a short time period because it is not water soluble.

Our conclusion from these results is not that the NSLP has little impact, though. Rather, we conclude that our identification strategy does not provide a good mechanism to identify the causal effects of the NSLP. Again, our identification strategy hinges on the assumption that school nutrition programs do not have an impact on the relatively high income groups. Our previous results suggest that this not the case for the SBP, and we have little reason to expect the NSLP to be different.

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[26] The regional problem previously identified is readily apparent. For example, 28.0 percent of the children who are attending school report being Hispanic, whereas 10.2 percent of the children not in school report being Hispanic. These differences are what would be expected given data are collected in the south and southwest during the winter and the northeast during the summer.

[27] We have also implemented this difference-in-difference strategy with a regression framework, and all of the conclusions remain the same.

6. School Nutrition Programs: A Family Perspective

6.1. Background

The report thus far treats children in isolation of their families, but children generally live with a family in which a parent (or guardian) is purchasing food to be shared among all members. It is possible that an altruistic parent would devote a relatively greater share of initial family income to the child to ensure the well-being of the child.[28] Such behavior would imply that the income range over which an income effect of the school nutrition programs could be observed for children would be even smaller. Thus, even fewer children would be observed at a household income level sufficiently low so that we would expect to observe an impact of a school nutrition program. However, the opposite relationship might hold for the altruistic adults in the household: adults might transfer more of the initial income to feeding children but utilize more of additional income to feed themselves. For an altruistic adult, the level of income would be higher at which impacts could be observed. Such issues regarding the allocation of resources within families are the focus of much research in development economics (for example, see Behrman 1997).

In fact, there exists a large literature in development economics that explicitly considers whether school nutrition programs benefit children because of the potential of family responses. For example, Beaton and Ghassemi (1982) review approximately 200 studies of preschool feeding programs, and Jacoby (1997) reviews more recent studies. The focus of many of these studies is whether there are positive impacts of the programs on child nutritional outcomes or if families effectively neutralize the programs by transferring at-home resources away from the child. For example, Jacoby (2002) asks whether there is an "intrahousehold flypaper" effect?   In other words, Jacoby (2002) studies whether a targeted program (such as a school nutrition program) sticks to its intended recipient (the child) or is some behavior (such as the food distribution at home) altered so that the program benefits others (such as other household members).

Our data present a unique opportunity to examine the impact of school nutrition programs from a family perspective. First, although a small number of studies have examined the impact of United States school nutrition programs on household food expenditures (West and Price 1976; Wellisch et al. 1983; Long 1990), these studies have not used a plausible identification

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[28] Such behavior is built into the USDA Food Security Scale. For example, consider the following two definitions for different levels of food insecurity:

> <u>Food insecure with moderate hunger</u>: "Food intake for adults in the household has been reduced to an extent that implies that adults have repeatedly experienced the physical sensation of hunger. In most (but not all) food-insecure households with children, such reductions are not observed at this stage for children."
>
> <u>Food insecure with severe hunger</u>: "…all households with children have reduced the children's food intake to an extent indicating that the children have experienced hunger. For some other households with children, this already has occurred at an earlier stage of severity. Adults in households with and without children have repeatedly experienced more extensive reductions in food intake."

See Bickel et al (2000) for more details.

strategy to handle the endogeneity of participation. Second, our data contain information about other household members so we can look at the impact on adults directly.[29] These data are in contrast to many of the studies of developing countries (such as Jacoby) that only have information on children, and therefore, must infer transfers to other family members based on the impact on the child.

Another important aspect of looking at the family is that it can provide further insights into our identification strategy. In the conceptual framework, we identify two distinct avenues through which children could benefit from school nutrition programs: an income effect (the food represents a transfer into the household) and a meal substitution effect (meals served at school may have different nutritional value than meals that would have been served at home). The former effect is expected to be concentrated among children receiving free or reduced-price meals, but the latter effect would benefit any child eating at school, as long as the school-served meal is of higher quality than the home-served meal. On the other hand, other household members can only benefit from the income effect of the programs because they are not the direct recipient of the schools meals. This reasoning would suggest that we should be more likely to find impacts of the school nutrition programs among the adults whose children qualify for free or reduced-price meals.

6.2. Regression Results for SBP Availability for Adult Household Members

In Tables 12 through 14, we examine the impact of SBP availability for adult household members aged 24 to 60 of the children in the primary sample. Specifically, we classify these adults according to whether the child in the household has school breakfast available and whether school is in session.[30] We then use the same identification strategy as used before.

Table 12 presents a difference-in-difference analysis, similar to that in Table 3. Looking at the household characteristics, many of the same patterns emerge that were observed before. The households with SBP available are worse off than those households without SBP available (measured by the income-to-poverty ratio and the Food Stamp receipt), implying that a simple difference analysis comparing those with SBP available and not available will provide misleading results. More problematic for our difference-in-difference approach, it is also clear that the racial composition changes between the school being in session and not in session as would be expected given the geographic nature of the NHANES data collection. Specifically, the sample is more non-Hispanic White and less Hispanic when school is not in session as compared to when school is in session, consistent with the data collection in the Northeast and Midwest being concentrated in the summer and the South and West during the winter.

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[29] Not everyone within a household is selected is into the sample given the NHANES sampling scheme, and some individuals may refuse to participate in some or part of the survey. However, family identification numbers are provided so that individuals within the same family can be connected.

[30] This description ignores the ambiguity that exists when a household has more than one child. To make the assignment, we randomly choose one child from each household and use that child to classify the adult members. Because most children within a multi-child household are interviewed at the same time and attend the same (or similar) schools, which child is chosen is irrelevant to the classification. In fact, only 148 of the 4,481 households have children who would suggest different classifications.

Turning to the nutritional outcomes, we find that the availability of the school nutrition programs improves some of the nutritional outcomes for the adults (higher HEI score, less calories from fat and saturated fat, lowers the prevalence of high cholesterol). However, none of these differences are significant even at the 0.1 statistical level.

The regressions provide somewhat stronger results. Table 13 presents regression results for all adults and Table 14 presents regression results that exclude adults with the highest income (over $40,000), from the South, and from the West. Table 13 suggests that the availability of SBP improves the dietary quality of adults and reduces the percent of calories from fat. These impacts are still somewhat concentrated among the higher income groups, but not as much as the results for children. The results are a little more concentrated among the lower income groups in Table 14, but as expected with smaller sample sizes, the results are fairly imprecise.

7. Discussion and Conclusion

In this report, we describe our broad evaluation of the School Breakfast Program (SBP) and the National School Lunch Program (NSLP). We use the National Health and Nutritional Examination Survey (NHANES) III, a nationally representative data set that contains detailed information on food consumption, a complete clinical exam, and a laboratory report for respondents. Relying on a transparent identification strategy in which we compare students and families when school is in session versus when school is out, we develop causal estimates of the efficacy of school nutrition programs on a broad range of dietary outcomes.

Our results suggest that the availability of SBP has beneficial effects for children. For example, we find evidence that children who have SBP available consume a better overall diet (as measured by the Healthy Eating Index), consume a lower percentage of calories from fat, are less likely to have a low intake of magnesium, and are less likely to have low serum levels of vitamin C and folate. Along no dimension that we analyze does SBP appear to harm the diets of children. This finding is in contrast to previous studies.

To better understand the underlying mechanism of these results, we further look to see which children are enjoying these gains. Although some benefits are often observed across the household income distribution (HEI score, low serum level of vitamin C, and low serum level of folate), many of the benefits are concentrated at the middle and upper parts of the income distribution. One interpretation of these results is that the meal substitution aspect of the SBP (substituting a relatively high quality school meal for a relatively low quality home meal) might be particularly important. However, the differences across income groups are often not statistically significant, and thus, we offer this interpretation cautiously."

We also present some results regarding the impact of SBP availability on other household members. Although studies in developing countries frequently consider a household perspective when analyzing school nutrition programs, such a perspective has rarely been applied to the United States programs. To the extent that there exist altruistic parents who direct a disproportionately large share of initial resources to children, then previous studies that have focused only on children may have overlooked an important impact of the school nutrition programs. Our findings provide some evidence that there are impacts on the overall dietary quality of adults, although contrary to our expectations, these effects are somewhat concentrated among the higher income families.

The results presented here should be interpreted with some caution. The main caveat arises because of the unfortunate method, at least from the perspective of our identification strategy, in which the data were collected. Specifically, the data were collected in such a way as to make geography highly collinear with season, implying that geography is also a confounding factor. In theory, our difference-in-difference identification strategy can potentially difference out geographic confounding factors as well as seasonality confounding factors. However, it is important to remember that difference-in-difference estimators rely on a linearity assumption and this assumption becomes more important as the role of underlying confounding factors become larger. Given the large differences by geography, our results must be interpreted somewhat cautiously.

Although we also examine the impact of NSLP on dietary outcomes, our results for the NSLP are more suspect. Our identification strategy for the SBP program relied on SBP not being available in enough locations so that we would have the statistical power for our difference-in-difference methodology. As noted our proposal to USDA, NSLP is too widely available to support a similar methodology. We had hoped to use the relatively high-income children as a potential differencing group so that we could examine the NSLP, but our results for the SBP suggest that such a strategy is not feasible. Quite simply, we observed an impact of the SBP on the high-income children.

Overall, we consider this research project to be very successful. First, we utilized a transparent identification strategy to examine the impacts of the school nutrition programs. Second, we have laid out the importance of examining school nutrition programs from a family perspective, as is commonly done in the developing literature, if we hope to obtain an accurate measure of their potential impacts. Third, we have also demonstrated that direct, physical measures can be used when analyzing the programs. The use of these measures can provide solid measures of potential impacts.

Although our results should be interpreted cautiously because of the data collection methodology of the NHANES III, we note that the next round of the NHANES data (NHANES IV) is now available. These new data were collected following different protocols, which should make geography less important. In addition, several changes were made to the school nutrition programs during the mid-1990s. The NHANES IV were collected after these changes, and thus, the data will provide a more up-to-date picture of the performance of the school nutrition programs.

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Table 1: Federal expenditures on the largest U.S. food and nutrition programs

Programs	1999 federal expenditures (billions)
Food Stamps	20.31
School nutrition programs	7.60
School Lunch Program (SLP)	6.25
School Breakfast Program (SBP)	1.35
Woman, Infants, and Children (WIC)	3.96

Notes: U.S. House of Representatives, Committee on Ways and Means 2000.

Table 2: Descriptive Statistics for Children in Primary Sample

	Eligible for free meals (IPR<=1.3)	Eligible for reduced-price meals (1.3 <IPR<=1.85)	Ineligible for subsidized meals (1.85<IPR)	Income information not provided
Sample Size	2,245	646	1,578	372
Male (1=yes)	0.487	0.491	0.529	0.589
Non-Hisp. white (1=yes)	0.454	0.661	0.804	0.467
Non-Hisp. black (1=yes)	0.262	0.167	0.080	0.195
Hispanic (1=yes)	0.230	0.128	0.076	0.241
Age	10.5	10.7	10.9	11.2
Food stamp receipt (1=yes)	0.549	0.076	0.013	0.190
School information				
School in session (1=yes)	0.748	0.724	0.746	0.624
SBP available (1=yes)	0.673	0.590	0.406	0.450
NSLP available (1=yes)	0.961	0.945	0.913	0.921
Dietary recall				
Eat brk. everyday[a] (1=yes)	0.842	0.799	0.884	0.785
HEI score	63.1	61.3	64.1	60.7
Total cals	2117	2173	2147	2103
% cals from fat	33.8	34.6	33.0	35.1
% cals from sat. fat	12.3	12.4	11.9	12.9
Low mag. intake (1=yes)	0.444	0.521	0.480	0.561
Low zinc intake (1=yes)	0.307	0.322	0.348	0.286
Exam measures				
Low vitamin A (1=yes)	0.097	0.109	0.050	0.052
Low vitamin C (1=yes)	0.031	0.038	0.037	0.048
Low vitamin E (1=yes)	0.004	0.010	0.004	0.005
Low folate (1=yes)	0.062	0.044	0.061	0.063
Low any ACEF[b] (1=yes)	0.175	0.182	0.135	0.144
Anemic (1=yes)	0.040	0.029	0.023	0.018
High cholesterol (1=yes)	0.115	0.077	0.095	0.146

Notes: Author's tabulations from the NHANES. All means are weighted. [a] The question regarding breakfast consumption is only available for children under 12. [b] The variable "Low any ACEF" is an indicator variable for whether someone is low vitamins A, C, E or folate.

Table 3: Difference-in-Difference Estimates of SBP Availability for Children

	SBP available			SBP not available			
	School in	School out	Diff.	School in	School out	Diff	Diff-in-diff
Observations	2754	471		1263	353		
Male	0.509	0.500		0.541	0.478		
Non-Hisp. White	0.534	0.565		0.751	0.881		
Non-Hisp. Black	0.231	0.216		0.078	0.058		
Hispanic	0.191	0.110		0.127	0.040		
Age	10.7	10.8		10.9	10.7		
Income-pov. ratio	1.85	1.76		2.69	2.47		
Share income N/A	0.036	0.066		0.047	0.072		
Food Stamp receipt	0.262	0.309		0.103	0.114		
Dietary recall							
Eats brk. everyday	0.844	0.809	0.035	0.876	0.873	0.003	0.032
HEI score	63.0	60.9	2.1	63.6	64.7	-1.1	3.2*
Total cals	2108	2247	-139	2125	2178	-53	-86
% cals from fat	34.0	34.7	-0.7	33.1	32.5	0.6	-1.3+
% cals from sat. fat	12.4	12.3	0.1	11.9	11.7	0.220	-0.1
Low mag. intake	0.491	0.464	0.027	0.481	0.450	0.031	-0.004
Low zinc intake	0.317	0.319	-0.002	0.360	0.301	0.059	-0.061
Exam measures							
Low vitamin A	0.093	0.054	0.039	0.062	0.052	0.010	0.029
Low vitamin C	0.034	0.070	-0.036	0.035	0.017	0.018	-0.055**
Low vitamin E	0.005	0.010	-0.005	0.005	0.000	0.005	-0.010
Low folate	0.064	0.081	-0.017	0.058	0.031	0.027	-0.044+
Low any (ACEF)	0.177	0.192	-0.015	0.140	0.094	0.047	-0.062+
Anemic	0.036	0.026	0.010	0.022	0.025	-0.003	0.013
High cholesterol	0.105	0.139	-0.034	0.081	0.109	-0.028	-0.006

Notes: Author's tabulations from the NHANES. All means are weighted; statistical tests take into account the complex survey design.

Significance: + at 0.10 level. * at 0.05 level. ** at 0.01 level.

Table 4: Regression Estimates of SBP Availability for Children, Dietary Recall Measures

	Eat brk everyday	HEI score	Total calories	% cals from fat	% cals from sat. fat	Low mag. intake	Low zinc intake
Sbav*inschool	0.04	3.89	-0.40	-2.04	-0.35	-0.00	-0.07
	(0.05)	(1.18)**	(99.82)	(0.73)**	(0.48)	(0.03)	(0.04)
Sbav	-0.01	-3.30	63.71	2.11	0.64	0.01	0.02
	(0.04)	(1.06)**	(89.36)	(0.54)**	(0.38)	(0.03)	(0.03)
Inschool	0.01	-0.86	-64.04	0.49	0.21	0.01	0.04
	(0.03)	(0.95)	(81.24)	(0.68)	(0.33)	(0.03)	(0.03)
Male	-0.06	-1.58	47.32	1.52	-0.14	0.03	0.00
	(0.03)*	(0.72)*	(42.29)	(0.47)**	(0.22)	(0.02)	(0.03)
NH-black	-0.03	0.15	-46.06	-0.15	-0.12	-0.02	0.01
	(0.03)	(0.97)	(65.20)	(0.63)	(0.29)	(0.02)	(0.03)
Hispanic	-0.00	3.69	174.34	-1.59	-0.33	-0.01	-0.09
	(0.05)	(1.67)*	(132.27)	(0.88)+	(0.48)	(0.06)	(0.05)
Other	0.03	0.01	561.34	-0.23	0.13	-0.12	-0.15
	(0.02)	(0.48)	(45.82)**	(0.39)	(0.17)	(0.02)**	(0.02)**
Obs.	3087	4841	4841	4841	4841	4841	4841
R-square	0.05	0.11	0.16	0.05	0.04	0.32	0.13

Notes: Author's tabulations from the NHANES. The regressions take into account the complex survey design. The other control variables include household size and indicator variables for age, income groups, and urban*census region.

Significance: + 0.10 level. * 0.05 level. ** 0.01 level.

Table 5: Regression Estimates of SBP Availability for Children, Exam Measures

	Low vit A	Low vit C	Low vit E	Low folate	Low ACEF	Anemic	High Chol
Sbav*inschool	0.01	-0.07	-0.01	-0.06	-0.10	0.01	-0.01
	(0.02)	(0.02)**	(0.01)+	(0.03)*	(0.04)**	(0.02)	(0.03)
Sbav	-0.00	0.06	0.01	0.04	0.09	-0.01	0.02
	(0.02)	(0.01)**	(0.01)+	(0.02)	(0.03)**	(0.01)	(0.03)
Inschool	0.01	0.02	0.00	0.02	0.04	-0.01	-0.04
	(0.02)	(0.01)*	(0.00)	(0.01)	(0.02)+	(0.01)	(0.02)+
Male	0.03	-0.04	0.00	0.03	0.03	0.07	0.07
	(0.01)*	(0.01)**	(0.00)	(0.01)*	(0.02)	(0.01)**	(0.02)**
NH-black	0.02	-0.03	0.00	-0.00	-0.01	0.00	0.02
	(0.01)	(0.01)*	(0.00)	(0.01)	(0.02)	(0.01)	(0.02)
Hispanic	-0.01	-0.06	-0.01	-0.03	-0.08	0.02	0.00
	(0.03)	(0.02)**	(0.00)	(0.02)	(0.03)*	(0.02)	(0.05)
Other	0.01	0.01	-0.00	-0.02	-0.00	-0.03	-0.01
	(0.01)	(0.01)	(0.00)	(0.01)*	(0.02)	(0.01)**	(0.01)
Obs.	4841	4150	4841	4836	4841	4841	4834
R-square	0.11	0.06	0.01	0.11	0.07	0.05	0.03

Notes: Author's tabulations from the NHANES. The regressions take into account the complex survey design. The other control variables include household size and indicator variables for age, income groups, and urban*census region.

Significance: + 0.10 level. * 0.05 level. ** 0.01 level.

Table 6: Regression Estimates of SBP Availability for Children, Dietary Recall Measures

	Eat brk everyday	HEI score	Total calories	% cals from fat	% cals from sat. fat	Low mag. intake	Low zinc intake
Sbav*inschool*	0.13	3.37	44.85	-0.97	-0.46	-0.02	0.03
low income	(0.09)	(2.50)	(213.86)	(1.51)	(0.63)	(0.08)	(0.08)
Sbav*inschool*	-0.07	1.51	-467.3	-2.57	0.43	0.15	-0.01
med. income	(0.19)	(1.71)	(313.57)	(1.81)	(0.71)	(0.17)	(0.10)
Sbav*inschool*	0.07	4.4	205.94	-3.11	-0.7	-0.03	-0.21
high income	(0.10)	(1.90)*	(176.65)	(1.04)**	(0.73)	(0.08)	(0.07)**
Sbav*inschool*	-0.1	6.47	45.85	-0.88	-0.53	-0.1	0.29
inc. unknown	(0.27)	(5.12)	(448.57)	(2.24)	(1.60)	(0.21)	(0.16)+
Observations	3087	4841	4841	4841	4841	4841	4841
R-squared	0.06	0.11	0.16	0.05	0.05	0.33	0.14

Notes: Author's tabulations from the NHANES. The regressions take into account the complex survey design. The other control variables include household size and indicator variables for age, income groups, and urban*census region.

Significance: + 0.10 level. * 0.05 level. ** 0.01 level.

Table 7: Regression Estimates of SBP Availability for Children, Exam Measures

	Low vit A	Low vit C	Low vit E	Low folate	Low ACEF	Anemic	High Chol
Sbav*inschool*	-0.02	-0.02	-0.02	-0.04	-0.12	0.01	-0.01
low income	(0.03)	(0.04)	(0.02)	(0.04)	(0.05)*	(0.03)	(0.05)
Sbav*inschool*	0.06	-0.14	-0.02	0.01	-0.09	0.01	0.08
med. income	(0.09)	(0.09)	(0.02)	(0.04)	(0.11)	(0.05)	(0.07)
Sbav*inschool*	0.01	-0.06	-0.06	-0.09	-0.13	0.02	-0.04
high income	(0.03)	(0.03)+	(0.03)+	(0.05)+	(0.05)*	(0.02)	(0.05)
Sbav*inschool*	0.01	-0.05	-0.03	-0.16	-0.18	0.01	-0.05
inc. unknown	(0.05)	(0.08)	(0.02)	(0.08)+	(0.09)+	(0.03)	(0.10)
Observations	4841	4150	4841	4836	4841	4776	4834
R-squared	0.11	0.07	0.03	0.12	0.07	0.05	0.03

Notes: Author's tabulations from the NHANES. The regressions take into account the complex survey design. The other control variables include household size and indicator variables for age, income groups, and urban*census region.

Significance: + 0.10 level. * 0.05 level. ** 0.01 level.

Table 8: Regression Estimates of SBP Availability for Children, Excluding Highest Income Families

Panel A: Key Dietary Recall Measures

	HEI score	HEI score	Total calories	Total calories	% cals from fat	% cals from fat	% cals from s.f.	% cals from s.f.
sbav*inschool	3.68		-120.28		-2.50		-0.56	
	(1.20)**		(126.38)		(0.69)**		(0.44)	
sbav*inschool*		3.5		7.4		-0.99		-0.58
low income		(2.52)		(216.3)		(1.51)		(0.62)
sbav*inschool*		2.39		-598.6		-3.37		0.11
med. income		(1.70)		(331.7)+		(1.66)*		(0.70)
sbav*inschool*		5.81		129.0		-6.48		-1.86
high income		(1.93)**		(180.7)		(1.97)**		(0.77)*
sbav*inschool*		5.71		-10.3		-0.75		-0.49
unknown		-5.08		-460.9		-2.23		-1.58
Obs.	3852	3852	3852	3852	3852	3852	3852	3852
R-square	0.11	0.12	0.15	0.16	0.04	0.05	0.03	0.04

Panel B: Key Exam Measures

	Low vit C	Low vit C	Low vit E	Low vit E	Low folate	Low folate	High chol.	High chol.
sbav*inschool	-0.07		-0.03		-0.05		-0.02	
	(0.02)**		(0.01)+		(0.03)		(0.03)	
sbav*inschool*		-0.03		-0.02		-0.04		-0.02
low income		(0.04)		(0.02)		(0.04)		(0.06)
sbav*inschool*		-0.15		-0.02		0.01		0.08
med. income		(0.10)		(0.02)		(0.04)		(0.07)
sbav*inschool*		-0.03		-0.06		-0.09		-0.15
high income		(0.03)		(0.03)+		(0.07)		(0.06)*
sbav*inschool*		-0.05		-0.03		-0.17		-0.04
unknown		-0.07		-0.02		(0.08)*		-0.1
Obs.	3275	3275	3852	3852	3848	3848	3846	3846
R-square	0.06	0.08	0.02	0.03	0.11	0.12	0.04	0.04

Notes: Author's tabulations from the NHANES. The regressions take into account the complex survey design. The other control variables include household size and indicator variables for age, income groups, and urban*census region.

Significance: + 0.10 level. * 0.05 level. ** 0.01 level.

Table 9: Sample Size of Children by Census Region and Season

Census region	Winter	Spring	Summer	Fall	Row totals
Northeast	0	20	276	198	494
Midwest	0	312	508	34	854
South + Texas	799	263	44	1,030	2,136
West	521	747	66	23	1,357
Column totals	1,320	1,342	894	1,285	4,841

Notes: Author’s tabulations form the NHANES. The sample includes all children used in the primary analysis.

Table 10: Regression Estimates of SBP Availability for Children, Excluding Highest Income, South, and West Families

Panel A: Key Dietary Recall Measures

	HEI score	HEI score	Total calories	Total calories	% cals from fat	% cals from fat	% cals from s.f.	% cals from s.f.
Sbav*inschool	1.7		-3.95		-1.5		-0.07	
	(1.54)		(177.88)		(1.26)		(0.48)	
Sbav*inschool*		-2.36		145.9		0.86		-0.1
low income		(3.08)		(241.6)		(2.00)		(0.74)
Sbav*inschool*		1.51		32.0		-2.7		0.36
med. income		(2.65)		(355.6)		(2.23)		(0.70)
Sbav*inschool*		10.66		324.0		-6.12		-1.01
high income		(2.24)**		(179.0)+		(2.84)*		(1.64)
Sbav*inschool*		-4.5		-1181.9		2.5		0.45
unknown		-4.54		(412.3)*		-3.2		-1.92
Obs.	1012	1012	1012	1012	1012	1012	1012	1012
R-square	0.11	0.14	0.19	0.22	0.10	0.12	0.09	0.10

Panel B: Key Exam Measures

	Low vit C	Low vit C	Low vit E	Low vit E	Low folate	Low folate	High chol.	High chol.
Sbav*inschool	-0.07		-0.05		-0.05		0.01	
	(0.03)+		(0.02)*		(0.04)		(0.04)	
Sbav*inschool*		-0.01		-0.13		-0.06		0.11
low income		(0.05)		(0.06)*		(0.07)		(0.07)
Sbav*inschool*		-0.24		0.04		0.05		0.07
med. income		(0.15)		(0.03)		(0.05)		(0.09)
Sbav*inschool*		-0.05		-0.02		-0.14		-0.26
high income		(0.05)		(0.02)		(0.11)		(0.07)**
Sbav*inschool*		-0.08		-0.02		-0.16		-0.02
unknown		-0.09		-0.04		-0.12		-0.14
Obs.	895	895	1012	1012	1009	1009	1011	1011
R-square	0.11	0.17	0.11	0.14	0.18	0.20	0.05	0.07

Notes: Author’s tabulations from the NHANES. The regressions take into account the complex survey design. The other control variables include household size and indicator variables for age, income groups, and urban*census region.

Significance: + 0.10 level. * 0.05 level. ** 0.01 level.

Table 11: Difference-in-Difference Estimates of NSLP Availability for Children

	NSLP available, IPR<=1.3			NSLP available, IPR>1.85			
	School in	School out	Diff.	School in	School out	Diff	Diff-in-diff
Observations	1,867	312		1,164	282		
Male	0.481	0.444		0.535	0.512		
Non-Hisp. White	0.387	0.609		0.785	0.870		
Non-Hisp. Black	0.286	0.212		0.088	0.070		
Hispanic	0.280	0.102		0.082	0.028		
Age	10.6	10.3		11.0	11.2		
Food Stamp receipt	0.555	0.576		0.012	0.020		
Dietary recall							
HEI score	63.3	62.7	0.6	63.6	64.5	-0.9	1.5
Total cals	2052	2286	-234	2156	2214	-58	-176
% cals from fat	33.9	33.2	0.7	33.3	32.9	0.4	0.3
% cals from sat. fat	12.4	11.8	0.6	12.1	11.7	0.4	0.2
Low mag. intake	0.465	0.428	0.037	0.495	0.460	0.035	0.002
Low zinc intake	0.311	0.301	0.010	0.345	0.318	0.027	-0.017
Exam measures							
Low vitamin A	0.097	0.070	0.027	0.058	0.035	0.023	0.004
Low vitamin C	0.025	0.052	-0.027	0.042	0.034	0.008	-0.035
Low vitamin E	0.030	0.011	0.019	0.006	0.022	-0.016	0.035*
Low folate	0.068	0.050	0.018	0.064	0.072	-0.008	0.026
Low any (ACEF)	0.195	0.159	0.036	0.150	0.133	0.017	0.019
Anemic	0.045	0.033	0.012	0.023	0.023	0.000	0.012
High cholesterol	0.120	0.113	0.007	0.086	0.100	-0.014	0.021

Notes: Author’s tabulations from the NHANES. All means are weighted; statistical tests take into account the complex survey design.

Significance: + at 0.10 level. * at 0.05 level. ** at 0.01 level.

Table 12: Difference-in-Difference Estimates of SBP Availability for Adults

	SBP available			SBP not available			
	School in	School out	Diff.	School in	School out	Diff	Diff-in-diff
Observations	1946	317		873	242		
Male	0.452	0.444		0.494	0.465		
Non-Hisp. White	0.583	0.657		0.782	0.878		
Non-Hisp. Black	0.190	0.187		0.066	0.059		
Hispanic	0.185	0.076		0.101	0.045		
Age	37.4	37.7		38.7	38.1		
Income-pov. Ratio	2.13	2.17		3.09	2.60		
Food Stamp receipt	0.197	0.176		0.076	0.058		
Dietary recall							
HEI score	60.4	59.9	0.5	62.8	64.2	-1.4	1.9
Total cals	2242	2302	-60	2294	2350	-56	-4
% cals from fat	33.7	34.0	-0.3	34.0	33.2	0.8	-1.1
% cals from sat. fat	11.3	11.2	0.1	11.7	11.3	0.4	-0.3
Exam measures							
Low vitamin C	0.210	0.153	0.057	0.170	0.113	0.057	0.000
Low folate	0.269	0.243	0.026	0.245	0.229	0.016	0.010
Low any (CF)	0.390	0.291	0.099	0.314	0.272	0.042	0.057
Anemic	0.065	0.069	-0.004	0.048	0.076	-0.028	0.024
High cholesterol	0.463	0.482	-0.019	0.484	0.448	0.036	-0.055

Notes: Author’s tabulations from the NHANES. All means are weighted; statistical tests take into account the complex survey design.

Significance: + at 0.10 level. * at 0.05 level. ** at 0.01 level.

Table 13: Regression Estimates of SBP Availability for Adults

Panel A: Key Dietary Recall Measures

	HEI score	HEI score	Total calories	Total calories	% cals from fat	% cals from fat	% cals from s.f.	% cals from s.f.
Sbav*inschool	3.59		55		-2.66		-0.45	
	(1.28)**		(131)		(1.46)+		(0.65)	
Sbav*inschool*		4.25		204		1.25		0.38
low income		(2.63)		(277)		(1.99)		(1.07)
Sbav*inschool*		5.54		328		-5.32		-1.95
med. income		(3.37)		(217)		(2.44)*		(1.14)+
Sbav*inschool*		3.49		4.00		-3.09		-0.14
high income		(1.74)+		(150)		(1.76)+		(0.76)
Sbav*inschool*		-2.06		-88		-2.73		-1.38
unknown		(3.85)		(526)		(3.37)		(1.35)
Obs.	3378	3378	3378	3378	3378	3378	3378	3378
R-square	0.11	0.11	0.22	0.23	0.10	0.10	0.09	0.10

Panel B: Key Exam Measures

	Low vit C	Low vit C	Low folate	Low folate	Anemic	Anemic	High chol.	High chol.
Sbav*inschool	-0.06		-0.04		0.02		-0.04	
	(0.05)		(0.08)		(0.03)		(0.09)	
Sbav*inschool*		-0.14		-0.11		-0.05		0.04
low income		(0.07)+		(0.10)		(0.06)		(0.12)
Sbav*inschool*		-0.02		-0.16		-0.10		-0.07
med. income		(0.08)		(0.14)		(0.09)		(0.11)
Sbav*inschool*		-0.03		0.01		0.06		-0.07
high income		(0.08)		(0.08)		(0.04)		(0.09)
Sbav*inschool*		0.10		0.12		0.00		-0.15
unknown		(0.14)		(0.14)		(0.08)		(0.25)
Obs.	3263	3263	3376	3376	3337	3337	3374	3374
R-square	0.11	0.11	0.08	0.08	0.10	0.11	0.10	0.10

Notes: Author's tabulations from the NHANES. The regressions take into account the complex survey design. The other control variables include household size and indicator variables for age, income groups, and urban*census region.

Significance: + 0.10 level. * 0.05 level. ** 0.01 level.

Table 14: Regression Estimates of SBP Availability for Adults, Excluding Highest Income, South, and West Families

Panel A: Key Dietary Recall Measures

	HEI score	HEI score	Total calories	Total calories	% cals from fat	% cals from fat	% cals from s.f.	% cals from s.f.
Sbav*inschool	0.54		807		-0.32		0.05	
	(2.79)		(234)**		(2.23)		(0.90)	
Sbav*inschool* low income		0.16		1,152		1.94		0.70
		(4.03)		(347)**		(3.74)		(1.74)
Sbav*inschool* med. income		-1.89		850		-2.59		-0.81
		(3.33)		(357)*		(2.88)		(1.05)
Sbav*inschool* high income		1.63		504		2.90		1.45
		(7.24)		(262)+		(4.27)		(1.91)
Sbav*inschool* unknown		-1.40		675		-2.76		0.78
		(6.08)		(691)		(3.39)		(1.54)
Obs.	636	636	636	636	636	636	636	636
R-square	0.23	0.24	0.32	0.33	0.15	0.17	0.15	0.17

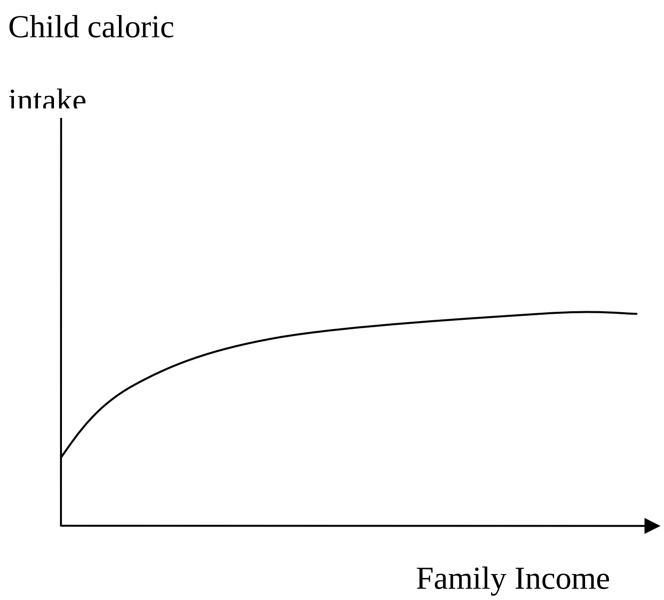
Panel B: Key Exam Measures

	Low vit C	Low vit C	Low folate	Low folate	Anemic	Anemic	High chol.	High chol.
Sbav*inschool	-0.10		-0.07		-0.01		-0.02	
	(0.09)		(0.15)		(0.04)		(0.08)	
Sbav*inschool* low income		-0.27		-0.23		0.03		0.19
		(0.13)+		(0.17)		(0.04)		(0.09)+
Sbav*inschool* med. income		-0.16		-0.08		-0.21		-0.30
		(0.12)		(0.21)		(0.12)+		(0.15)+
Sbav*inschool* high income		0.09		0.40		-0.01		0.18
		(0.17)		(0.28)		(0.08)		(0.23)
Sbav*inschool* unknown		0.31		-0.11		0.15		-0.38
		(0.24)		(0.23)		(0.17)		(0.22)
Obs.	626	626	636	636	630	630	636	636
R-square	0.18	0.21	0.14	0.16	0.22	0.24	0.21	0.23

Notes: Author's tabulations from the NHANES. The regressions take into account the complex survey design. The other control variables include household size and indicator variables for age, income groups, and urban*census region.

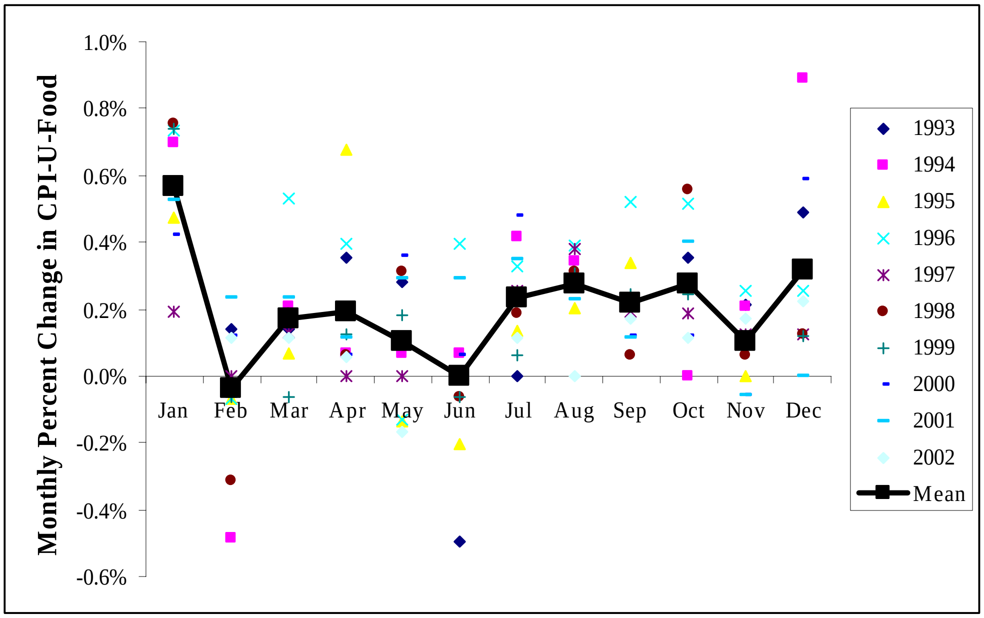
Significance: + 0.10 level. * 0.05 level. ** 0.01 level.

Figure 1: A Stylized Engel Curve for Child Caloric Intake



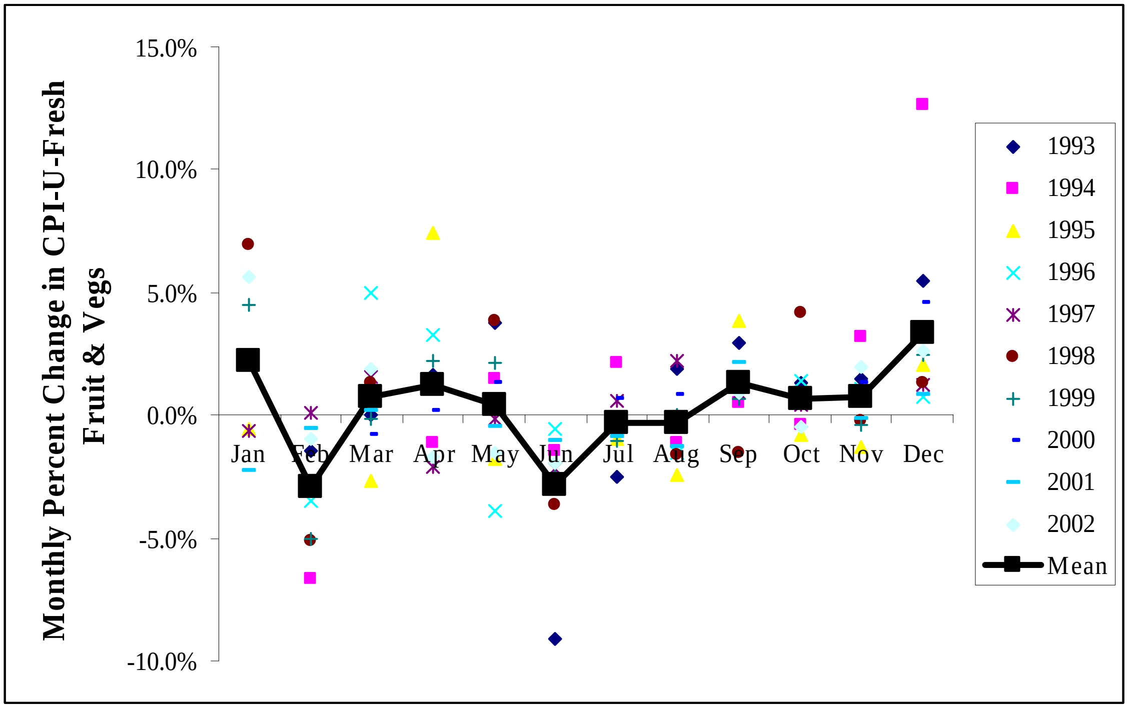
Notes: This figure represents a stylized Engel Curve for child caloric intake.

Figure 2: Monthly Variation in the CPI-U, Total Food Component



Notes: This figure graphs the percent change of the total food component of the CPI-U from the previous month to the current month.

Figure 3: Monthly Variation in the CPI-U, Fresh Fruit and Vegetables Component



Notes: This figure graphs the percent change of the fresh fruit and vegetables component of the CPI-U from the previous month to the current month.

Appendix

A.1. Variable Construction

We use several outcome measures that are based on dietary recall data, all of which are based on computations by the NHANES. The first is the Healthy Eating Index (HEI), which is a summary measure of the overall dietary quality. The underlying ten components and cut-offs are listed in Table A1. The second is the caloric content of the 24-hour dietary recall data, which is based on a recipe analysis. Low magnesium intake and low zinc intake are based on intake levels also determined by the recipe analysis of the 24-hour dietary recall data; the cut-offs for low intake are listed in Table A2.

We use several outcomes measures that are based on the laboratory analysis of blood. We construct measures of low vitamins A, C, and E, folate, and high cholesterol based on serum measures. We create a measure of anemia based on hemoglobin and hematocrit levels. The cut-offs for each of these assessments are presented in Table A3. Although blood was potentially taken from individuals of all analyzed in our sample, vitamin C levels were not reported for children under 6. We do not analyze vitamin E for individuals over 16.

A.2. Empirical Nutrition-Income Relationships

Figures A1 and A2 present the underlying relationship between various nutrition measures and the income-to-poverty ratio in our data. For children in our primary sample (Figure A1), the relationship is fairly monotonic at low levels of income for both being low in vitamins and minerals (A, C, E, and folate) and caloric intake. For 18-39 year olds (Figure A2), the relationships are much simpler, suggesting that the detection of beneficial effects may be easier for adults than for children.

A.3. Unweighted Regression Results

In Tables A3 to A6, we present many of the key results for children and adults based on unweighted regressions. Given that we control for many of the factors over which the over-sampling occurred (race, income, age, and geography), some economists argue that weights should not be used (for example, see DuMouchel and Duncan 1983). From comparing the unweighted results to the weighted results reported in the text, none of our basic conclusions would change.

We choose to use weights for our main results for several reasons. First, we do not control exactly for the sampling variables. For example, only census region is provided in the public release data. Second, to illustrate our identification strategy, we report means, which must be weighted. For consistency, we choose to weight throughout. Third, it is more efficient to weight for correctly specified models (Wooldridge 2002).

Table A1: Components of the Healthy Eating Index

Component	Criteria for Score of 0	Criteria for Score of 10
1. Grains	0 servings	6–11 servings*
2. Vegetables	0 servings	3–5 servings
3. Fruits	0 servings	2–4 servings
4. Milk	0 servings	2–3 servings
5. Meat	0 servings	2–3 servings
6. Total fat	>44% calories from fat	<31% calories from fat
7. Saturated fat	>14% calories from s.f.	<10% calories from s.f.
8. Cholesterol	>449 mg	<300 mg
9. Sodium	>4,799 mg	<2,400 mg
10. Variety	<4 different categories a day	>7 different categories a day

Notes: This table is taken from the NHANES III manual. People with consumption or intakes between the maximum and minimum ranges or amounts were assigned scores proportionately.

Table A2: Criteria for Nutrition Measures

Outcome	Age/Gender	Criteria for Inadequacy
Laboratory Measures		
Anemia	0–12	hemoglobin < 11.5 g/dL and hematocrit < 35%
	13–17	hemoglobin < 12 g/dL and hematocrit < 37%
	>17/Female	hemoglobin < 12 g/dL and hematocrit < 36%
	>17/Male	hemoglobin < 13 g/dL and hematocrit < 39%
High blood cholesterol		Serum cholesterol >= 200 mg/dL.
Low vitamin A	0–11	< 1.05 μmol/L
	>11	< 0.7 μmol/L
Low vitamin C	6 and above	< 11.4 μmol/L
Low vitamin E	4-16	< 11.6 μmol/L
Low folate	4 and above	< 7 nmol/L
Dietary Recall Measures		
Low magnesium intake	5-8	< 130 mg/day
	9-13	< 240 mg/day
	14-18/Female	< 360 mg/day
	14-18/Male	< 410 mg/day
	19-30/Female	< 310 mg/day
	19-30/Male	< 400 mg/day
	31-60/Female	< 320 mg/day
	31-60/Male	< 420 mg/day
Low zinc intake	5-8	< 5 mg/day
	9-13	< 8 mg/day
	14-18/Female	< 9 mg/day
	19-60/Female	< 8 mg/day
	14-60/Male	< 11 mg/day

Notes: All laboratory measure values were taken from Wilson et al. (1991). Dietary recall measures were taken from the *Dietary Reference Intake* reports produced by the National Academy of Sciences, summarized in tables on the USDA Food and Nutrition Information Center website (http://www.nal.usda.gov/fnic/etext/000105.html).

Table A3: Unweighted Regression Estimates of SBP Availability for Children

Panel A: Key Dietary Recall Measures

	HEI score	HEI score	Total calories	Total calories	% cals from fat	% cals from fat	% cals from s.f.	% cals from s.f.
sbav*inschool	2.92		98.21		-0.52		0.01	
	(0.94)**		(66.75)		(0.61)		(0.28)	
sbav*inschool*		2.78		110.25		0.66		0.36
low income		(1.32)*		(94.03)		(0.86)		(0.40)
sbav*inschool*		3.01		83.96		-2.12		-0.04
med. income		(1.96)		(139.49)		(1.27)+		(0.59)
sbav*inschool*		2.84		112.19		-1.95		-0.41
high income		(1.46)+		(104.01)		(0.95)*		(0.44)
sbav*inschool*		-1.40		150.45		1.50		0.14
unknown		(3.11)		(221.44)		(2.02)		(0.94)
Obs.	4841	4841	4841	4841	4841	4841	4841	4841
R-square	0.10	0.10	0.11	0.11	0.04	0.04	0.02	0.02

Panel B: Key Exam Measures

	Low vit C	Low vit C	Low vit E	Low vit E	Low folate	Low folate	High chol.	High chol.
sbav*inschool	-0.02		-0.01		-0.01		-0.04	
	(0.01)+		(0.01)+		(0.02)		(0.03)	
sbav*inschool*		0.01		0.01		0.03		-0.03
low income		(0.02)		(0.01)		(0.03)		(0.04)
sbav*inschool*		-0.07		-0.01		0.03		-0.07
med. income		(0.03)*		(0.02)		(0.04)		(0.05)
sbav*inschool*		-0.03		-0.03		-0.06		-0.06
high income		(0.02)		(0.01)*		(0.03)+		(0.04)
sbav*inschool*		-0.05		-0.09		-0.13		-0.00
unknown		(0.05)		(0.03)**		(0.06)*		(0.08)
Obs.	4150	4150	4841	4841	4836	4836	4834	4834
R-square	0.04	0.04	0.02	0.02	0.09	0.09	0.02	0.02

Notes: Author’s tabulations from the NHANES. The other control variables include household size and indicator variables for age, income groups, and urban*census region.

Significance: + 0.10 level. * 0.05 level. ** 0.01 level.

Table A4: Unweighted Regression Estimates of SBP Availability for Children, Excluding Highest Income, South, and West Families

Panel A: Key Dietary Recall Measures

	HEI score	HEI score	Total calories	Total calories	% cals from fat	% cals from fat	% cals from s.f.	% cals from s.f.
sbav*inschool	1.77		231.3		0.46		0.06	
	(1.56)		(118.)+		(1.03)		(0.46)	
sbav*inschool*		0.74		276.5		2.09		0.40
low income		(2.06)		(157.5)+		(1.37)		(0.61)
sbav*inschool*		2.81		317.7		-2.22		-0.49
med. income		(3.31)		(252.9)		(2.20)		(0.98)
sbav*inschool*		5.70		287.6		-3.68		-1.49
high income		(3.64)		(278.1)		(2.42)		(1.08)
sbav*inschool*		-3.95		-173.6		2.81		0.68
unknown		(4.92)		(375.4)		(3.26)		(1.46)
Obs.	1012	1012	1012	1012	1012	1012	1012	1012
R-square	0.12	0.13	0.11	0.11	0.05	0.06	0.03	0.03

Panel B: Key Exam Measures

	Low vit C	Low vit C	Low vit E	Low vit E	Low folate	Low folate	High chol.	High chol.
sbav*inschool	-0.06		-0.02		-0.01		-0.09	
	(0.02)**		(0.01)*		(0.03)		(0.04)*	
sbav*inschool*		-0.07		-0.01		0.01		-0.01
low income		(0.03)*		(0.02)		(0.04)		(0.06)
sbav*inschool*		-0.14		0.01		0.06		-0.15
med. income		(0.05)**		(0.03)		(0.06)		(0.09)+
sbav*inschool*		-0.04		-0.02		-0.00		-0.25
high income		(0.06)		(0.03)		(0.07)		(0.10)*
sbav*inschool*		-0.12		-0.15		-0.18		-0.12
unknown		(0.08)		(0.04)**		(0.09)*		(0.13)
Obs.	895	895	1012	1012	1009	1009	1011	1011
R-square	0.08	0.11	0.05	0.07	0.13	0.14	0.05	0.06

Notes: Author's tabulations from the NHANES. The other control variables include household size and indicator variables for age, income groups, and urban*census region.

Significance: + 0.10 level. * 0.05 level. ** 0.01 level.

Table A5: Unweighted Regression Estimates of SBP Availability for Adults

Panel A: Key Dietary Recall Measures

	HEI score	HEI score	Total calories	Total calories	% cals from fat	% cals from fat	% cals from s.f.	% cals from s.f.
sbav*inschool	3.55		25.12		-1.33		-0.50	
	(1.16)**		(90.36)		(0.89)		(0.38)	
sbav*inschool* low income		3.97		175.18		0.31		-0.11
		(1.73)*		(135.46)		(1.33)		(0.57)
sbav*inschool* med. income		3.95		80.10		-3.22		-0.97
		(2.55)		(199.39)		(1.96)		(0.83)
sbav*inschool* high income		2.56		-53.06		-1.47		-0.24
		(1.61)		(125.95)		(1.24)		(0.53)
sbav*inschool* unknown		-0.68		-157.89		1.52		0.36
		(3.92)		(305.81)		(3.01)		(1.28)
Obs.	3378	3378	3378	3378	3378	3378	3378	3378
R-square	0.07	0.08	0.18	0.18	0.05	0.06	0.04	0.05

Panel B: Key Exam Measures

	Low vit C	Low vit C	Low folate	Low folate	Anemic	Anemic	High chol.	High chol.
sbav*inschool	-0.04		-0.02		0.03		-0.03	
	(0.04)		(0.04)		(0.05)		(0.03)	
sbav*inschool* low income		-0.02		0.03		0.04		-0.07
		(0.05)		(0.06)		(0.07)		(0.04)
sbav*inschool* med. income		-0.02		-0.16		0.02		-0.06
		(0.08)		(0.10)+		(0.10)		(0.06)
sbav*inschool* high income		-0.08		-0.07		0.01		0.02
		(0.05)		(0.06)		(0.07)		(0.04)
sbav*inschool* unknown		0.02		0.22		0.22		-0.09
		(0.12)		(0.15)		(0.16)		(0.10)
Obs.	3263	3263	3376	3376	3374	3374	3337	3337
R-square	0.07	0.07	0.03	0.04	0.07	0.08	0.10	0.10

Notes: Author's tabulations from the NHANES. The regressions take into account the complex survey design. The other control variables include household size and indicator variables for age, income groups, and urban*census region.

Significance: + 0.10 level. * 0.05 level. ** 0.01 level.

Table A6: Unweighted Regression Estimates of SBP Availability for Adults, Excluding Highest Income, South, and West Families

Panel A: Key Dietary Recall Measures

	HEI score	HEI score	Total calories	Total calories	% cals from fat	% cals from fat	% cals from s.f.	% cals from s.f.
sbav*inschool	1.62		505		-0.03		-0.03	
	(2.02)		(170)**		(1.61)		(0.67)	
sbav*inschool*		2.36		667		1.85		0.12
low income		(2.92)		(247)**		(2.33)		(0.97)
sbav*inschool*		-2.70		356.07		0.39		0.25
med. income		(4.30)		(363.82)		(3.42)		(1.43)
sbav*inschool*		-0.24		317.29		0.09		0.98
high income		(4.33)		(366.38)		(3.45)		(1.44)
sbav*inschool*		2.98		365.15		-2.57		-0.60
unknown		(6.05)		(512.41)		(4.82)		(2.01)
Obs.	636	636	636	636	636	636	636	636
R-square	0.18	0.19	0.23	0.23	0.11	0.12	0.09	0.10

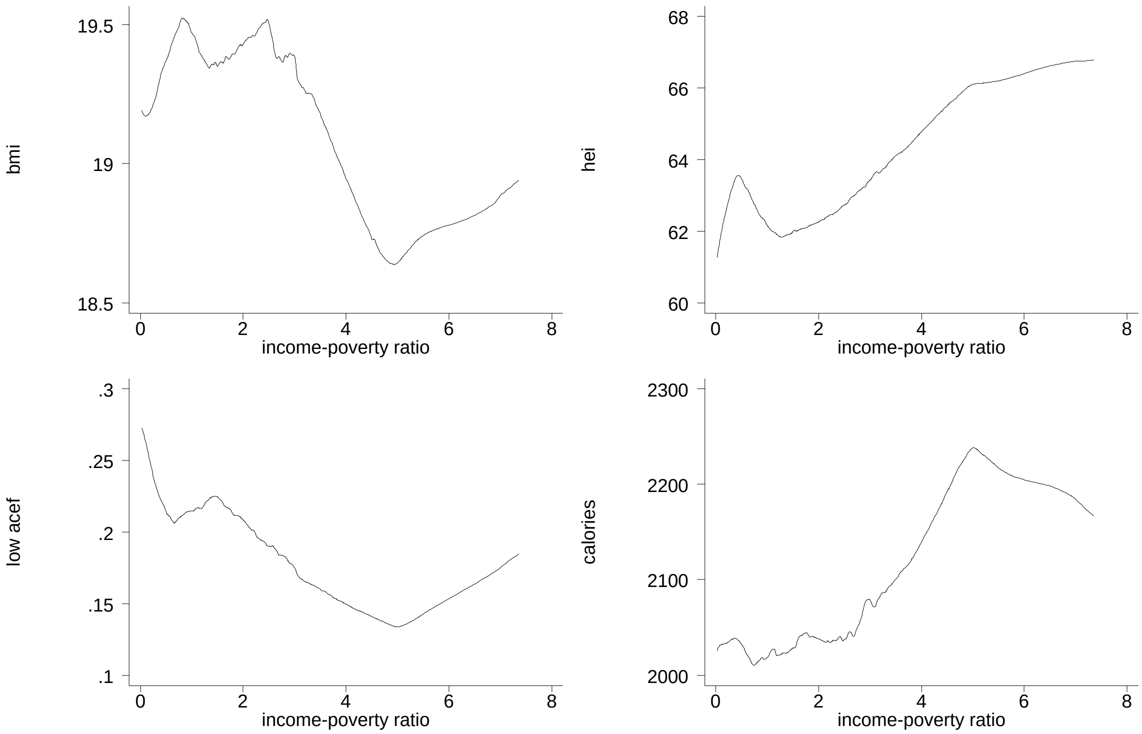
Panel B: Key Exam Measures

	Low vit C	Low vit C	Low folate	Low folate	Anemic	Anemic	High chol.	High chol.
sbav*inschool	-0.07		0.07		0.05		0.00	
	(0.06)		(0.07)		(0.08)		(0.05)	
sbav*inschool*		-0.15		-0.07		0.17		0.06
low income		(0.09)+		(0.11)		(0.12)		(0.08)
sbav*inschool*		-0.12		0.12		-0.07		-0.18
med. income		(0.13)		(0.16)		(0.17)		(0.11)
sbav*inschool*		-0.04		0.27		0.09		-0.04
high income		(0.13)		(0.16)+		(0.17)		(0.11)
sbav*inschool*		0.16		0.23		-0.04		0.04
unknown		(0.18)		(0.22)		(0.24)		(0.16)
Obs.	626	626	636	636	636	636	630	630
R-square	0.15	0.17	0.09	0.12	0.13	0.15	0.17	0.18

Notes: Author's tabulations from the NHANES. The regressions take into account the complex survey design. The other control variables include household size and indicator variables for age, income groups, and urban*census region.

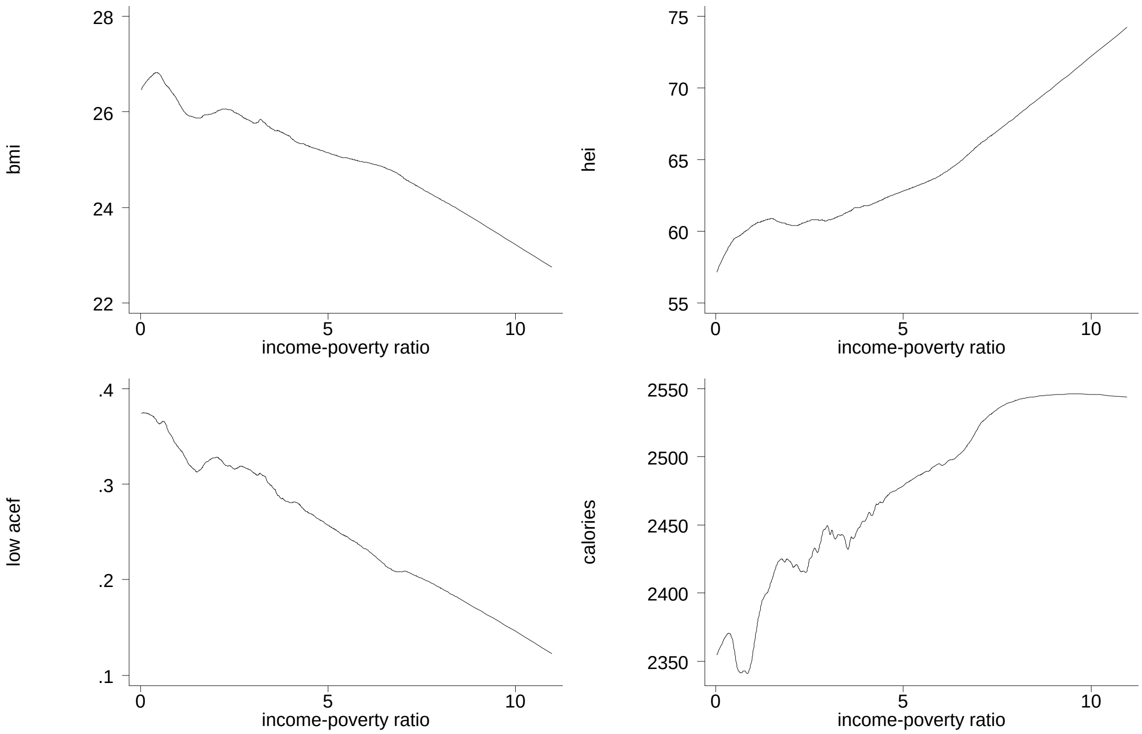
Significance: + 0.10 level. * 0.05 level. ** 0.01 level.

Figure A1: Empirical Nutrition to Income/Poverty Ratio Relationships, 5-16 Year Olds



Notes: These figures are based on the 4,481 children in the primary sample. They present the smoothed relationship based on a Lowess smoother with a bandwidth of 0.4.

Figure A2: Empirical Nutrition to Income/Poverty Ratio Relationships, 18-34 Year Olds



Notes: These figures are based on the 3,378 adults. They present the smoothed relationship based on a Lowess smoother with a bandwidth of 0.4.