SCHOOL BREAKFAST PROGRAM AND CHILDREN'S NUTRITIONAL STATUS

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I. Introduction

I. A. Nature of the Research Problem

The prevalence of obesity among children aged 6 to 11 doubled from about 7% during the late 1970s to more than 15% today, while among adolescents, the obesity rate tripled from 5% to nearly 16% (Dietz, 2004). Childhood obesity increases an individual's risk of developing cardiovascular disease, hypertension and type II diabetes (Ebbeling, Pawlek and Ludwig, 2002). Moreover, childhood obesity is a significant predictor of adult obesity, which can result in a myriad of health consequences including premature death (Fontaine et al., 2003; Peeters et al., 2003). Because childhood obesity has become a major public health concern, which has long-term health and economic consequences, this "epidemic" has also prompted considerable action by state legislatures to implement reforms within school systems. Several factors have been cited as contributing to the childhood obesity epidemic. Among these are changes in diet and eating habits, lack of exercise, increased television viewing, increased video game and computer usage, the proliferation of fast-food restaurants, marketing practices of the fast food industry, widespread availability of junk food sold at schools, genetics and food assistance programs.

In this study, we examine the relationship between participation in the School Breakfast Program (SBP), one federal food assistance program, and children's nutritional status. While food assistance programs were initially implemented by Congress to address the problems of food insecurity and nutritional deficiencies, the increasing prevalence of childhood obesity points to the importance of re-evaluating school nutrition programs to ascertain if there is any linkage between participation in such programs and children's nutritional status. The question of whether and by what mechanism food assistance programs are linked to the increasing prevalence of childhood obesity would provide useful information for policymakers and program administrators regarding whether structural or operational reforms are warranted.

The National School Breakfast Program (SBP) was established by Congress during the late 1960s as a categorical grant program to provide impoverished children with access to a nutritious breakfast. Over time, it was revised to reimburse schools on a per meal basis. In 1975, Congress made the program permanent. The US Department of Agriculture (USDA) under the Food and Nutrition Service (FNS) is responsible for administering and managing the SBP. School breakfasts must meet certain dietary guidelines. For example, qualifying school breakfasts must provide one-fourth of the recommended dietary allowance (RDA) for protein, calcium, iron, vitamin A, vitamin C and calories. The program offers severe need payments to encourage low-income schools to participate. To qualify as "severe need", a school must meet three criteria: 1) the breakfast must accord with minimum dietary guidelines; 2) the school must demonstrate that the regular reimbursement rate does not cover the costs of a school breakfast; and 3) the school must demonstrate that 40% of the lunches served in the preceding year were either free or reduced price. Program eligibility is based on household income. Children are eligible to receive a free breakfast if household income is less than 130% of the poverty line. Reduced price breakfasts are available to children from households with income between 130% and 185% of the poverty line. Children from households with income above 185% of the poverty line receive a small subsidy for full-price meals. The per-meal subsidies are indexed for inflation. For the 2005-2006 academic year, schools were reimbursed by the USDA $1.27 for each free breakfast,

$0.97 for each reduced-price breakfast, and $0.23 for each full priced breakfast served. Schools that qualify as severe need are reimbursed an additional $0.23 for each free and reduced-price breakfast served. In FY 1989, the SBP served over 658 million breakfasts to about 3.7 million students. During FY 2005, the SBP served 1.6 billion meals to 9.3 million children.

Childhood nutrition and obesity is one of the top ten legislative priorities today. (National Conference of State Legislatures, 2006) Between 2003-2005, 19 states implemented nutrition standards in schools or restricted vending machine sales within schools to nutritious foods and beverages. School breakfast is an important component of this legislative focus on childhood nutrition. Bhattacharya, Currie, and Haider (2006) find a positive impact of SBP on nutrition in 1990. Our research contributes to this important line of research by focusing on the impact of SBP under the recent legislative interest in child nutrition and the school's role in health promotion. Whether we find that recent SBP programs improve nutrition or not, our results will contribute to the evaluation of the SBP's effectiveness in achieving the state nutrition and health goals. If we find that participants in the SBP do not improve their diets over non-participants, then other more cost effective policies should be encouraged in states or the SBP should be carefully examined to determine why the program does not achieve its goals. If the program does lead to improved nutrition, then other states and local school districts could be encouraged to adopt similar initiatives.

I. B. Purpose and Scope

Our proposed research focuses on evaluating the effects of participation in the National School Breakfast program on children's nutritional status. This proposed research expands on the limited research that has examined the possible linkage between SBP participation and children's nutritional status in several respects. First, we will analyze data from the four most recent waves of the National Health and Nutrition Survey from 1999 through 2006. This time period coincides with the heightened prevalence of childhood obesity and increased concerns about the negative health effects of consuming foods that contain high levels of saturated fats and/or cholesterol. Even the most recent evidence documenting potential effects of the SBP is based on data from the early 1990s and thus predates widespread concerns about the increased prevalence of childhood obesity. Second, we will examine the direct effect of participation in the SBP on a range of nutrient intake indicators controlling for the potential non-random selection associated with participation. The most recent study on this subject analyzed the effects of SBP availability rather than participation. Our preliminary results suggest that SBP availability is a good predictor of participation but may not be a good proxy for actual participation. Thus, prior research has not adequately addressed the potential non-random selection associated with the decision to participate. Third, we will use propensity score matching to address the potential non-random selection. Propensity score matching approximates a randomized experiment by creating matched treatment and control groups that are comparable except for treatment status. When the matched groups are compared on particular outcomes, any differences should reflect treatment effects rather than unobserved differences between the two groups. Fourth, we construct indicators of nutrient intake based on dietary recall as well as serum blood measures.

Our study addresses the following strategic research issue identified by the Maternal and Child Health Bureau for FY 2004-2009: Strategic Research Issue #IV: Promoting the healthy development of MCH populations. We evaluate whether participation in the SBP improves the nutrient intake of children. Our comparisons of participants and non-participants control for potential selection bias that arises from using non-experimental data. Our specific aims are:

1. Evaluate the effect of SBP on eating breakfast on a regular basis.
2. Evaluate the effect of SBP on nutrient intake as measured by the Healthy Eating Index; the consumption of sugar, total fat, saturated fat, cholesterol, fiber, and calories; and the consumption of vitamins A, C, E, iron, magnesium, zinc, folate, potassium, and calcium.

II. Review of the Literature

Breakfast consumption is an important component of good nutrition and health in adults and children, but breakfast consumption by children and adolescents has been declining over time (Siega-Riz, Popkin, and Carson, 1998). The effect of this decline in breakfast consumption on health has been studied extensively. This literature is summarized in three reviews (Dickie and Bender, 1982; Ruxton and Kirk, 1997; and Rampersaud, et al., 2005) The studies find a strong association between breakfast consumption and nutritional adequacy. Children who eat breakfast have healthier diets than breakfast skippers and report higher energy intake and greater consumption of protein, fiber, calcium and several essential vitamins and minerals than children who skip breakfast regularly. Breakfast skipping leads to more snacking, usually of higher fat foods. In addition, children who skip breakfast are less likely to participate in physical activity. The connection between breakfast consumption and weight is less clear than the effect of breakfast on nutrition. Rampersaud et al. (2005) reviewed 16 studies of breakfast consumption and weight; four found no association between breakfast and weight, one study (Berkey et al., 2003) found that overweight breakfast skippers lost BMI over time in comparison to breakfast eaters, and the remaining 11 studies found that breakfast skippers were more likely to be overweight or obese or of higher body mass than breakfast eaters. These reviews suggest that policy which promotes breakfast consumption and provides more nutritious breakfast to children and adolescents (such as the SBP) may reduce the incidence of overweight or obesity.

Much of the literature that has examined the effects of the SBP focuses on two questions. The first is whether the SBP increases the probability that a child eats breakfast. The second is whether the SBP improves the nutritional intake of participants. While several studies have examined whether the SBP increases the chances that a child eats breakfast, the findings are mixed. Some evidence indicates that the SBP had no impact on whether a child consumes breakfast (Devaney and Fraker, 1989; Gleason, 1995), whereas more recent research found the opposite effect (Devaney and Stuart, 1998). The findings regarding the effects of the SBP on nutrient intake are also mixed. For example, both Devaney et al. (1993) and Gordon et al. (1995) found that participation in the SBP was associated with significant increases in the consumption of protein, thiamin, calcium, phosphorous, magnesium and food energy. SBP participation had negligible effects on the consumption of fats, saturated fats, sodium and cholesterol.

Although much of the evidence cited regarding the effects of the SBP is based on well designed studies that analyzed data from large representative samples, the studies share some deficiencies

that limit the implications of their findings for the childhood obesity epidemic. First, these studies are based on non-experimental data and for the most part fail to adequately address the fact that program participation is endogenous. Even those studies that employed instrumental variables to address potential selection bias associated with program participation failed to control for selection effects due to the reliance on weak instruments (Gordon, Devaney and Burghardt , 1995). Second, evidence documenting the effects of the SBP on dietary quality is based on the 24 hour dietary recall data which are subject to reporting error. Third, prior research predates major changes in federal dietary guidelines that apply to school food programs. Clearly, such changes are likely to have influenced the effects of the SBP. Finally, prior research documenting potential effects of the SBP is based on relatively old data from the early 1990s and thus predates widespread concerns about the increased prevalence of childhood obesity.

In a recent study, Bhattacharya, Currie and Haider (2006) addressed some of the deficiencies of earlier research on the SBP. Their study analyzed data from the NHANES spanning the years 1988 though 1994 using a difference-in-differences approach to account for unobserved differences between schools that offer the SBP and those that do not. Their identification strategy relied on the assumption that children will only receive a subsidized breakfast when school is in session. Specifically, they compared the dietary intake of students when school is in session to students' dietary intake when school is not in session. The authors recognized that the program only examined the impact of SBP availability and not SBP participation. The effects of SBP availability are likely to be smaller than those linked to participation because some children do not participate. Their findings suggest that SBP availability improves the diet quality without increasing calories. In particular, the SBP increases the scores on the healthy eating index, reduces the percentage of calories from fat, and lowers the probability of low fiber, iron and potassium. Second, availability of the SBP reduces the likelihood a child will experience vitamin and mineral deficiencies. Third, SBP availability appears to have positive spillover effects on adults and other pre-school children in the household. In particular, SBP availability increases the healthy eating index and reduces the percentage of calories from fat, yet it has negligible effects on nutrient intake. While this study addresses many of the shortcomings of prior research, the data were collected in such a way that geography is highly collinear with season. As a consequence, it is difficult to isolate the impact of the program from those associated with geographic location. Moreover, this study like previous work evaluating the SBP, is based on data collected prior to the implementation of many reforms in school nutrition programs that occurred during the late 1990s. Finally, the data used in this study likewise predate the time period of heightened concern among policymakers, health care professionals and parents about the increasing prevalence of obesity among children and adolescents. The research design, described below, attempts to address the shortcomings of prior studies evaluating the impact of the SBP on children's nutrient intake and health status.

The William F. Goodling Child Nutrition Act of 1998 authorized a pilot program to study whether the availability of a universal free school breakfast to children regardless of their household income would improve their dietary and academic outcomes relative to children in schools with the current School Breakfast Program (SBP), which offers free or reduced price breakfasts depending on income eligibility. The program was administered over three school years from Fall 2000 to Spring 2003. Six school districts were chosen for the pilot to represent the universe of districts which participate in the SBP. These districts were located in Boise, ID,

Columbiana, AL, Gulfport, MS, Phoenix, AZ, Santa Rosa, CA, and Wichita, KS (McLaughlin, et al., 2004). Within the chosen districts, schools were matched based on demographic variables and then randomly assigned to the treatment (universal-free school breakfast) or to the control (regular SBP). A sample of 4,358 students was randomly assigned from these schools for participation in the study (Crepinsek et al., 2006).

The most dramatic impact observed was in school breakfast participation. In the treatment schools, participation almost doubled from 19 percent to 36 percent. In contrast, participation only increased marginally in control schools from 19 percent to 21 percent (McLaughlin et al., 2004). Data on the dietary intake of students were collected in Year 1 of the study. Although students in treatment schools were more likely to eat a nutritious breakfast (80 percent as opposed to 76 percent in control schools), this difference did not translate into any important impacts in terms of 24 hour intake. There were no statistically significant differences in food energy intake or percent of food energy from fats, carbohydrates, or proteins. The only difference was in cholesterol; treatment students consumed slightly less cholesterol than control students (202 mg vs. 214 mg) (Crepinsek et al., 2006). Moreover, children in both the treatment and control groups consumed more energy than their Estimated Energy Requirements (EERs). There was no difference in energy intake or BMI between the two groups. There were also no consistent patterns in the data to suggest impacts on student behavior, achievement or health.

III. Study Design and Methods

III. A. Study Design

The conceptual framework for our evaluation is derived from the economic model of intra-household resource allocation. The cost of investing in each child depends on the cost of good food, medical care, and other health inputs as well as the cost of education, training, and other investments. The School Breakfast Program changes the cost of investing in the productivity of eligible children by lowering the price of nutritious food so that the cost of good nutrition and better health declines. The lower price of breakfast for the eligible child encourages parents to invest in the health of the eligible child and to purchase more nutritious food for this child through the school; the nutrition, health, and productivity of the eligible child are expected to improve because the cost of good nutrition for this child has fallen. The lower price of food for the eligible child increases the overall well-being of the household because parents now have more income to spend on other things; under the SBP if parents do not have to pay for breakfast for eligible children, they can afford to purchase more nutritious food for their children. Parents can also use these extra resources to purchase food and non-food goods that will not improve nutrition and health such as fast food meals, high fat or sugary foods, and video games. The extent to which the nutrition and health of each child change under the SBP depends on the extent to which parents compensate ineligible children with additional healthy inputs. We focus on the nutrition implications of this model. The SBP lowers the cost of breakfast and a child is more likely to have breakfast ***(Hypothesis 1)*** and to eat a more nutritious breakfast if he participates in the SBP. Overall nutrition is expected to improve with participation in the SBP **(Hypothesis *2)*.**

Participation in the SBP is not random; this selection bias will be taken into account in our econometric model. The consumption of nutrients and the health of children are also affected by preexisting household conditions such as race, ethnicity, marital status, and income. Children in lower income households (including single parent households and households on public assistance) have fewer resources to spend on health and nutrition, and health and nutrition are expected to be lower than in other households. Children with more educated parents are better able to attain good health and nutrition at any level of income, and children's health and nutrition are expected to be higher as a result. Nutrition may also differ by the gender, race, ethnicity, age, preexisting chronic health conditions of children in the family, and the characteristics of the community in which these households reside.

III. B. Population Studied

We analyze data from the four most recent waves of the National Health and Nutrition Examination Survey (NHANES): the NHANES 1999-2000, the NHANES 2001-2002, the NHANES 2001-2002, the NHANES 2003-2004, and the NHANES 2005-2006. The NHANES is a nationally representative survey conducted by the National Center for Health Statistics (NCHS), which is part of the Department of Health and Human Services' Center for Disease Control and Prevention (CDC). Each year, the survey examines approximately 5000 people in 15 counties. The sample is selected to be representative of the U.S. population by both age and race. Adolescents (15-19), seniors (60 and older), African Americans, and Mexican Americans are over-sampled to ensure accurate group estimates. We include only children in school in our samples.

III. C. Sample Selection

Figures 1 and 2 describe participation in the SBP over the 1999-2006 period. The program was available to 75-81 percent of the children in our sample; peak availability was in 2003-2004 (Figure 1). Actual participation in the program was about 30 percent; most of these children participated at least three times a week (29-31 percent) with a slight upward trend over time (Figure 2). Only three percent of children received a reduced price breakfast; other participants received a free breakfast. Figures 3-5 compare participants and nonparticipants on three characteristics: gender, ethnicity, and income. We find that boys are more likely to participate in the program than girls in each year. Not surprisingly, participants are more likely to be African-American or Hispanic than nonparticipants, and the ethnic gap is larger when we compare children who participate at least three times a week to other children. Participants are also more likely to come from low income families (income less than $20,000 per year) than nonparticipants; the poorest children are most likely to receive a school breakfast at least three times a week.

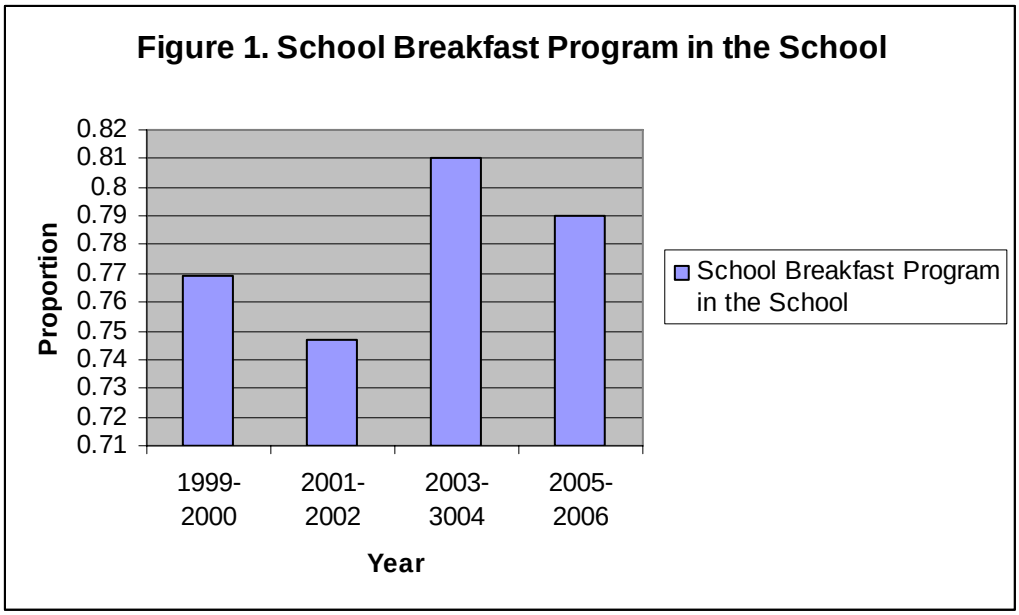


Figure 1. School Breakfast Program in the School
0.82
0.81
0.8
0.79
0.78
0.77
0.76
0.75
0.74
0.73
0.72
0.71
Proportion
1999-2000
2001-2002
2003-3004
2005-2006
Year
School Breakfast Program in the School

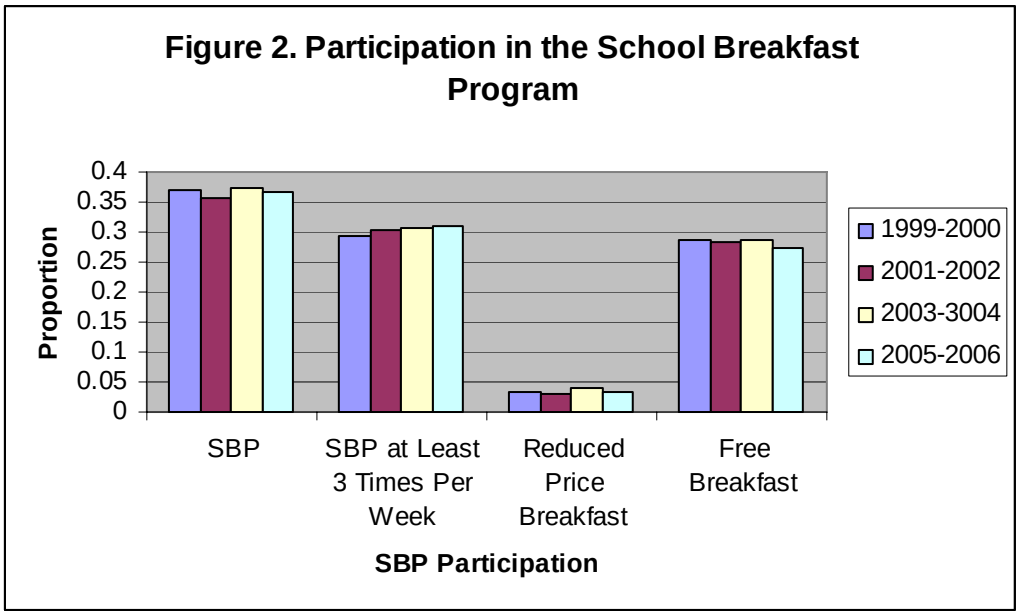


Figure 2. Participation in the School Breakfast Program
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Proportion
SBP
SBP at Least 3 Times Per Week
Reduced Price Breakfast
Free Breakfast
SBP Participation
1999-2000
2001-2002
2003-3004
2005-2006

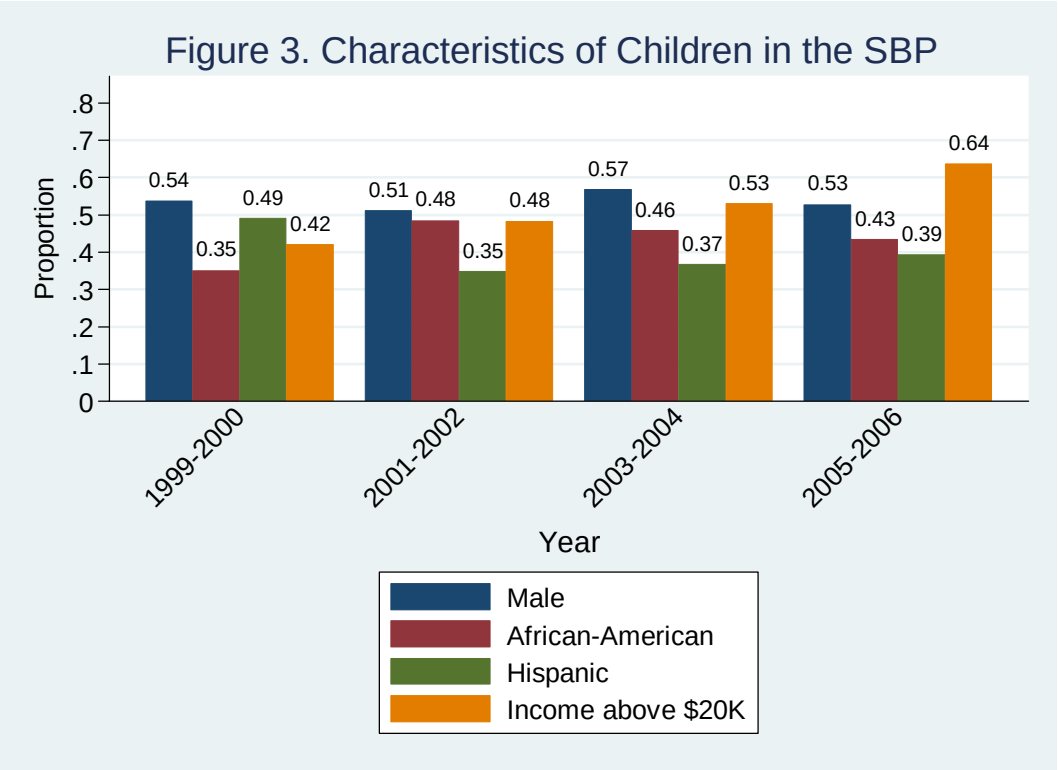


Figure 3. Characteristics of Children in the SBP
Proportion
.8
.7
.6
.5
.4
.3
.2
.1
0
0.54
0.35
0.49
0.42
0.51
0.48
0.35
0.48
0.57
0.46
0.37
0.53
0.53
0.43
0.39
0.64
1999-2000
2001-2002
2003-2004
2005-2006
Year
Male
African-American
Hispanic
Income above $20K

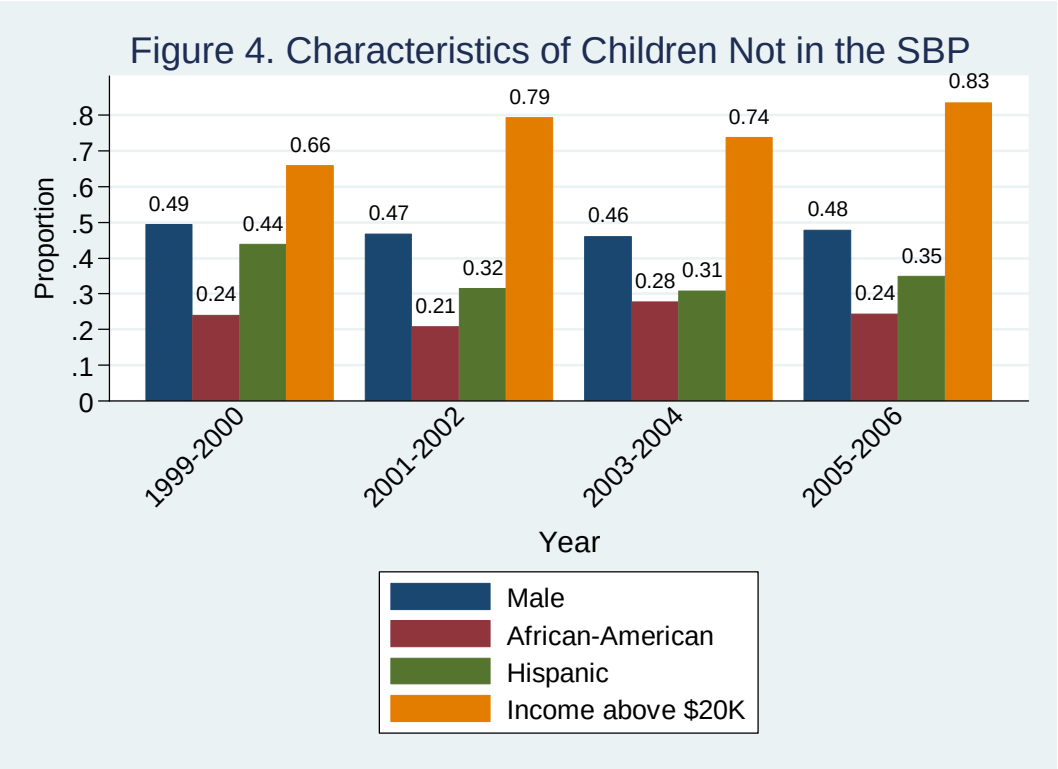
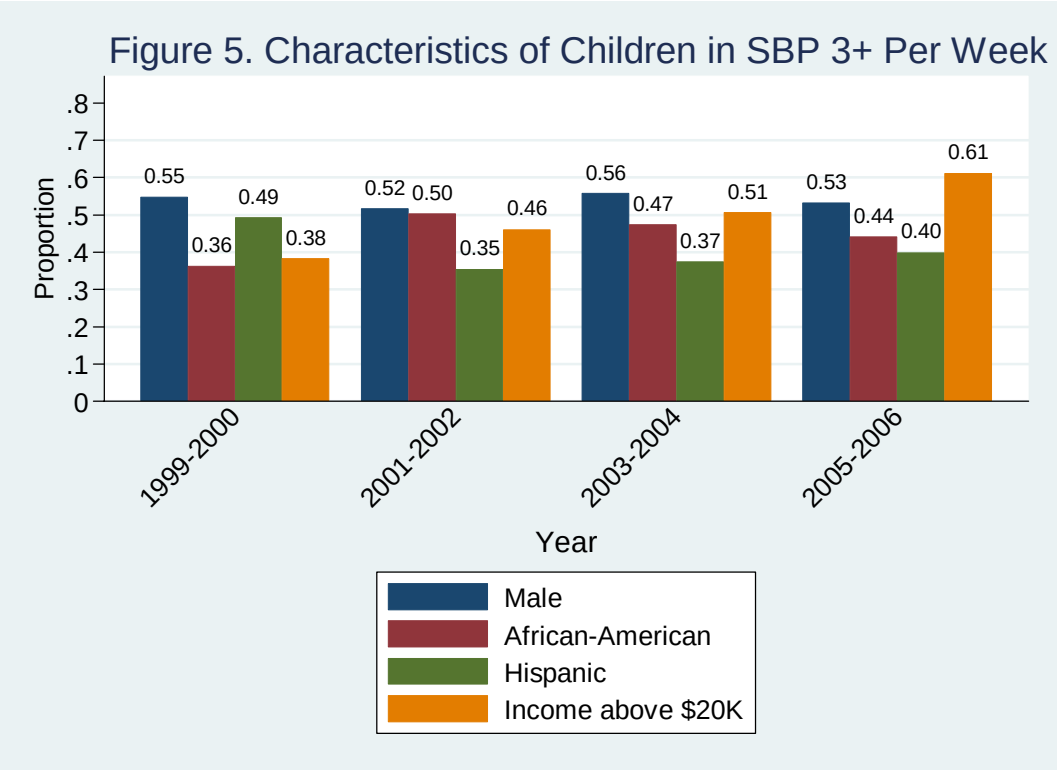


Figure 4. Characteristics of Children Not in the SBP
Proportion
.8
.7
.6
.5
.4
.3
.2
.1
0
0.49
0.24
0.44
0.66
0.47
0.21
0.32
0.79
0.46
0.28
0.31
0.74
0.48
0.24
0.35
0.83
1999-2000
2001-2002
2003-2004
2005-2006
Year
Male
African-American
Hispanic
Income above $20K



III. D. Instruments Used

1. *Dependent Variables: Nutritional Outcomes*

We evaluate the effect of the SBP on several indicators of nutritional status. The measures are derived from both the dietary recall interview and the laboratory component of the NHANES. The dietary recall interview asks respondents to recall the foods they ate in the past 24 hours. This information is used to calculate how many servings of different foods the person ate, as well as quantities of carbohydrates, proteins, fats, vitamins, and other nutrients that were consumed. Below we provide a brief justification for the indicators of nutrition that we examine.

Calories: *Excessive caloric intake can result in overweight status if a child consumes more calories than needed for growth, metabolism and physical activity.*
Fats: *Needed to promote brain and nervous system development, build hormones and assist in the absorption of vitamins. Yet, excessive consumption of fats can contribute to obesity. Unsaturated fats, contained in fruits, vegetables and fish are healthy, whereas saturated fats found in meats and dairy products can increase cholesterol and risk of heart disease.*
Fiber: *Found in fruits, vegetables, legumes and grains, helps control weight because these foods are filling and fiber has no calories. Fiber protects against stomach cancers and constipation.*
Calcium: *Necessary to build and maintain strong teeth and bones.*

Iron: *Deficiencies can lead to anemia, a condition where body tissues are deprived of adequate oxygen needed to function and grow.*
Folate*: Needed for the creation of DNA, RNA and red blood cell production. Helps to prevent damage to DNA by controlling levels of the amino acid homocysteine.*
Magnesium*: Its functions include maintaining a steady heartbeat, regulating blood sugar, strengthening bones, synthesizing proteins and metabolizing energy.*
Zinc: *Stimulates enzyme activity, supports the immune system, helps heal wounds, supports normal growth and is required for the production of DNA.*
Vitamin A*: Aids in regulating the immune system, disease prevention and guarding the body from bacteria.*
Vitamin E: *Works as an antioxidant and protects cells against damage from the process of energy metabolism.*
Vitamin C*: Helps to control infections and aids in the production of collagen, a tissue needed for the health of bones, teeth, gums and blood vessels.*
Potassium: *Reduces the negative effects of too much salt consumption and decreases the risk of kidney stones.*

We also examine the effect of participation in the SBP on a set of short term measures that have the potential to contribute to childhood obesity. These measures include total calories consumed, total sugars, total fat, total saturated fats, total monounsaturated fats, and total polyunsaturated fats. These data come from the dietary recall interview.

We evaluate the effect of the SBP on several measures that are drawn from the lab component of the NHANES. These measures include serum levels of vitamin A, vitamin C, vitamin E, folate, and cholesterol. We construct indicator variables to identify if a child's nutrient intake is deficient in each of the following: vitamin A, vitamin C, or vitamin E, and folate. For blood cholesterol, we construct a binary indicator to identify if the child has high cholesterol (in excess of 200 mg). We create indicator variables to measure deficient levels of the following nutrients: calcium, fiber, magnesium, potassium, and zinc. We also construct an indicator for anemia based on levels of hemocrit and hemoglobin (obtained from laboratory tests). The specification of these variables is given in Table A below.

Our final health measure is the number of school days missed. The SBP may encourage parents to send their children to school to receive breakfast in addition to education. In addition, if the school breakfast improves their nutrition significantly, children may be less likely to miss school because of illness.

Table A. Criteria for Nutrient Intake Indicators.

Outcome	Age/Gender	Inadequacy Criteria
Laboratory Measures		
Anemia	0-12	hemoglobin< 11.5 g/dL
	13-17	hemoglobin < 12 g/dL and hematocrit < 37%
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	6and above	< 11.4 µmol/L
Low vitamin E	4—16	< 11.6 µmol/L
Low folate	4 and above	< 7 nmol/L
Low calcium	4-8	< 800 mg/day
	9-18	< 1300 mg/day
Low fiber	4-8	< 25 g/day
	9-18 (female)	< 26 g/day
	9-13 (male)	< 31 g/day
	14-18 (male)	< 38 g/day
Low potassium	4-8	< 3.8 g/day
	9-13	< 4.5 g/day
	14-18	< 4.7 g/day
Low protein	4-8	< 19 g/day
	9-13	< 34 g/day
	14-18 (female)	< 52 g/day
	14-18 (male)	< 46 g/day
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
Low zinc intake	5-8	< 4 mg/day
	9-13	< 8 mg/day
	14-18/Female	< 9 mg/day
	14-60/Male	< 11 mg/day

Source: Indicators derived from serum blood are in Wilson et al. Dietary recall measures are in the *Dietary Reference Intake* (National Academy of Sciences).

2. *Intervening and Independent Variables*

The NHANES asks each child a series of three questions about the participation decision in the SBP. The first question asked is "whether the school offers the School Breakfast Program?" If the child responded "yes", a second question is asked "How many School Breakfast Program meals per week do you eat?" The third question identifies whether the child qualifies for a free or reduced price breakfast. These questions are used to construct an indicator variable measuring

program participation. We create a measure of participation that reflects whether the child is regularly receiving breakfast at school. If the child eats breakfast three or more times a week on average, our SBP participation is equal to one; it is equal to zero for children who do not participate at all or eat only one or two breakfasts a week. We experimented with other measures of participation but the results were weaker than the results for this measure of participation. The program has stronger nutrition and health effects if participation is regular.

The empirical model includes a number of other factors that may affect a child's nutrient intake and participation in the school breakfast program. The variables include age, gender, race/ethnicity, income, wealth, insurance, and measures of the child's preexisting health conditions and current health habits. These variables are defined in Table B below.

Table B. Definitions of Independent/Control Variables.

Variable	***Definition***
Demographic Characteristics:	
Male	*1 if male; 0 if female*
Age 11-16	*1 if age 11-16; 0 otherwise*
African-American	*1 if African American; 0 otherwise*
Hispanic	*1 if white Hispanic; 0 otherwise*
Other race	*1 if other race; 0 otherwise*
Mother born in US	*1 if Mother was born in US;0 otherwise*
Father born in US	*1 if Father was born in US;0 otherwise*
English at home	*1 if English is spoken in the home;0 otherwise*
Mother's age at birth	*Mother's age in years at birth*
Income/Wealth	
Household income	*Household income*
Family income	*Family income*
Household income A20	*=1 if income >= $20,000;0 otherwise*
Family income A20	*=1 if income3 >= $20,000;0 otherwise*
Food Stamps	*1 if family receives food stamps;0 otherwise*
WIC	*1 if family participates in WIC;0 otherwise*
Own home	*1 if family owns their home;0 otherwise*
TV	*Number of hours child watches TV per day*
Computer	*Number of hours child is on the computer per day*
Health:	
Day care[a]	*1 if child attended day care;0 otherwise*
Eat out	*1 if child eats out at least once a week;0 otherwise*
Diabetes[a]	*1 if child has Type I or Type II diabetes;0 otherwise*

Asthma[a]	*1 if child has asthma;0 otherwise*
Learning disability[a]	*1 if child has a learning disability;0 otherwise*
Dietary supplements	*1 if child takes dietary supplements;0 otherwise*
Exercise	*1 if child exercises regularly;0 otherwise*
Miminal exercise[a]	*1 if child gets minimal exercise;0 otherwise*
Moderate exercise[a]	*1 if child gets moderate exercise;0 otherwise*
High exercise[a]	*1 if child gets a lot of exercise;0 otherwise*
Elementary school: minimal exercise[a]	*1 if child aged 5-11 gets minimal exercise; 0 otherwise*
Elementary school: moderate exercise[a]	*1 if child aged 5-11 gets moderate exercise; 0 otherwise*
Elementary school: high exercise[a]	*1 if child aged 5-11 gets a lot of exercisel; 0 otherwise*
High school: minimal exercise[a]	*1 if child aged 12-16 gets minimal exercise; 0 otherwise*
High school: moderate exercise[a]	*1 if child aged 12-16 gets moderate exercise; 0 otherwise*
High school: high exercise[a]	*1 if child aged 12-16 gets a lot of exercise; 0 otherwise*
Insurance:	
Private insurance	*1 if family has private health insurance;0 otherwise*
Public insurance	*1 if family has public health insurance;0 otherwise*

III. E. Statistical Techniques Employed

Participation in the SBP is voluntary. For this reason, we anticipate that students who opt to participate will differ from those who do not. As is the case with most non-experimental data, potential selection bias linked to voluntary participation could bias the effect of the SBP on each student's nutrient intake indicators. We employ propensity score matching to address the potential selection bias associated with voluntary program participation.

We hypothesize that the SBP has short term and longer term effects on the nutrient intake and health of both participants and other household members. To estimate the existence and size of these effects, we compare the nutritional and health outcomes of participants in the SBP with comparable non-participants within a non-experimental setting. If Y_1 is the nutrition outcome if the child participates in the SBP and Y_0 is the nutrition outcome if the child does not participate, then $\Delta_i = Y_{1i} - Y_{0i}$ is the effect of the SBP on any child i. The average effect of the treatment on the treated is: $E[\Delta|D=1] = E[Y_1|D=1] - E[Y_0|D=1]$ where D=1 indicates participation in the SBP and D=0 indicates non-participation. This treatment effect cannot be estimated directly because $E[Y_0| D=1]$ is not observed. However, we can approximate this counterfactual by

employing a matching strategy. If we assume that (Y_0, Y_1) is conditionally independent of D so that $E(Y_0| D=1, Z) = E(Y_0|D=0, Z)$ where Z is a set of individual child, family, and location characteristics that determines participation in the program, we can estimate the effect of the treatment on the treated by matching participants to nonparticipants on propensity scores. The observed outcome for nonparticipants can be used to estimate the outcome for participants if they had not participated in the breakfast program but conditional on Z. Recent examples of the use of matching to estimate the treatment effect include Currie and Tekin (2006) on child abuse and crime, Dehejia and Wahba (2002) and Smith and Todd (2004) on the National Supported Work experiment, Agodini and Dynarski (2004) on dropout prevention programs, and Acosta (2006) on school attendance and migration.

We match all participants in the program at time t with children who are comparable to participants on observable characteristics (Z) (Rosenbaum and Rubin 1983). Matching is based on observable characteristics (Z) that affect program eligibility and baseline health (Dehejia and Wahba, 2002; Levine and Painter, 2003). The average treatment effect is the within match difference in nutrition outcomes. The advantage of the matching approach is that no functional form is assumed. However, matches are based only on observable factors. If selection into the program is based on unobservables as well (household tastes for good nutrition, for example), then the estimated treatment effect based on matched pairs may yield a biased estimate of the true treatment effect (Heckman, Ichimura, and Todd, 1997, 1998).

The matching procedure is multidimensional if there is more that one characteristic in Z. To ensure that the procedure is tractable, we estimate the probability of participating in the program with a probit model and condition on Z; from the probit model, we predict the probability of participation (propensity score) for individual i, P_i. We then match participants to non-participants based on the predicted propensity scores.

First, we match the nearest single neighbor and match without replacement. This method matches a single SBP nonparticipant to each SBP participant where they are comparable and guarantees the smallest propensity-score distance between the treatment and comparison units.[1,2] This strategy reduces the variance of the estimate but increases bias because the quality of the match may be poor. Second, we select the k SBP nonparticipants whose propensity scores are closest to the SBP participant in question; we use k=10 nearest neighbors. The propensity-score distance between the matched comparison units (SBP nonparticipants) and the treatment unit (SBP participant) is also minimized here, where each treatment unit can be matched to the nearest comparison unit, even if a comparison unit is matched more than once. Bias reduction is an important benefit of this technique (Dehejia and Wahba 2002).

Third, we employ caliper matching. A match is selected only if $\left\| P_i - P_j \right\| < \varepsilon,\ j \in I_0,$ where ε is the pre-determined tolerance level, or the "neighborhood". The neighborhood or caliper (C_i) is:

[1]When there are few comparison units similar to the treated units, matching without replacement forces treated units to be matched with comparable units that have rather different estimated propensity scores.
[2]The sort order of the data could affect the results from the nearest neighbor matching without replacement when the propensity score is estimated using categorical variables (Rosenbaum 1995, Leuven and Sianesi 2001).

$\{P_i \mid \|P_i - P_j\| < \varepsilon\}$. Observations with no match within the caliper are often excluded from the analysis although Dehejia and Wahba (2002) choose the single nearest neighbor outside the caliper. Dehejia and Wahba (2002) employ radius matching where the counterfactual is the mean probability of all observations within the caliper, not just the nearest neighbors. The difficulty with all of the caliper models is choosing the tolerance level (Smith and Todd 2005). Dahejia and Wahba (2002) in their analysis of the effectiveness of Supported Work on employment experimented with calipers of .001, .0001, .00001, and .00005. Caliper matching avoids bad matches by specifying a maximum tolerable distance between the propensity scores of the participant and non-participant groups. Caliper matching uses all of the SBP nonparticipants within a predefined propensity score radius or "caliper". Using only as many SBP nonparticipants as are available within the calipers is a benefit of caliper matching since it allows for the use of extra SBP nonparticipants when good matches are available and fewer SBP nonparticipants when good matches are not available (Dehejia and Wahba 2002).

Finally, we use kernel estimation to obtain the matched sample. The kernel estimation method centers a kernel function at each propensity score data point. Kernel estimators smooth out the contribution of each observed data point over a local neighborhood of that data point. The contribution of data point x_i to the estimate at some point x^* depends on how apart x_i and x^* are. The extent of this contribution is dependent upon the shape of the kernel function adopted and the width (bandwidth) accorded to it (Hwang, Lay, and Lippman, 1994). Performance of the kernel is measured by MISE (mean integrated squared error) or AMISE (asymptotic MISE). A common method to choose the optimal bandwidth is to use the bandwidth that minimizes the AMISE. The Epanechnikov kernel minimizes the AMISE; we use the Epamechnikov kernel with a bandwidth of 0.06.

Once the matching models are estimated and the matches determined, we test for the similarity of the average propensity score between the treatment and control groups. We rank the scores into two strata of n members; half of the members are in the treatment group, and half are controls. We test for the similarity of the average propensity score between participants and non-participants using a t-test. We then perform an F-test to test for the similarity of participants and non-participants across all strata. If these test results are not significant, then the comparison group is well-matched to the participant group. If the test result is significant, then we balance the groups by adding interaction and higher order terms to the participation model, and reselect the comparison group until all tests fail (Agodini and Dynarski, 2004; Dehejia and Wahba, 2002). Once we have determined the matched pairs for our analysis, we estimate the average effect of the treated in comparison to the average effect of the comparison group. This difference is our estimate is the effect of the SBP on nutrition and health of children.

IV. Detailed Findings

The results from the estimation of the propensity score matching models are given in Tables 1-8. Table 1 is the probit model of participation in the school breakfast program; propensity scores are estimated from this model. Table 2 is the single nearest neighbor matching model. Table 3 is the 10 nearest neighbors matching model. Tables 4-7 are caliper matching models with calipers of .001 (Table 4), .0001 (Table 5), .00001 (Table 6), and .00005 (Table 7). Table 8 contains the kernel matching model.

The probit participation model has a pseudo-R^2 that ranges from .13 for 1999-2000 to .24 for 2001-2002; the R^2 for the pooled model is .16. The model for 1999-2000 is the weakest. The R^2 for the 1999-2000 model is the lowest, and this model was never balanced even with the addition of interactions and higher order variables. The explanatory power for the other models is relatively low. One reason for this is the exclusion of all district and other regional covariates from the models for each year. These are potentially important determinants of participation, but this information is not available in the public use data.

The pooled matching model results are robust to the type of model estimated for most of the nutrition results. We find a statistically significant effect of the school breakfast program on the consumption of vitamin A, protein, magnesium, and folate; the program increases the consumption of protein, magnesium, and folate but reduces the consumption of vitamin A. From the kernel and 10 nearest neighbors models, we find that children who participate in the program miss fewer days in school. The nearest neighbor model also finds a significant decline in BMI and greater consumption of calcium and fiber among participants.

There are differences across years in the impact of the SBP. The propensity model for 1999-2000 is not balanced, and the results for this year are not reliable. We focus on the results for the other years. In general and as expected, we find for all years that there are more significant differences between participants and non-participants with nearest neighbor models in comparison to the caliper models, and among caliper models, fewer significant differences are detected when the caliper is reduced.

For 2001-02, the nearest neighbor, low caliper (.001), and kernel models find that children in the SBP were significantly less likely to have low consumption of vitamin E, but they were more likely to be anemic and to have low consumption of vitamin A. We also find that participants miss fewer days of school than nonparticipants in 2001-02. For 2003-04, the impact of the SBP is smaller. Across all models except for the caliper .00005 model, our results indicate that SBP participants are less likely to be deficient in protein and magnesium. The 10 nearest neighbor model and the kernel model indicate that SBP children are less likely to be deficient in folate, and they have higher cholesterol and miss fewer days in school than other children.

For the most recent year 2005-06, nearest neighbor and kernel models find that the SBP reduced the consumption of sugar and fat and increased the consumption of folate. Nearest neighbor models suggested higher consumption of calories among participants. No other consistent patterns are found in the data for this year.

Table 1. Probit model of school breakfast program participation.[a]

Variables	Pooled	1999-2000	2001-2002	2003-2004	2005-2006
Constant	**-0.776**	**0.621**	**-0.945**	**0.971**	**-0.858**
Demographics:					
Age 11-16	**-0.134**	0.081	0.109	0.186	-0.121
Male	**0.138**	**0.128**	**0.104**	**0.175**	**0.160**
African/American	**0.655**	**0.458**	**0.818**	**0.666**	**0.627**
Hispanic	**0.379**	**0.239**	**0.546**	**0.445**	**0.309**

Other race	**0.169**	0.047	0.248	**0.322**	0.022
Income:					
Food Stamps	**0.200**	0.144	**0.319**	**0.225**	0.151
WIC	**0.193**	0.060	**0.282**	**0.228**	**0.216**
HH income (/100,000)	**-0.457**	**-0.734**	**-1.270**	**0.588**	0.661
Fam. income (/100,000)	**-0.280**	**0.637**	-0.145	**-1.440**	**-1.570**
HH income A20	**0.222**	**0.365**	**0.394**	-0.216	0.087
Fam. income A20	-0.215	**0.630**	**-0.273**	**0.320**	-0.024
Wealth:					
Own home	**-0.147**	**-0.172**	-0.037	**-0.119**	**-0.265**
TV	**0.018**	0.005	**0.045**	-0.016	**0.051**
Computer	-0.012	0.004	-0.039	-0.012	-0.015
Insurance:					
Private	**-0.357**	**-0.323**	**-0.322**	**-0.381**	**-0.394**
Public	**0.080**	0.010	**0.167**	0.057	0.033
Health:					
Learning disability	**0.304**	**0.258**	**0.348**	**0.345**	
Diabetes	-0.256	-0.410			-0.270
Asthma	**-0.091**	**-0.261**	-0.069	0.079	-0.052
Dietary supplements	**-0.248**	**-0.186**	**-0.330**	-0.027	
Exercise	**0.003**	-0.002	0.002	**0.006**	**0.007**
Minimal exercise	**0.454**	0.310	-0.194	0.021	0.346
Moderate exercise	0.049	**0.528**	-0.004	**0.345**	-0.183
High exercise	0.069	**0.582**	0.062	**0.570**	
HS minimal exercise	**-0.500**	**-0.350**	**0.808**		-0.263
HS moderate exercise		**-0.342**	**0.524**	-0.182	
HS high exercise		**-0.414**	**0.498**	**-0.504**	-0.068
Elem moderate exercise	**0.383**				**0.447**
Elem high exercise	**0.476**				**0.425**
Eat out	0.052	-0.014	**-0.272**	**-0.411**	0.073
Day care	**-0.054**	**-0.144**	0.006	0.099	
Parents:					
Mom born in US	0.015	-0.031	-0.284	0.220	
Dad born in US	**-0.196**	**-0.368**	-0.090	-0.021	
English at home	**-0.092**	-0.142	-0.032	-0.162	-0.051
Mom age at birth	0.001	-0.0007	-0.003	-0.005	**0.011**
Pseudo R-square	0.165	0.130	0.241	0.170	0.173
Sample size	11,014	2832	3001	2594	2571

[a]A blank cell indicates that the variable was highly collinear with other variables in the model and had to be dropped from the probability model.

Table 2. Matching model of the impact of the school breakfast program on nutrition and health: nearest neighbor model.[a]

Variable	1999-2006		1999-2000		2001-2002		2003-2004		2005-2006	
	Difference	t-stat	Difference	t-stat	Difference	t-stat	Difference	t-stat	Difference	t-stat
Overweight	-0.004	-0.350	-0.029	-1.39	-0.005	-0.200	***-0.114***	-2.180	0.034	1.560
Underweight	-0.002	-0.330	***-0.023***	-1.72	0.008	0.400	-0.015	-0.420	0.001	0.100
Sugar	0.801	0.370			-9.110	-1.510	1.080	0.130	***-9.151***	-2.660
Transfat	0.139	0.130	***4.171***	1.97	0.337	0.120	-1.887	-0.400	-1.889	-0.960
Monosaturated fat	0.023	0.060	***1.530***	1.82	0.046	0.040	-0.073	-0.040	-0.511	-0.690
Polyunsaturated pfat	-0.159	-0.670	***0.865***	1.81	0.122	0.190	-1.367	-1.110	***-0.880***	-1.930
Saturated fat	0.276	0.750	***1.535***	1.98	0.159	0.150	0.011	0.010	-0.364	-0.520
Low vitamin A	***0.034***	5.390	***0.035***	2.41	0.012	0.680	0.000	0.000		
Low vitamin C	0.000	-0.280	0.000		0.000		-0.008	-0.360		
Low vitamin E	-0.004	-1.390	-0.005	-0.61	***-0.015***	-1.750	-0.015	-0.780		
Low calcium	***-0.031***	-2.680	0.019	0.82	-0.021	-0.700	-0.068	-1.130	-0.003	-0.100
low fiber	***-0.014***	-1.780	0.025	1.45	***-0.039***	-1.910	-0.038	-0.920	-0.003	-0.150
Low potassium	-0.012	-1.480	***0.033***	1.93	***-0.059***	-2.940	-0.045	-1.160	-0.006	-0.380
Low protein	***-0.040***	-5.300	-0.020	-1.27	***-0.039***	-1.690	-0.045	-1.270	***-0.033***	-2.380
Low magnesium	***-0.066***	-5.430	-0.033	-1.37	***-0.055***	-1.690	-0.023	-0.370	***-0.050***	-2.010
Low zinc	***-0.040***	-3.600	-0.010	-0.43	-0.028	-0.910	***0.098***	1.680	***-0.054***	-2.500
Calories	-15.316	-0.620	82.207	1.59	-8.811	-0.130	-18.371	-0.160	***-85.444***	-1.790
Low folate RBC	***-0.010***	-2.850	-0.007	-1.29	0.011	1.120	-0.008	-0.430	-0.010	-1.580
School days missed	-0.234	-1.400	-0.256	-0.7	***-0.745***	-1.710	-0.750	-1.090	-0.063	-0.160
BMI	***-0.480***	-2.800	-0.185	-0.56	-0.527	-1.080	-0.903	-0.940	-0.247	-0.680
Anemic	-0.001	-0.140	***-0.022***	-2.54	***0.025***	2.250	-0.008	-0.550	-0.008	-1.010
High cholesterol	0.004	0.610	***-0.024***	-1.7	-0.008	-0.440	0.038	0.970	0.009	0.650

[a]Difference = (school breakfast participant – non-participant). Boldface indicates significance at the 10% level.

Table 3. Matching model of the impact of the school breakfast program on nutrition and health: 10 nearest neighbors model.[a]

Variable	1999-2006		1999-2000		2001-2002		2003-2004		2005-2006	
	Difference	t-stat	Difference	t-stat	Difference	t-stat	Difference	t-stat	Difference	t-stat
Overweight	-0.009	-0.860	-0.004	-0.18	-0.018	-0.820	-0.024	-1.160	0.017	0.750
Underweight	-0.009	-1.380	-0.021	-1.58	0.010	0.640	***-0.040***	-3.140	-0.001	-0.050
Sugar	1.166	0.520			-3.150	-0.660	0.281	0.070	***-8.847***	-2.420
Transfat	0.992	0.920	***4.999***	2.28	0.964	0.410	1.744	0.840	-2.986	-1.420
Monosaturated fat	0.334	0.800	***1.816***	2.09	0.119	0.120	0.736	0.930	-0.853	-1.090
Polyunsaturated pfat	0.054	0.220	***1.046***	2.09	0.193	0.360	0.019	0.040	***-1.160***	-2.390
Saturated fat	0.539	1.390	***1.880***	2.36	0.527	0.610	0.916	1.250	-0.773	-1.030
Low vitamin A	***0.015***	2.400	0.016	1.14	***0.038***	2.700	0.021	1.420		
Low vitamin C	0.000	0.050	0.000				-0.003	-0.590		
Low vitamin E	-0.003	-0.930	-0.001	-0.1	-0.009	-1.470	0.000	-0.070		
Low calcium	-0.007	-0.570	0.017	0.74	-0.014	-0.550	-0.027	-1.060	0.021	0.830
low fiber	-0.007	-0.810	0.025	1.46	***-0.035***	-2.010	-0.005	-0.280	0.003	0.160
Low potassium	-0.006	-0.720	***0.040***	2.35	***-0.033***	-1.870	-0.009	-0.550	0.001	0.040
Low protein	***-0.023***	-2.950	-0.015	-0.92	-0.026	-1.420	***-0.022***	-1.690	-0.021	-1.450
Low magnesium	***-0.038***	-3.020	-0.023	-0.95	***-0.050***	-1.870	***-0.058***	-2.240	-0.011	-0.400
Low zinc	-0.019	-1.620	-0.006	-0.28	-0.032	-1.280	-0.005	-0.210	-0.023	-0.990
Calories	12.659	0.490	***119.059***	2.24	11.315	0.200	23.093	0.460	***-83.527***	-1.660
Low folate RBC	***-0.009***	-2.740	-0.005	-0.94	0.009	1.150	***-0.029***	-3.740	***-0.014***	-2.070
School days missed	***-0.418***	-2.410	-0.202	-0.57	***-0.679***	-2.210	***-0.978***	-2.640	-0.075	-0.190
BMI	-0.137	-0.770	0.054	0.16	-0.440	-1.100	-0.108	-0.310	-0.045	-0.120
Anemic	-0.002	-0.420	-0.010	-1.21	***0.017***	1.770	0.002	0.160	-0.009	-1.190
High cholesterol	0.002	0.280	-0.018	-1.28	0.006	0.400	***0.030***	2.040	0.014	0.970

[a]Difference = (school breakfast participant – non-participant). Boldface indicates significance at the 10% level.

Table 4. Matching model of the impact of the school breakfast program on nutrition and health: .001 caliper matching model.[a]

Variable	1999-2005		1999-2000		2001-2002		2003-2004		2005-2006	
	Difference	t-stat	Difference	t-stat	Difference	t-stat	Difference	t-stat	Difference	t-stat
Overweight	0.007	0.550	-0.013	-0.48	-0.005	-0.200	-0.011	-0.430	0.042	1.500
Underweight	0.002	0.220	-0.025	-1.38	0.008	0.400	***-0.034***	-2.090	0.001	0.090
Sugar	1.722	0.600			-9.110	-1.510	-0.079	-0.020	-4.625	-1.050
Transfat	0.151	0.110	3.825	1.35	0.337	0.120	1.299	0.490	-3.624	-1.370
Monosaturated fat	-0.032	-0.060	1.475	1.32	0.046	0.040	0.648	0.640	-1.084	-1.110
Polyunsaturated pfat	0.029	0.090	0.797	1.27	0.122	0.190	-0.070	-0.110	***-1.219***	-1.990
Saturated fat	0.158	0.320	1.300	1.23	0.159	0.150	0.677	0.730	-0.967	-1.030
Low vitamin A	***0.022***	2.810	0.005	0.29	0.012	0.680	***0.030***	1.680		
Low vitamin C	0.000	0.200					-0.004	-0.610		
Low vitamin E	0.000	0.000	-0.012	-1.06	***-0.015***	-1.750	-0.004	-0.580		
Low calcium	-0.008	-0.500	0.022	0.73	-0.021	-0.700	-0.042	-1.340	0.019	0.610
low fiber	-0.008	-0.760	0.022	0.97	***-0.039***	-1.910	-0.013	-0.610	0.009	0.410
Low potassium	-0.004	-0.370	0.020	0.85	***-0.059***	-2.940	-0.023	-1.070	0.012	0.550
Low protein	***-0.025***	-2.380	-0.016	-0.74	***-0.039***	-1.690	***-0.035***	-2.000	-0.026	-1.420
Low magnesium	***-0.054***	-3.350	***-0.054***	-1.69	***-0.055***	-1.690	***-0.085***	-2.610	-0.028	-0.860
Low zinc	-0.023	-1.580	-0.021	-0.71	-0.028	-0.910	-0.023	-0.780	-0.034	-1.180
Calories	-5.479	-0.160	105.788	1.56	-8.811	-0.130	12.006	0.180	-81.485	-1.290
Low folate RBC	***-0.013***	-2.700	***-0.015***	-1.83	0.011	1.120	-0.013	-1.320	***-0.020***	-2.070
School days missed	-0.156	-0.780	-0.284	-0.6	***-0.745***	-1.710	0.098	0.280	-0.035	-0.060
BMI	-0.092	-0.410	0.150	0.33	-0.527	-1.080	-0.494	-1.060	0.363	0.790
Anemic	-0.003	-0.500	***-0.020***	-1.66	***0.025***	2.250	0.001	0.110	-0.012	-1.170
High cholesterol	-0.001	-0.130	-0.005	-0.29	-0.008	-0.440	0.028	1.490	0.010	0.570

[a]Difference = (school breakfast participant – non-participant). Boldface indicates significance at the 10% level.

Table 5. Matching model of the impact of the school breakfast program on nutrition and health: .0001 caliper matching model.[a]

Variable	1999-2005		1999-2000		2001-2002		2003-2004		2005-2006	
	Difference	t-stat	Difference	t-stat	Difference	t-stat	Difference	t-stat	Difference	t-stat
Overweight	0.013	0.980	-0.030	-0.770	0.030	0.740	-0.048	-1.270	***0.079***	1.970
Underweight	0.006	0.650	-0.020	-0.770	0.017	0.550	-0.024	-0.940	-0.012	-0.520
Sugar	1.488	0.500			-0.585	-0.060	-5.150	-0.680	2.135	0.320
Transfat	0.431	0.300	3.771	0.920	0.813	0.180	1.779	0.450	-1.080	-0.270
Monosaturated fat	0.094	0.170	1.782	1.110	-0.322	-0.180	1.001	0.660	-0.064	-0.040
Polyunsaturated fat	0.103	0.320	1.051	1.130	0.584	0.610	-0.101	-0.100	-0.407	-0.450
Saturated fat	0.217	0.420	0.713	0.480	0.466	0.290	0.888	0.650	-0.383	-0.270
Low vitamin A	***0.021***	2.640	-0.016	-0.750	0.022	0.860	0.000	0.000		
Low vitamin C	0.000	0.250					-0.012	-0.860		
Low vitamin E	0.000	0.000	-0.010	-0.590	-0.017	-1.370	-0.008	-0.680		
Low calcium	-0.010	-0.600	-0.016	-0.390	0.000	0.000	-0.028	-0.610	0.071	1.590
low fiber	-0.014	-1.270	-0.023	-0.680	-0.017	-0.530	-0.028	-0.930	0.035	1.110
Low potassium	-0.010	-0.940	-0.016	-0.490	-0.026	-0.800	-0.036	-1.190	0.024	0.760
Low protein	***-0.033***	-3.040	-0.007	-0.210	-0.030	-0.990	***-0.060***	-2.320	-0.016	-0.560
Low magnesium	***-0.055***	-3.310	***-0.092***	-2.060	-0.056	-1.130	-0.056	-1.190	-0.012	-0.250
Low zinc	***-0.029***	-1.880	-0.066	-1.550	-0.039	-0.830	0.036	0.840	-0.035	-0.860
Calories	0.693	0.020	133.852	1.380	25.836	0.240	11.311	0.120	-21.313	-0.220
Low folate RBC	***-0.009***	-1.710	***-0.026***	-2.280	0.000	0.000	-0.016	-1.240	0.004	0.310
School days missed	-0.013	-0.060	-0.007	-0.010	***-1.461***	-1.730	-0.120	-0.180	-0.217	-0.470
BMI	-0.138	-0.600	0.118	0.180	-0.280	-0.370	-0.569	-0.830	***1.242***	1.890
Anemic	-0.001	-0.220	-0.010	-0.570	***0.052***	2.780	-0.024	-1.360	-0.020	-1.320
High cholesterol	0.000	0.050	-0.020	-0.760	0.009	0.310	0.044	1.550	0.016	0.610

[a]Difference = (school breakfast participant – non-participant). Boldface indicates significance at the 10% level.

Table 6. Matching model of the impact of the school breakfast program on nutrition and health: .00001 caliper matching model.[a]

Variable	1999-2005		1999-2000		2001-2002		2003-2004		2005-2006	
	Difference	t-stat	Difference	t-stat	Difference	t-stat	Difference	t-stat	Difference	t-stat
Overweight	0.042	1.580	-0.111	-1.220	0.034	0.290	-0.063	-0.600	-0.069	-0.640
Underweight	0.000	0.000	-0.022	-0.440	0.034	1.000	-0.031	-0.460	0.069	1.440
Sugar	-1.049	-0.180			13.730	0.470	10.726	0.540	18.358	1.240
Transfat	0.335	0.120	-2.588	-0.270	8.219	0.680	-5.507	-0.510	12.501	1.530
Monosaturated fat	-0.039	-0.040	-1.302	-0.360	0.482	0.100	-1.744	-0.440	***5.224***	1.740
Polyunsaturated fat	-0.348	-0.560	-0.402	-0.190	2.329	0.900	-1.795	-0.570	2.194	1.010
Saturated fat	0.747	0.780	-0.735	-0.200	4.106	0.920	-1.246	-0.350	3.846	1.290
Low vitamin A	0.000	0.000	0.022	0.440	0.034	0.440	0.031	1.000		
Low vitamin C	0.002	0.560					0.000	0.000		
Low vitamin E	-0.006	-1.010	0.022	0.440	-0.034	-0.900	-0.031	-1.000		
Low calcium	-0.038	-1.280	-0.089	-0.900	-0.172	-1.390	-0.094	-0.750	0.069	0.530
low fiber	-0.006	-0.280	0.044	0.590	-0.069	-1.000	***-0.188***	-2.100	0.000	0.000
Low potassium	-0.011	-0.570			-0.103	-1.370	-0.156	-1.820	0.034	0.580
Low protein	***-0.038***	-1.840			-0.069	-0.680	***-0.188***	-2.330	-0.103	-1.400
Low magnesium	-0.029	-0.910	0.044	0.420	-0.172	-1.290	***-0.281***	-2.320	-0.069	-0.520
Low zinc	-0.036	-1.240	0.089	0.860	-0.207	-1.570	0.063	0.550	***-0.207***	-1.780
Calories	-8.073	-0.130	28.062	0.120	293.966	0.890	-15.453	-0.060	278.414	1.470
Low folate RBC	***-0.019***	-1.990	***-0.089***	-1.940			-0.031	-0.580	0.000	0.000
School days missed	-0.213	-0.610	-0.333	-0.390	-0.724	-0.450	0.500	0.520	0.793	0.460
BMI	0.056	0.120	0.014	0.010	-1.243	-0.780	-0.900	-0.480	-0.602	-0.430
Anemic	-0.013	-1.100			-0.034	-0.550			-0.069	-1.440
High cholesterol	***0.031***	1.670	-0.022	-0.340	-0.034	-0.550	0.031	0.460	-0.034	-0.360

[a]Difference = (school breakfast participant – non-participant). Boldface indicates significance at the 10% level.

Table 7. Matching model of the impact of the school breakfast program on nutrition and health: .00005 caliper matching model.[a]

Variable	1999-2005		1999-2000		2001-2002		2003-2004		2005-2006	
	Difference	t-stat	Difference	t-stat	Difference	t-stat	Difference	t-stat	Difference	t-stat
Overweight	***0.027***	1.750	-0.022	-0.45	-0.008	-0.150	***-0.114***	-2.180	0.047	0.940
Underweight	0.005	0.490	-0.039	-1.29	0.023	0.620	-0.015	-0.420	-0.027	-0.960
Sugar	2.839	0.840			-5.583	-0.430	1.080	0.130	7.342	0.870
Transfat	0.494	0.310	0.288	0.06	-2.863	-0.480	-1.887	-0.400	2.575	0.520
Monosaturated fat	0.111	0.170	0.376	0.19	-2.285	-0.970	-0.073	-0.040	1.300	0.690
Polyunsaturated fat	0.157	0.430	0.315	0.27	0.126	0.100	-1.367	-1.110	-0.077	-0.070
Saturated fat	0.225	0.380	-0.358	-0.2	-0.671	-0.300	0.011	0.010	1.152	0.660
Low vitamin A	***0.021***	2.420	0.006	0.2	***0.094***	2.730	0.000	0.000		
Low vitamin C	0.001	0.270					-0.008	-0.360		
Low vitamin E	-0.002	-0.540			-0.016	-0.900	-0.015	-0.780		
Low calcium	-0.007	-0.370	-0.006	-0.1	-0.039	-0.630	-0.068	-1.130	***0.115***	2.050
low fiber	-0.010	-0.830	-0.017	-0.38	-0.047	-1.120	-0.038	-0.920	***0.068***	1.780
Low potassium	-0.006	-0.490	-0.028	-0.63	-0.047	-1.160	-0.045	-1.160	***0.081***	2.200
Low protein	***-0.034***	-2.740	0.022	0.58	-0.023	-0.560	-0.045	-1.270	-0.007	-0.180
Low magnesium	***-0.041***	-2.210	-0.088	-1.57	***-0.117***	-1.800	-0.023	-0.370	-0.041	-0.690
Low zinc	-0.026	-1.520	-0.006	-0.1	***-0.117***	-1.940	***0.098***	1.680	-0.074	-1.380
Calories	-0.243	-0.010	57.169	0.47	-19.273	-0.130	-18.371	-0.160	78.108	0.650
Low folate RBC	***-0.012***	-2.110	-0.017	-1.15	-0.008	-0.380	-0.008	-0.430	-0.007	-0.430
School days missed	0.057	0.240	-0.182	-0.3	-1.414	-1.030	-0.750	-1.090	-0.649	-1.030
BMI	-0.052	-0.200	0.206	0.26	-1.075	-1.120	-0.903	-0.940	1.220	1.580
Anemic	-0.005	-0.720	-0.006	-0.22	0.039	1.480	-0.008	-0.550	-0.027	-1.230
High cholesterol	0.007	0.620	-0.028	-0.86	0.008	0.210	0.038	0.970	0.007	0.210

[a]Difference = (school breakfast participant – non-participant). Boldface indicates significance at the 10% level.

Table 8. Matching model of the impact of the school breakfast program on nutrition and health: kernel matching model.[a]

Variable	1999-2005		1999-2000		2001-2002		2003-2004		2005-2006	
	Difference	t-stat	Difference	t-stat	Difference	t-stat	Difference	t-stat	Difference	t-stat
Overweight	-0.008	-0.750	-0.001	-0.050	-0.010	-0.450	-0.020	-0.990	0.009	0.410
Underweight	-0.011	-1.630	***-0.026***	-2.020	0.009	0.580	-0.035	-2.820	0.006	0.410
Sugar	1.745	0.810			-4.642	-1.000	2.373	0.620	***-10.573***	-2.910
Transfat	1.194	1.150	***4.921***	2.280	0.965	0.420	2.313	1.140	***-4.273***	-2.040
Monosaturated fat	0.445	1.090	***1.678***	1.960	0.139	0.150	0.894	1.140	***-1.312***	-1.670
Polyunsaturated pfat	0.055	0.230	***1.078***	2.170	0.219	0.420	0.178	0.380	***-1.383***	-2.870
Saturated fat	0.611	1.630	***1.871***	2.380	0.478	0.570	1.096	1.510	***-1.243***	-1.650
Low vitamin A	***0.018***	2.990	0.014	1.050	***0.029***	2.160	***0.025***	1.720		
Low vitamin C	0.000	0.000					-0.002	-0.340		
Low vitamin E	-0.002	-0.730	-0.002	-0.260	***-0.010***	-1.660	0.000	0.020		
Low folate	0.000	-0.140			0.000	-0.040	0.000	-0.160		
Low calcium	-0.008	-0.650	0.011	0.460	-0.006	-0.230	-0.016	-0.670	0.020	0.770
Low fiber	-0.003	-0.410	0.026	1.580	***-0.035***	-2.060	0.004	0.270	-0.007	-0.400
Low potassium	-0.002	-0.250	***0.034***	2.010	***-0.031***	-1.810	0.007	0.440	-0.005	-0.320
Low protein	***-0.024***	-3.160	-0.019	-1.190	-0.025	-1.430	***-0.029***	-2.270	-0.019	-1.330
Low magnesium	***-0.037***	-3.050	-0.030	-1.260	-0.036	-1.370	***-0.044***	-1.720	-0.013	-0.480
Low zinc	-0.018	-1.610	-0.014	-0.610	-0.022	-0.900	-0.003	-0.140	-0.023	-1.010
Calories	17.166	0.690	***117.117***	2.240	4.509	0.080	48.937	0.990	***-118.046***	-2.360
Low folate RBC	***-0.008***	-2.630	-0.005	-1.020	0.010	1.320	***-0.027***	-3.890	***-0.017***	-2.630
School days missed	***-0.397***	-2.390	-0.177	-0.520	***-0.517***	-1.770	***-0.824***	-2.360	-0.265	-0.680
BMI	-0.117	-0.690	0.154	0.470	-0.301	-0.800	0.000	0.000	-0.209	-0.560
Anemic	-0.001	-0.240	***-0.014***	-1.880	***0.017***	1.800	0.007	0.830	-0.007	-0.920
High cholesterol	0.001	0.220	-0.020	-1.470	-0.004	-0.260	***0.030***	2.070	0.008	0.590

[a]Difference = (school breakfast participant – non-participant). Boldface indicates significance at the 10% level.

V. Discussion and Interpretation of Findings

V. A. Conclusions

Our comparisons of participants and non-participants in the SBP indicate that this program had positive effects on the nutritional status of school aged children. Results from the pooled model show that the SBP statistically significant effect of the school breakfast program on the consumption of vitamin A, protein, magnesium, and folate; the program increases the consumption of protein, magnesium, and folate but reduces the consumption of vitamin A. From the kernel and 10 nearest neighbor's models, we find that children who participate in the program miss fewer days in school. The nearest neighbor model also finds a significant decline in BMI and greater consumption of calcium and fiber among participants. These results are driven by observations from the years 2001-2006 as the data for the matching model based on the years 1999-2000 are unstable.

V. B. Study Limitations

The major limitations to this study can be attributed to deficiencies in the NHANES data. First, we had no information on parental educational attainment and occupation both of which are likely to be significant determinants of children's food consumption patterns. Second, with the public use files we were not able evaluate possible spillover effects of the school breakfast program on the nutritional status of other family members of participant children. These spillover effects may occur because households of participant children have more resources to purchase more nutritious food for other family members. Third, our propensity score matching models predicting SBP participation lacked information on school characteristics because such data was not available in the NHANES survey. Fourth, although the NHANES survey includes information on child weight and height, it lacks information on parental weight and height that are likely to be significant determinants of child body mass index. Finally, the NHANES surveys are cross-sectional so we could not follow the food consumption patterns of the same children over time.

V. C. Comparisons with Findings from Other Studies

Results from our study are consistent with those reported by Bhattacharya et al. (2006) who analyzed the effects of the SBP on children's nutritional status using NHANES data for the years 1988 through 1994. One new finding is that children who participate in the SBP miss fewer days of school than nonparticipants.

V. D. Possible Application of Findings to Actual MCH Health Care Delivery Systems

This is not applicable.

V. E. Policy Implications

The results from this study suggest that participants in the SBP consume a healthier diet than those who opt not to participate. It also appears that consumption of this healthier diet has positive effects of school attendance. Encouraging greater participation in the SBP is one approach that schools can use to improve the nutritional status and attendance of children.

V. F. Suggestions for Further Research

Future research should focus on the following questions:

1) what is the impact of the SBP on child health outcomes including body weight and the child's risk of being obese;
2) what is the effect of the SBP on educational achievement;
3) what is the effect of the SBP on the nutritional status and health outcomes of other family members of children who participate in the SBP.

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