Breakfast of Champions?

The School Breakfast Program and the Nutrition of Children and Families

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ABSTRACT

We examine the effect of the School Breakfast Program (SBP) availability with the National Health and Nutritional Examination Survey III. Our work builds on previous research by developing a transparent difference-in-differences strategy to account for unobserved differences between students with access to SBP and those without, using serum measures in addition to intake measures to assess the potential program effects, and examining program effects on other household members. Our results suggest that the SBP program improves the nutritional outcomes of the direct recipient across a wide array of different measures. Our results indicate fewer positive effects for other household members.

I. Introduction

"Hunger in America," a report issued by a group of physicians in 1968, documented appalling levels of malnutrition among poor children in America. The authors wrote that "Wherever we went and wherever we looked, whether it was the rural south, Appalachia, or an urban ghetto, we saw children in significant numbers

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who were hungry and sick, children for whom hunger was a daily fact of life and sickness in many forms, an inevitability" (U.S. Congress 1968).

School nutrition programs were one public initiative to combat the problem of widespread nutritional deficiencies. These programs are now second only to the Food Stamps Program in terms of federal expenditures on nutrition programs. The National School Lunch Program (NSLP) currently serves children in 98 percent of the nation's public schools. In contrast, the national School Breakfast Program (SBP) was offered in only 78.3 percent of the 97,674 schools that offered school lunch during the 2002–2003 school year, which represents a doubling in size since 1990 (U.S. Congress 2004). Several studies have linked poor nutrition to poor school performance (Middleman et al. 1996; Pollitt et al. 1998), and advocacy groups argue that school breakfast should be available to all children because skipping breakfast impairs a child's ability to learn (FRAC 2003).

Today, however, we hear more about the rising epidemic of obesity, even among young children, than about nutritional deficiencies. The poor are at a higher risk of obesity than the rich, hence the growth in obesity will exacerbate existing differences in health between rich and poor (Cutler, Glaeser, and Shapiro 2003). Some commentators blame federal nutrition programs for some of the growth in obesity among the poor, citing evidence that school meals, for example, exceed federal guidelines for fat (Besharov 2003). The Surgeon General's 2001 report on obesity calls for schools to ensure that school meals meet dietary guidelines and for more research into the effects of school nutrition programs on the quality of children's diets (U.S. Department of Health and Human Services 2001).

The shift away from scarcity to excess, even among the poor, underscores the importance of measuring the effects of school nutrition programs on the quality of food consumed. School meals have been criticized for being high in saturated fat and sodium (Burghardt, Devaney, and Gordon 1995). It is possible that school breakfast could harm child health if it is substituted for more nutritious food than would have been consumed otherwise. At the same time, poor children often consume foods that are high in calories and low in nutrients, so there may be considerable scope for school nutrition programs to improve the quality of children's diets even if these programs fall short of federal nutritional guidelines (Dietz 1995). In addition, the SBP might in principle affect nutritional outcomes for family members of the child participant, by inducing a reallocation of resources within the family or through educational materials provided by the SBP. As a final motivation, the SBP must be reauthorized periodically, often leading to intense scrutiny. Such a policy environment makes it important to ask whether the SBP is having its intended effects.

We investigate this question using the third National Health and Nutritional Examination Survey (NHANES) III, a nationally representative survey on diet, demographics, and health. We rely on a simple strategy to identify the effects of the SBP. In schools where SBP is not available, differences in short-term nutritional outcomes between the school year and the summer cannot be attributed to SBP. Such differences can be used to "net out" seasonal variation in places where SBP is offered, allowing us to isolate the short-term nutritional effects of the SBP.[1]

1. Bhattacharya and Currie (2001) use a similar strategy to examine the impact of the National School Lunch Program. However, because the NSLP is offered in almost all schools, they compare children who are and are not eligible for NSLP when school is and is not in session. One problem with this identification strategy is that eligibility cannot be perfectly determined given the information available in the NHANES.

We find that SBP availability has no effect on the total number of calories consumed or on the probability that a child eats breakfast, but it improves the nutritional quality of the diet substantially. Children with access to a SBP consume fewer calories from fat and are less likely to have low serum levels of vitamin C, vitamin E, and folate. They are also more likely to meet recommendations for the intake of fiber, potassium, and iron. We also find an overall improvement in dietary quality, as measured by the Healthy Eating Index (HEI). Our results for other household members are not as clear. Although we find some evidence of improvements in general dietary quality (HEI score and percent calories from fat), we find little improvement across serum and intake measures.

II. Background

The School Breakfast Program (SBP) provides nutritionally balanced, low-cost meals to children each school day.[2] It is administered by the United States Department of Agriculture (USDA) through its Food and Nutrition Service (FNS). On an average day in fiscal year (FY) 2001, 7.79 million children ate school breakfast, up from 3.4 million children in 1990. The cash payments for this program in FY 2001 were $1.5 billion. School breakfasts must meet minimum dietary requirements to qualify for reimbursement.[3] Typically, a breakfast might include orange juice, fresh fruit, cereal, and milk. These foods are relatively low in fat and are good sources of vitamin C, folate, calcium, protein, and other important nutrients.

Children are eligible for free meals if their family income is less than 1.3 times the federal poverty line and for reduced-price meals if their family income is between 1.3 and 1.85 times the federal poverty line. Children from higher-income families must pay full price to participate. Currently, schools are reimbursed $1.21 for each free breakfast, $0.90 for each reduced-price breakfast, and $0.22 for each full price breakfast served.[4] To encourage participation by low-income schools, the SBP offers a severe need payment (an additional subsidy of $0.23) if a specified percentage of their breakfasts are served free or at reduced price. In FY 2001, an average of 5.8 million children (74 percent of all participants) received a free breakfast daily, and 0.67 million children (9 percent) received a reduced price breakfast daily.

Several studies have examined the effects of SBP (Wellisch et al. 1983; Devaney and Fraker 1989; Burghardt, Devaney, and Gordon 1995; Gleason 1995; Devaney and Stuart 1998; Fox et al. 2001; Gleason and Suitor 2001).[5] These studies have focused on whether the SBP increases the likelihood that children eat breakfast and has positive effects on the nutritional outcomes of children. While some studies find that the

2. 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 website.

3. Since 1995, these guidelines have included: (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.

4. Reimbursement rates are higher in Alaska and Hawaii.

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

SBP increases breakfast eating, others find that the SBP decreases it, and still others find no effect. Similarly, many of the studies find that a SBP improves some dietary outcomes and harms others, but the studies come to different conclusions regarding which outcomes are improved and which are harmed.

There are several criticisms that apply to the previous studies of school nutrition programs. First, many of the studies rely on 24-hour dietary recall data to estimate intakes. These calculations require accurate recall of food intake and accurate analysis of food content. Even if these quantities are accurately obtained, nutrient intakes can vary considerably from day to day. Second, many studies look at whether the SBP increases intakes of nutrients. If most children already exceed the recommended daily intakes for the nutrient, then there may be no benefit or even harm to increasing intakes further.

Third, no study has dealt convincingly with endogenous participation in the SBP, casting doubt on whether these studies have identified the causal effect of participation. Quite simply, children who are most in need of the program are likely to be those who participate. Such issues could explain the counterintuitive finding in some studies that the SBP reduces the likelihood that children eat breakfast—poorer children who are most likely to skip breakfast in the first place are also most likely to be enrolled. Two studies have used statistical techniques beyond simple regression in an attempt to obtain causal estimates of the effects of SBP participation.[6] Devaney and Fraker (1989) find that SBP participation in 1980–81 increased breakfast intakes of calcium and magnesium, while it reduced intakes of cholesterol and iron. They model the choice to participate jointly with their outcome equations, and they estimate their model using a Heckman two-step estimator. However, they have no exclusion restrictions to identify their participation equation, so the validity of their estimates depends upon unverifiable assumptions about functional form. Gordon, Devaney, and Burghardt (1995) evaluate the effect of SBP on nutrient intakes using an instrumental variables approach. However, they report that their first stage equation does not predict participation well.[7]

Fourth, none of the previous studies of the SBP has considered its effects on household members other than the school-age child. To the extent that the program loosens the family budget constraint, resources freed up by the program may be redirected toward other household members.[8] Because the NHANES collects nutritional outcome information about multiple household members, our data present a unique opportunity to examine the effect of school nutrition programs on all family members.[9] A small

6. Akin, Guilkey, and Popkin (1983) use a switching regression model to allow the behavior of poor and nonpoor 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.

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

8. The lack of a household perspective in the literature on the SBP contrasts with the substantial literature on child-feeding programs in developing countries. The explicit alternative hypothesis in the developing country literature is that the feeding programs induce families to transfer household resources toward other family members, spreading benefits directed at a particular child over a greater number of individuals (Jacoby 2002). Beaton and Ghassemi (1982) review approximately 200 studies of preschool feeding programs in developing countries, and Jacoby (1997) reviews more recent studies. Studies of these issues in developing countries often only have information on children, and, therefore, must infer transfers to other family members based on the estimated impacts on the child. See Behrman (1997).

9. Not everyone within a household is selected 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 who are sample members can be connected.

number of studies have examined the effect of U.S. school nutrition programs on household food expenditures (West and Price 1976; Wellisch et al. 1983; Long 1990), but these studies have not addressed the endogeneity of program participation.

Our study addresses each of these criticisms. Our data allow us to examine a broad array of dietary measures, including several measures based on blood serum levels and thus are not plagued by recall error. We carefully consider the quantity and quality of the diet by examining multiple outcomes and asking whether measures exceed or fall short of generally accepted levels of adequacy. In addition, we rely on a simple and explicit strategy to identify the causal effect of SBP availability. Finally, our data allow us to examine the effects of SBP on other family members.

One limitation our study shares with previous work is that it is based on data collected prior to late 1990s reforms of the school nutrition programs. These reforms placed great emphasis on reducing the fat and saturated fat content of school meals. To the extent that these reforms have been effective, our estimates will likely understate the current beneficial effects of the SBP program, especially with regard to fat intakes.[10] However, the SBP now reaches many more schools than it did in 1990 when only half of the schools that offered NSLP also offered SBP. Thus, our identification strategy, which relies on differences in the availability of the SBP, is well suited to our data from before the reforms.

III. Data and Outcome Measurement

The NHANES III is a nationally representative survey that was conducted between October 1988 and October 1994. It includes nearly 34,000 respondents, aged two months and over. The NHANES collects much of the usual information found in household surveys, such as demographics (for example, age, gender, education) and income. The survey also collects information on dietary intakes, data from a physical exam conducted by doctors, and laboratory tests of blood and urine. For our primary analysis sample, we select individuals from the NHANES who were between 5 and 16 years old, were attending school or on vacation from school, had a completed dietary questionnaire available, and underwent a physical exam. There are 4,841 children who meet these criteria.[11]

10. See footnote 3 above. These reforms seem to have had a smaller effect on the SBP than on the National School Lunch Program because the average prereform school breakfast was closer to the new standards than the average prereform school lunch. A USDA study of the issue compared breakfasts in 1991–92 with those in 1998–99 and finds that breakfasts in 1991–92 were already meeting standards for supplying vitamins and minerals. The average fraction of calories from fat decreased from 30.7 to 25.8 percent while the average fraction of calories from saturated fat decreased from 13.8 to 9.8 percent (USDA 2001).

11. 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 have 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 older than 11 years old. Vitamin C levels are not provided for children younger than six 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.

A primary contribution of this study is that we analyze measures based on laboratory tests and clinical examination. These measures include serum levels of vitamin A, vitamin C, vitamin E, folate, anemia, and high cholesterol.[12] We use cutoff values for abnormal serum levels from standard medical textbooks (see Appendix Table 1). We also examine the probability a child is overweight.[13]

Like previous evaluations, we examine whether SBP availability increases the probability that children eat breakfast. This outcome is important because children who skip breakfast are thought to be less able to learn (Pollitt, Cueto, and Jacoby 1998). NHANES respondents are asked to report categorically how often breakfast is eaten: never, every day, some days, rarely, and weekends only. We focus on whether or not a child eats breakfast every day.

We also examine measures of dietary intake. NHANES respondents are asked what they ate in the past 24 hours (midnight to midnight) and how many times they ate various foods in the past month. The USDA then calculates nutrient values using a standard recipe analysis. We analyze a summary measure of overall dietary quality called the Healthy Eating Index (HEI). The index has ten components (each scored between 0 and 10) including grains, vegetables, fruits, milk, meat, total fat, saturated fat, cholesterol, sodium, and variety.[14] We also analyze the intake of fiber, sodium, potassium, magnesium, zinc, iron, calcium, total calories, and the percentage of total calories from fat and saturated fat. We construct measures of nutritional adequacy by comparing intake against standard nutritional recommendations set by the USDA (see Appendix Table A1).

IV. Analysis Strategy

A. *Identifying the Causal Effect*

We are interested in measuring the causal effect of SBP availability on nutritional outcomes.[15] Simple comparisons, such as directly comparing students who have a SBP available to those who do not, would confound the true causal effect of the SBP because students who attend schools where a SBP is available differ from those who do not. Table 1 provides ample and directly observable evidence of these differences. For example, Table 1 shows that a SBP is much more likely to be available to children in poor families, and it shows that these children have systematically worse diets than children from higher-income families.

12. We examine macronutrient and micronutrient intake levels relative to USDA recommended intake or adequate intake cutoffs whenever those cutoffs have been set by the USDA. These cutoffs are listed in Appendix Table 1. We examine serum nutrient measures when there is a reasonable physiological basis to think that such measures reflect nutritional deprivation. For example, some nutrients such as potassium are stored in the body, and serum levels will not fluctuate with intakes unless there is a prolonged period of severe deprivation or some medical condition associated with hypokalemia. Hence, we look at potassium intakes but not at serum levels of potassium.

13. Children are overweight if their body-mass-index is over the 85th percentile in the sex and age-appropriate growth chart.

14. See Kennedy et al. (1995) for more details on the index.

15. We focus on availability rather than participation because policymakers have considerably more control over availability than participation, and hence the former is more directly policy relevant.

Instead, our identification strategy is based on the simple observation that most school systems are not in session year around, so students are not exposed to the SBP year around. We first compare students' diets while school is in session to diets while school is not in session. Where school breakfast is *not* available, any differences in outcomes are a measure of seasonal factors that affect the outcomes, such as changes in activity levels or food prices, but not the effect of the SBP. Where the SBP is available, seasonal differences are due both to changes in outcomes induced by the SBP and by these other seasonal factors. Hence, we use a difference-in-differences (D-D) strategy, relying on children from schools without an SBP to "net out" the other seasonal differences in nutritional outcomes. This strategy allows us to focus on differences caused by the SBP.

We implement this strategy with a direct comparison of means and in a regression that allows us to control for observable differences across people such as age, gender, race, and income. The models, which we estimate using ordinary least squares, take the form:[16]

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

Here, $sbav_i$ is an indicator for school breakfast being available, $inschool_i$ is an indicator for school being in session, and X_i is a vector of control variables.[17] The coefficient on the interaction between $sbav_i$ and $inschool_i$ measures the causal impact of program. All of our results account for the complex sampling design of the NHANES, including the possibility that our sample contains multiple children from the sample household.

Our strategy can only identify the causal effect of SBP on nutritional outcomes that are likely to change within a couple of months after a change in diet. Longer-term outcomes, such as body weight measured by the body mass index (BMI), may show little change between the school year and the summer. However, we still measure the effect on BMI as a check on our estimation strategy.

B. SBP and Family Nutritional Decisions

Other household members also might benefit from the SBP. First, the SBP represents a transfer that might be shared by all household members through the allocation of other household food resources. Second, it might be the case that when the household experiences food shortages children are always fed first.[18] In this case, adults might benefit more from the additional resources directed to the household than children. Third, the SBP includes an explicit educational component that the recipient children could share with their family members.

16. We have estimated logit models for all of our outcomes and the results are substantively similar. See unpublished appendix.

17. The vector of control variables *X* includes age (indicators for each year of age), male, race (indicators for Hispanic, non-Hispanic black, and "other race"), income (indicators for $5,000 increments, for income greater than $50,000 and for missing income), household size, and geography (a complete set of interactions between indicators for urban and the four census regions).

18. For evidence that poor families protect children against economic shocks in the United States, see Bhattacharya, Deleire, Haider, and Currie (2003)

Table 1
Difference-in-Difference Estimates of SBP Availability for School Children

		SBP available			SBP not available			
	Full Sample	School In	School Out	Difference	School In	School Out	Difference	Difference-in-Difference[a]
Observations	4,841	2,754	471		1,263	353		
Male	0.514	0.509	0.500	0.009	0.541	0.478	0.063	–0.054
Non-Hispanic white	0.663	0.534	0.565	– 0.031	0.751	0.881	–0.130	0.099
Non-Hispanic black	0.152	0.231	0.216	0.015	0.078	0.058	0.020	–0.005
Hispanic	0.138	0.191	0.110	0.081	0.127	0.040	0.087	–0.006
Age	10.78	10.67	10.83	–0.160	10.93	10.69	0.240	–0.400
Income-poverty ratio	2.22	1.85	1.76	0.090	2.69	2.47	0.220	–0.130
Share income missing	0.048	0.036	0.066	–0.030	0.047	0.072	–0.025	–0.005
Food stamp receipt	0.191	0.262	0.309	–0.047	0.103	0.114	–0.011	–0.036
Eats school lunch	0.813	0.874	0.879	– 0.005	0.735	0.746	–0.011	0.006
Primary outcome variables								
Eat breakfast everyday[b]	0.855	0.844	0.809	0.035	0.876	0.873	0.003	0.032
HEI score	63.2	63.0	60.9	2.1	63.6	64.7	–1.1	3.2*
Calories	2139	2108	2247	–139	2124	2178	–54	–86
Percent calories from fat	33.6	34.1	34.7	–0.7	33.2	32.5	0.6	–1.3[+]

Low serum vitamin A	0.072	0.093	0.054	0.039	0.062	0.052	0.010	0.029
Low serum vitamin C	0.036	0.034	0.070	–0.036	0.035	0.017	0.018	–0.055**
Low serum vitamin E	0.014	0.015	0.033	–0.018	0.012	0.004	0.008	–0.026$^+$
Low serum folate	0.059	0.064	0.081	– 0.017	0.058	0.031	0.027	–0.044$^+$
Low calcium intake	0.673	0.665	0.665	0.000	0.690	0.664	0.026	–0.027
Low fiber intake	0.942	0.924	0.967	– 0.043	0.961	0.928	0.033	–0.075**
Low iron intake	0.287	0.314	0.275	0.039	0.292	0.211	0.081	–0.041
Low potassium intake	0.942	0.927	0.959	–0.032	0.954	0.945	0.009	–0.041*
Other outcome variables								
Percent calories from saturated fat	12.1	12.42	12.29	0.13	11.91	11.69	0.22	–0.10
High cholesterol	0.101	0.105	0.139	– 0.034	0.081	0.109	–0.028	–0.006
Anemic	0.029	0.036	0.026	0.010	0.022	0.025	–0.003	0.013
Low magnesium intake	0.478	0.491	0.464	0.027	0.481	0.450	0.031	–0.005
Low protein intake	0.088	0.086	0.065	0.021	0.099	0.087	0.012	0.009
High sodium intake	0.777	0.774	0.831	–0.057	0.742	0.821	–0.079	0.022
Low zinc intake	0.329	0.317	0.319	–0.002	0.360	0.301	0.059	–0.061
BMI	19.4	19.6	19.8	–0.2	19.1	19.3	–0.2	0.1

Notes: Author's tabulations from the NHANES. All means are weighted; statistical tests take into account the complex survey design.
a. Breakfast consumption is only available for children younger than 12.
b. Significance: + at 0.10 level. * at 0.05 level. ** at 0.01 level.

If the cash value of the school breakfast was $1.12 (the USDA reimbursement rate for free breakfasts), the SBP would represent a monthly transfer of about $25 for each child receiving free breakfasts. This is much less than a typical family's food budget, so conventional economic analysis suggests that the family will treat this in-kind transfer in the same way as they would treat an equivalent cash transfer. Multiplying this additional income by a realistic marginal propensity to consume food suggests that the effect on consumption is likely to be very modest. The studies reviewed by Currie (2003) estimate the marginal propensity to spend on food to be between $0.17 and $0.47. Hence, the SBP subsidy should induce an increase in the value of food consumed by between $4.25 and $11.75 per month.

This calculation underestimates the potential effect of school nutrition programs. First, 55 percent of the sample children with family incomes less than 130 percent of poverty lived in households that used Food Stamps. In these households, there may not be much opportunity to offset SBP transfers by spending less on food.[19] Second, this simple calculation ignores the fact that not all calories are equal. For example, some calories are replete with vitamins and minerals, while other calories come with few nutrients and perhaps even negative attributes such as a high fat content. Similarly, calories also vary tremendously in price, particularly when the purchase price and the time cost of preparation are considered. Cutler, Glaeser, and Shapiro (2003) argue that technological change has made high fat, empty calories inexpensive relative to high quality, nutrient-rich calories and that this may explain why poorer individuals are more likely to be obese. Hence, even if the SBP has little effect on the quantity of calories consumed, it might lead children to substitute for relatively low-quality food consumed at home.

V. Results

A. *Main Results for Children*

Table 1 provides some basic descriptive statistics. Unsurprisingly, children with the SBP available have lower incomes, are more likely to participate in the Food Stamp Program, and are less likely to be non-Hispanic white than other children. Nutritional outcomes are also worse for children who have SBP available when compared to those who do not. For example, the children with SBP available are less likely to eat breakfast every day and have lower scores on the HEI. They consume a higher fraction of calories from fat and saturated fat, and are more likely to have high cholesterol. They are more likely to have low serum values of vitamins A, C, and E and folate, and are more likely to be anemic. While there are a few anomalous outcomes (for example, serum calcium), the overall pattern shows worse nutritional outcomes for SBP-available children. Clearly a simple comparison of children with and without a SBP available will not measure the causal effect of the SBP.

19. 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. However, if families can sell food stamp entitlements for cash, then this constraint will not be binding.

Table 1 also shows basic D-D estimates. Children with access to the SBP have a healthier diet when school is in session than when school is not. For example, the HEI is 63.0 in session compared to 60.9 out of session. But can seasonal differences in diet explain this result? Children in schools without a SBP available have an HEI of 63.6 when school is in session, and an HEI of 64.7 when school is out. Thus, in the absence of a SBP, diets are better in the summer. The D-D estimate implies that the SBP is responsible for 3.2 [= (63.0 -60.9) – (63.6 -64.7)] point increase in the HEI, an effect that is statistically significant at the 95 percent level.

The D-D estimates suggest that SBP has no effect on total calories or on the probability of eating breakfast, but improves the quality of the diet. Aside from the effect on the HEI, the SBP lowers the probability of low vitamin C intake by 5.5 percentage points, reduces the probability of low fiber intake by 7.5 percentage points, and reduces the probability of low potassium intake by 4.1 percentage points, all statistically significant at the 95 percent level. The effects of SBP availability on the percentage of calories from fat, low vitamin E, and low folate suggest that the program is beneficial, with the estimates statistically significant at a 90 percent confidence level. We find no statistically significant effect of the SBP on percent calories from saturated fat; high cholesterol; anemia; low intake of magnesium, protein and zinc; and high intake of sodium. Overall, our results are remarkably consistent: All of the statistically significant coefficients imply that the SBP improves nutritional outcomes. Finally, we also present the effects of the SBP on BMI. Because it is unlikely that the BMI would change in the short run, we expect and indeed find no effect on BMI.

As a check of our identification strategy, Table 1 also presents D-D estimates for the additional control variables we use to estimate Equation 1. The purpose of this check is to examine the extent to which any observable differences exist after our identification strategy is applied. Although we control for these observable differences (gender, race, age, and income) in Equation 1, any observable differences might suggest that other differences exist for which we are not controlling. No statistically significant D-D estimates exist for these controls. In addition, we examine two nutrition-related variables that could potentially confound our estimates, an indicator for food stamp receipt and an indicator for school lunch participation. A concern, for example, could be that the children who have SBP available are more likely to participate in the school lunch program because they have greater needs. Our SBP effects would then represent the effect of SBP availability *and* greater school lunch participation. We do not see any such pattern in the data, further buttressing our identification strategy.

Table 2 presents the regression estimates of the causal effect of the SBP.[20] The estimated coefficients on the interaction terms are generally very similar to the basic D-D estimates shown in Table 1 but are more precisely estimated. They confirm that the SBP has many positive effects on nutrition: increased HEI; reduced calories from fat; increased probability of adequate iron, fiber, or potassium intakes; and reduced probability of low vitamin C and E and folate. Furthermore, our estimates suggest that SBP availability does not cause higher caloric intake, implying that the effect of SBP

20. Regression estimates for the other outcomes listed in Table 1 are available in the unpublished appendix. They were relegated to an appendix because the causal effect estimates were generally insignificant or sensitive to specification.

Table 2
Main Regression Estimates of SBP Availability for School Children

	Eat breakfast	Total calories	HEI score	Percent calories from fat	Low serum vitamin A	Low serum vitamin C	Low serum vitamin E	Low serum folate	Low calcium intake	Low fiber intake	Low iron intake	Low potassium intake
Sbavl*	0.04	–0.4	3.89	–2.04	0.01	–0.07	–0.03	–0.06	–0.02	–0.08	–0.08	–0.05
inschool	(0.05)	(99.8)	(1.18)**	(0.73)**	(0.02)	(0.02)**	(0.01)+	(0.03)*	(0.05)	(0.03)**	(0.04)*	(0.02)**
Sbav	–0.01	63.7	–3.30	2.11	–0.00	0.06	0.03	0.04	–0.01	0.05	0.07	0.02
	(0.04)	(89.3)	(1.06)**	(0.54)**	(0.02)	(0.01)**	(0.02)+	(0.02)	(0.04)	(0.02)*	(0.03)*	(0.02)
Inschool	0.01	–64.0	–0.86	0.49	0.01	0.02	0.01	0.02	0.01	0.03	0.06	–0.01
	(0.03)	(81.2)	(0.95)	(0.68)	(0.02)	(0.01)*	(0.01)	(0.01)	(0.04)	(0.02)+	(0.03)*	(0.02)
Hispanic	–0.03	–46.0	0.15	–0.15	0.02	–0.03	–0.00	–0.00	0.00	–0.04	0.05	–0.02
	(0.03)	(65.2)	(0.97)	(0.63)	(0.01)	(0.01)*	(0.01)	(0.01)	(0.03)	(0.02)*	(0.03)	(0.02)
NH-black	–0.06	47.3	–1.58	1.52	0.03	–0.04	–0.00	0.03	0.07	0.00	0.01	–0.00
	(0.03)*	(42.2)	(0.72)*	(0.47)**	(0.01)*	(0.01)**	(0.01)	(0.01)*	(0.02)**	(0.02)	(0.02)	(0.01)
Other race	–0.00	174.3	3.69	–1.59	–0.01	–0.06	–0.01	–0.03	–0.01	–0.03	–0.03	–0.03
	(0.05)	(132.2)	(1.67)*	(0.88)+	(0.03)	(0.02)**	(0.00)	(0.02)	(0.07)	(0.04)	(0.05)	(0.03)
Male	0.03	561.3	0.01	–0.23	0.01	0.01	0.00	–0.02	–0.13	0.01	–0.21	–0.06
	(0.02)	(45.8)**	(0.48)	(0.39)	(0.01)	(0.01)	(0.00)	(0.01)*	(0.02)**	(0.01)	(0.02)**	(0.01)**
HH size	–0.00	–14.4	0.04	–0.20	0.01	–0.00	0.00	0.00	–0.00	–0.01	–0.01	0.00
	(0.01)	(12.5)	(0.17)	(0.10)+	(0.00)**	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)
Observation	3087	4841	4841	4841	4841	4150	4841	4836	4841	4841	4841	4841
R-square	0.05	0.16	0.11	0.05	0.11	0.06	0.02	0.11	0.17	0.03	0.17	0.04

Notes: Author's calculations from the NHANES. The regressions take into account the complex survey design. The other control variables include indicator variables for single years of age, ten income groups ($0 to $4,999; $5000 to $9,999; $10,000 to $10,499; . . . ; $35,500 to $39,999; $40,000 and above; and not provided), and urban *census region. Significance: + at 0.10 level. * at 0.05 level. ** at 0.01 level.

is through the quality of food, not the quantity of food. Again, all of our statistically significant results suggest that SBP improves nutritional outcomes for children.

B. Specification Checks and Falsification Tests for Children

In this section, we describe several specification checks and falsification tests aimed at examining the validity of our identification strategy. In general, these tests confirm the validity of our main findings—that the SBP improves nutritional outcomes—and provide evidence that these results are robust to a wide variety of decisions about sample selection and regression specification. However, these tests raise the possibility that the subsidies induced by the SBP do not accrue only to poor children, but also to children from other socioeconomic strata.

Although we control for income in our regressions, it is possible that our specification for income (indicators for $5,000 intervals up to $40,000 and then an indicator for income above $40,000) is insufficient to make the underlying individuals comparable. Such comparability is critical to the plausibility of our identification scheme, which depends upon children in schools without a SBP to control for seasonal differences in nutrition. Panel B of Table 3 shows the results of one attempt to increase the comparability across individuals: exclude from the sample all children from families with incomes above $40,000. This exclusion trades sample size and statistical power for comparability. Nevertheless, we find estimates that are very similar to our main results.

Another threat to the validity of our estimates is due to the design of the NHANES, which confounds seasonality and geography. The NHANES survey relies on fully equipped medical clinics (Mobile Examination Centers or MECs) that are housed in the back of tractor trailers, and are transported to each of the data collection sites.[21] Data collection is limited by the number and transportation costs of the MECs. Appendix Table A2 shows that, due perhaps to these constraints, few interviews took place in the South and West during the summer. Thus, our differencing strategy would need to eliminate these geographic differences in addition to seasonal differences. The effects of these geographic differences can be observed in that Hispanics are more likely to be interviewed when school is in session, regardless of whether or not the SBP was available (see Table 1).

Table 3 shows three responses to this potential problem. First, Panel C shows D-D estimates excluding Hispanic children. These estimates are similar to the main results in Table 2 and are, in fact, slightly larger. Panels D and E of Table 3 exclude households from the South and West, respectively. Both sets of results are similar to our main results.

Because the SBP provides larger subsidies to children from poor families than children from richer families and because richer children tend to have better diets than poorer children, one might expect that children from higher socioeconomic strata would not benefit or at least benefit less than poorer children. Surprisingly, Panel F of Table 3 indicates that children from families with more than $50,000 annual income have better diets as a result of the SBP. The statistically significant results suggest that the SBP raises the HEI by 3.69 points, reduces the frequency of low serum vitamin E

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

Table 3

Alternative Regression Specifications for School Children

	Eat Breakfast	Total Calories	HEI Score	Percent Calories From Fat	Low Serum Vitamin A	Low Serum Vitamin C	Low Serum Vitamin E	Low Serum Folate	Low Calcium Intake	Low Fiber Intake	Low Iron Intake	Low Potassium Intake
Panel A: Main regression estimates (from Table 2)												
Sbav* inschool	0.04	–0.4	3.89	–2.04	0.01	–0.07	–0.03	–0.06	–0.02	–0.08	–0.08	–0.05
	(0.05)	(99.8)	(1.18)**	(0.73)**	(0.02)	(0.02)**	(0.01)+	(0.03)*	(0.05)	(0.03)**	(0.04)*	(0.02)**
Observations	3,087	4,841	4,841	4,841	4,841	4,150	4,841	4,836	4,841	4,841	4,841	4,841
R-square	0.05	0.16	0.11	0.05	0.11	0.06	0.02	0.11	0.17	0.03	0.17	0.04
Panel B: Excluding high-income households												
Sbav* inschool	–0.01	–120.3	3.68	–2.50	0.01	–0.07	–0.03	–0.05	0.04	–0.06	–0.04	–0.06
	(0.04)	(126.3)	(1.20)**	(0.69)**	(0.03)	(0.02)**	(0.01)+	(0.03)	(0.07)	(0.03)+	(0.04)	(0.03)*
Observations	2,493	3,852	3,852	3,852	3,852	3,275	3,852	3,848	3,852	3,852	3,852	3,852
R-square	0.05	0.15	0.11	0.04	0.11	0.06	0.02	0.11	0.16	0.04	0.17	0.04
Panel C: Excluding Hispanic children												
Sbav* inschool	0.06	0.1	3.97	–2.06	0.00	–0.07	–0.03	–0.07	–0.02	–0.08	–0.11	–0.05
	(0.05)	(102.5)	(1.33)**	(0.83)*	(0.03)	(0.02)**	(0.02)+	(0.03)*	(0.05)	(0.03)**	(0.04)*	(0.02)*
Observations	1,864	2,979	2,979	2,979	2,979	2,598	2,979	2,975	2,979	2,979	2,979	2,979
R-square	0.05	0.16	0.13	0.05	0.11	0.07	0.03	0.12	0.17	0.03	0.18	0.05

Panel D: Excluding households from the South region												
Sbav* inschool	0.04	67.9	4.11	–2.20	–0.00	–0.05	–0.03	–0.04	–0.06	–0.09	–0.10	–0.08
	(0.05)	(116.1)	(1.42)**	(0.93)*	(0.03)	(0.02)**	(0.02)*	(0.03)	(0.06)	(0.03)**	(0.05)*	(0.03)**
Observations	1,756	2,705	2,705	2,705	2,705	2,384	2,705	2,700	2,705	2,705	2,705	2,705
R-square	0.05	0.18	0.10	0.06	0.10	0.09	0.05	0.10	0.17	0.04	0.18	0.05
Panel E: Excluding households from the West region												
Sbav* inschool	–0.00	15.5	3.37	–1.97	0.03	–0.06	–0.02	–0.08	0.02	–0.09	–0.05	–0.05
	(0.05)	(92.8)	(1.31)*	(0.86)*	(0.03)	(0.02)**	(0.01)+	(0.03)*	(0.05)	(0.03)**	(0.04)	(0.02)*
Observations	2,176	3,484	3,484	3,484	3,484	2,966	3,484	3,480	3,484	3,484	3,484	3,484
R-square	0.06	0.15	0.11	0.06	0.11	0.07	0.03	0.13	0.17	0.03	0.18	0.04
Panel F: Only households with income > $50,000												
Sbav* inschool	0.18	318.8	3.69	–0.74	–0.02	–0.05	–0.07	–0.03	–0.10	–0.19	–0.19	–0.05
	(0.14)	(254.05)	(1.98)+	(1.89)	(0.04)	(0.06)	(0.04)+	(0.05)	(0.08)	(0.07)**	(0.10)*	(0.06)
Observation	533	846	846	846	846	738	846	845	846	846	846	846
R-square	0.13	0.23	0.14	0.08	0.12	0.20	0.11	0.18	0.24	0.10	0.17	0.09
Panel G: Middle of winter vs. almost winter (everyone in school)												
Sbav* inschool	0.04	16.0	1.89	0.45	0.04	–0.02	0.01	–0.05	0.02	0.04	–0.04	0.03
	(0.04)	(113.76)	(1.28)	(0.91)	(0.02)+	(0.02)	(0.01)	(0.03)	(0.06)	(0.03)	(0.05)	(0.02)
Observations	2,569	4,017	4,017	4,017	4,017	3,403	4,017	4,014	4,017	4,017	4,017	4,017
R-square	0.06	0.17	0.11	0.04	0.12	0.07	0.03	0.11	0.19	0.03	0.17	0.05

Notes: See notes for Table 2.

levels by seven percentage points, and lowers the probability of low fiber and low iron intake by 19 percentage points. Moreover, some of these statistically significant point estimates (vitamin E, fiber, and iron results) are larger among the richer children as compared to the sample as a whole. Taken together, these results suggest that the benefits of the SBP are not confined to children from lower socioeconomic strata. However, given the size of the standard errors for the high-income children and the variability in effects across outcomes, we consider these results to be only suggestive.[22]

Panel G of Table 3 shows the results of a falsification exercise to examine the potential effects of seasonality. In this exercise, we limit the sample to children who reported that school was in session. We then repeat our analysis treating the students who were surveyed between November and March as the "not in school" group and the students who were surveyed between April and October as the "in school" group. Because all students in this sample were actually in school, we should find no measured effect of the SBP if our estimation strategy is valid. The small and statistically insignificant results for nearly all the outcomes in Panel G suggest that our identification scheme strongly passes this falsification test.

C. The Effects of the SBP on Preschool Children and Adult Family Members

Tables 4 and 5 extend the empirical analysis to other family members in households with school-aged children. Table 5 shows descriptive statistics for children aged 0 to 5 and for adults aged 25 to 64 in families with school-aged children.[23] Table 5 shows that sample adults tend to have worse diets than those of the preschool children. For example, the preschool children have a score of 68.1 on the HEI compared to 61.8 for adults. The children are also less likely to have low serum values of vitamins and folate and to have low-intake values of fiber and minerals.

Table 5 indicates that the estimated effects of SBP availability on the HEI score and on the fraction of calories from fat are remarkably similar for all members of the household. These results suggest that the SBP improves diet quality even for family members who are not directly exposed to it, but we find no statistically significant effects of the SBP on nutritional outcomes for preschool and adult household members. Thus, unlike the specific nutritional benefits that the SBP has for school

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22. In addition to the specification checks we report in Table 3, we also conducted two others that are reported in the unpublished appendix. First, our main results are estimated on the sample of NHANES children for whom some blood information was collected and some dietary information was collected, excluding children that didn't provide at least some of both types of information. We estimated regressions using all available children for each outcome and our substantive results do not change. Second, we checked the sensitivity of our results to the inclusion of state or county fixed effects. With one notable exception, these results with geographic fixed effects are also substantively similar to our main result that the SBP improves dietary quality and nutritional outcomes. The exception is that we find that the SBP leads to a statistically significant increase in caloric intake (by about 300 calories per day). We do not highlight these findings as a main result because, due to confidentiality concerns, the NHANES only reports information about state and county of residence for nonrural households. In addition, due to the exclusion of many observations, we did not account for survey design effects in these regressions.

23. We choose this age range for adults because it is not clear whether adults aged 18 to 24 should be thought of as dependents or as household decisionmakers and dietary outcomes for the elderly are significantly different than dietary outcomes for prime-aged adults.

Table 4
Descriptive Statistics for Younger and Adult HH members

	Ages 0–5 Household Members	Ages 25–64 Household Members
Sample Size	1,332	3,260
Male	0.532	0.467
Non-Hispanic white	0.486	0.703
Non-Hispanic black	0.229	0.127
Hispanic	0.207	0.126
Age	2.82	38.39
Food stamp receipt	0.377	0.131
Schooling variables[a]		
School in session	0.734	0.752
SBP available	0.567	0.515
NSLP available	0.906	0.925
Outcome variables		
HEI score	68.1	61.8
Percent calories from fat	34.1	34.1
Low serum vitamins A, C or E or folate	0.089	0.334
Low calcium, fiber, iron, or potassium intake	0.925	0.967

Notes: Author's tabulations from the NHANES. All means are weighted.
a. The schooling variables are defined with respect to a household child; if there is more than one school-aged child in the household, a child is chosen at random.

children (such as increasing fiber intake or lowering the prevalence of inadequate serum folate), the SBP leads to improved diets for other family members only in a general sense. Our point estimates also suggest that the effects of SBP are larger for school children and younger household members as compared to adults. However, the standard error estimates are relatively large on the regressions for other household members, in part due to smaller sample sizes, implying that direct comparisons across family members should be made cautiously.

One explanation for these results is that households use the transfer implicit in the SBP to improve the quality of the diets of other household members and these improvements are focused on children. An alternative explanation is that the SBP is working through some other mechanism, like nutrition education, to improve household outcomes. Though these results are intriguing, a larger sample size and different research design would be needed to verify our results and to make progress on identifying the underlying mechanisms at work.

Table 5
Regression Estimates of SBP Availability for Other Household Members

	HEI Score	Percent Calories from Fat	Low Serum Vitamins A, C, or E or folate	Low Intake Calcium, Fiber, Iron, or Zinc
School children				
Sbav*inschool	3.89	–2.04	–0.11	–0.02
	(1.18)**	(0.73)**	(0.04)**	(0.01)
Observations	4,841	4,841	4,841	4,841
R-square	0.11	0.05	0.07	0.03
Younger HH members				
Sbav*inschool	5.45	–4.31	–0.10	–0.08
	(2.93)+	(2.09)*	(0.08)	(0.05)
Observations	850	1,224	1,332	1,332
R-square	0.14	0.09	0.23	0.05
Adult HH members				
Sbav*inschool	3.52	–2.58	–0.04	–0.02
	(1.47)*	(1.53)+	(0.08)	(0.02)
Observations	3,260	3,260	3,260	3,260
R-square	0.09	0.08	0.09	0.06

Notes: Author's calculations from the NHANES. The regressions take into account the complex survey design. The children samples include indicator variables for single years of age and the adult sample includes indicator variables for five-year age groups. The other control variables include 10 income groups ($0 to $4,999, $5000 to $9,999, $10,000 to $10,499, . . . , $35,500 to $39,999, $40,000 and above, and not provided) and urban*census region interactions. Significance: + at 0.10 level. * at 0.05 level. ** at 0.01 level.

VI. Discussion and Conclusion

We use the National Health and Nutritional Examination Survey (NHANES) III to examine the effect of the availability of the SBP. Our work builds on previous research by developing a simple difference-in-differences strategy to account for unobserved differences between schools with and without the program, focusing on meaningful threshold levels for serum levels and nutrient intakes, and examining the effects of the SBP on other family members.

Our findings for school children suggest a remarkably consistent story. Across a range of outcomes, we find that the SBP leads to better dietary habits. Without increasing total calories consumed or increasing the frequency of eating breakfast, the SBP increases scores on the healthy eating index, reduces the percentage of calories from fat, and reduces the probability of low fiber, iron and potassium intake. In addition, we find that the SBP reduces the prevalence of vitamin and mineral deficiencies.

The availability of the SBP reduces the probability that children have low serum vitamin C, vitamin E, and folate serum levels.

Despite the consistency of our results for school-age children, we remain cautious in our interpretation. First, due to the NHANES collection methodology, our identification strategy must be able to "difference out" both underlying seasonal and geographic variation in diet. Although our results are robust to several alternative specifications that examine the role of geography, geographic variation in the United States is substantial and thus places a substantial burden on our identification strategy. Second, we find fairly large effects of the SBP on children in families with relatively high incomes. This finding is surprising and deserves further research.

At the same time, there are at least two reasons to suspect that our results are lower bounds on the nutritional benefits of the SBP. First, we have not accounted for the Summer Food Service Program (SFSP), which provides free nutritious meals and snacks to children in low-income areas during the summer months when school is not in session.[24] In 1990, the program served 1.7 million children per day compared with 3.4 million served by the SBP. To the extent that the SFSP improves summer nutritional outcomes, the SFSP confounds our identification strategy, leading to an estimate of the SBP effect that is biased downward. Second, the SBP underwent substantive reform in the mid 1990s.

Our results for other household members are less consistent. Although we find statistically significant effects for two general measures of dietary quality (the HEI score and the percent calories from fat), we are not able to reject the hypothesis that the SBP has no effect on specific measures based on serum levels and nutrient intakes. This lack of statistical significance, at least for younger children, appears to be related to small sample sizes. Despite these weaker findings, our results raise the possibility that some of the positive effects of school nutrition programs might be overlooked if one ignores that children are often part of a larger economic unit—the family. Such concerns could be relevant to the evaluation of many U.S. social programs. Although we leave these and other issues to future research, our findings suggest that the SBP is effective at improving the nutritional outcomes for American children.

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

Table A1
Cutoffs for Nutrient Intakes by Age and Gender

Age and Gender	F/M	0–6 mo	7–12 mo	1–3y	4–8y	9–13y	14–18y	19–30y	31–50y	51–70y
RDA levels										
Calcium (mg/day)	F/M	210[a]	270[a]	500[a]	800[a]	1300[a]	1300[a]	1000[a]	1000[a]	1200[a]
Fiber (g/day)	F	ND	ND	19[a]	25[a]	26[a]	26[a]	25[a]	25[a]	21[a]
	M	ND	ND	19[a]	25[a]	31[a]	38[a]	38[a]	38[a]	30[a]
Iron (mg/day)	F	0.27[a]	11	7	10	8	15	18	18	8
	M	0.27[a]	11	7	10	8	11	8	8	8
Magnesium (mg/day)	F	30[a]	75[a]	80	130	240	360	310	320	320
	M	30[a]	75[a]	80	130	240	410	400	420	420
Potassium (g/day)	F/M	0.4[a]	0.7[a]	3.0[a]	3.8[a]	4.5[a]	4.7[a]	4.7[a]	4.7[a]	4.7[a]
Protein (g/day)	F	9.1[a]	13.5	13	19	34	52	56	56	56
	M	9.1[a]	13.5	13	19	34	46	46	46	46
High sodium (g/day)	F/M	ND	ND	>1.5	>1.9	>2.2	>2.3	>2.3	>2.3	>2.3
Zinc (mg/day)	F	2	3	3	4	8	9	8	8	8
	M	2	3	3	4	8	11	11	11	11
Laboratory measures										
Vitamin A (μmol/L)	F/M	1.05	1.05	1.05	1.05	1.05[b]	0.7	0.7	0.7	0.7
Vitamin C (μmol/L)	F/M	NC	NC	NC	11.4[b]	11.4	11.4	11.4	11.4	11.4
Vitamin E (μmol/L)	F/M	NC	NC	NC	11.6	11.6	11.6[b]	NC	NC	NC
Folate (nmol/L)	F/M	NC	NC	NC	7	7	7	7	7	7
Anemia (hemoglobin g/dL; hematocrit %)	F	11.5;35	11.5;35	11.5;35	11.5;35	11.5;35[b]	12;37[b]	12;36	12;36	12;36
	M	11.5;35	11.5;35	11.5;35	11.5;35	11.5;35	12;37	13;39	13;39	13;39
High cholesterol (mg/dL)	F/M	>200	>200	>200	>200	>200	>200	>200	>200	>200

Notes: Recommended Daily Allowance (RDA) values were taken from the Dietary Reference Intake reports produced by the National Academy of Sciences, summarized in tables on the USDA website (http://www.nal.usda.gov/fnic/etext/000105.html). Laboratory values were taken from Wilson et al. (1991). ND indicates values not defined and NC indicates values not considered.

a. This cutoff represents an Adequate Intake (AI) value rather than a RDA value because no RDA value was available.

b. The age cutoffs for the laboratory measures are not coincident with the age-cutoffs for the dietary intake measures. The actual cutoffs are as follows: for vitamin A, 12y and 13y are grouped with 14–18y; for vitamin C, 4y and 5y are grouped with 1–3y; for vitamin E, 17y and 18y are grouped with 19–30y; for Anemia, 13y are grouped with 14–18y and 18y are grouped with 19–30y.

Table A2
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.

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