

Submitted Article

Children's Consumption of Fruits and Vegetables: Do School Environment and Policies Affect Choices at School and Away from School?

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Abstract *School environment and policies may affect children's ability to make healthy food choices both at and away from school. Using data from the third School Nutrition Dietary Assessment Study conducted in 2005 we estimate the effect of environment and policies on children's fruit and vegetable intakes. We use an instrumental variable approach to control for the endogeneity of participation in the National School Lunch Program (NSLP). On an average school day, school lunch participants consume more fruits and vegetables, including relatively more at school and less away from school compared to nonparticipants. Meal policies had little effect on NSLP participation itself. Policies that restrict high fat milks or deserts and restrict the sale of competitive foods are associated with greater fruit and/or vegetable intake at school; some policies affected consumption at home as well.*

Key words: Food assistance, Fruits and vegetables, National School Lunch Program, Endogeneity, Censoring.

JEL codes: C34, C36, I38.

Childhood and adolescence are unique periods of growth and development. In addition to maturing physically, children begin to make independent choices about when, where, and what they eat. Good nutrition during childhood and adolescence plays a key role in assuring adequate growth and development, preventing the long-term risk of obesity and other chronic disease, and enhancing overall health and well-being (USDA/HHS 2010). Since food habits are still developing during childhood and adolescence, it is important to help young people adopt healthy eating behaviors to improve longer-term health outcomes. Although individual factors such as food preferences play an important role (Birch and Fisher 1998), environmental factors also influence children's eating behaviors (Story, Neumark-Sztainer, and French 2002). In addition to the home environment and parental influence, the school environment is recognized as contributing to the eating habits of children (Just and Wansink 2009; Hanks et al. 2012).

Most children spend the majority of their weekdays at school and obtain, on average, more than one-third of their daily caloric intake from foods consumed at school during the school year (Briefel, Wilson, and Gleason 2009); schools are therefore a natural place to implement policies that promote healthy eating habits. Federal, state, and local school nutrition programs and policies can influence the types and amounts of foods available to students in school. In this regard, the U.S. Department of Agriculture's (USDA) two school meal programs, the National School Lunch Program (NSLP) and the School Breakfast Program (SBP), can play an important role in children's diets and food habit formation, and thus positively influence children's weight status, and health (Gundersen, Kreider, and Pepper 2012).

The NSLP is the second largest government food assistance program in the United States, and its primary objective is to "safeguard the health and well-being of the nation's children" (Child Nutrition Act of 1966). The program seeks to provide nutritious lunches at low-cost or free of charge to school children. Children from lower-income families are eligible for free or reduced-price lunches, while children from families with higher income levels can purchase a "full-price" lunch.¹ In 2012, 68% of the lunches served nationwide were provided free or at a reduced price (USDA 2013a). All public and non-profit private schools and residential child-care institutions are eligible to participate in the NSLP. The NSLP provides lunches to 31.6 million children each school day, costing the federal government \$10.4 billion in cash payments and another \$1.2 billion for USDA Foods (formerly known as commodity foods) available for use by schools that participate in the NSLP (USDA 2013b) annually. Similar to NSLP, the SBP was designed to ensure that all children have access to healthy, well-balanced meals on school days. In 2012, 12.8 million children participated in the program, with 8% of these children receiving free or reduced-price breakfasts, costing the federal government over \$3 billion annually (USDA 2013c, 2013b).

Recent national data show that school-age children consume only 40% of the daily amounts of vegetables recommended by the 2005 Dietary Guidelines for Americans, and have low levels of intake of vitamins A and C, potassium and dietary fiber, and high levels of intake of saturated fat and sodium (IOM 2010). Fruits and vegetables are rich in vitamins, minerals, and fiber and low in calories. Increased consumption of fruits and vegetables is associated with reduced risk of health conditions such as obesity, diabetes, cancer and cardiovascular disease, although the mechanisms linking dietary intakes to health outcomes are often complex (Hung et al. 2004; Briefel, Wilson, and Gleason 2009; Ledoux, Hingle, and Baranowski 2011; Cooper et al. 2012). Despite the public's increased knowledge about the health benefits of diets high in fruits and vegetables, school-age children's diets are characterized by low intakes of vegetables and fruits (Cole and Fox 2008; Condon, Crepinsek, and Fox 2009). In

¹Children are eligible to receive free lunches if their family income is no more than 130% of the federal poverty level (adjusted for family size), or if they have families participating in the Supplemental Nutrition Assistance Program (SNAP), Temporary Assistance for Needy Families (TANF), or the Food Distribution Program on Indian Reservations (FDPIR). For reduced-price lunches, family income must be between 130-185% of the poverty level, and for paid or "full-price" lunch, above 185% of the poverty level. Local school food authorities determine their own prices for full-price lunches, but must operate their meal services as non-profit programs.

addition to offering healthful meals that include a variety of fruits and vegetables, schools can implement policies and provide nutrition education programs that focus on increasing the intake of fruits and vegetables and decreasing the consumption of “competitive foods,” which tend to be high in fat and sugar (Fox, Gordon, Nogales, and Wilson 2009; Hanks et al. 2012). Competitive foods refer to any foods or beverages that are sold or served to students outside of the school meal programs through venues such as à la carte sales, vending machines, school stores, and fundraisers. Unlike school meals, which must meet specified nutrition standards to receive USDA funding, competitive foods historically have not been required to meet federal nutrition standards.² During the 2004-2005 school year, which is the school year portrayed in our dataset, one or more sources of competitive foods were available in 75% of elementary schools, 97% of middle schools, and 100% of high schools (Fox, Gordon, Nogales, and Wilson 2009).

Many studies have examined the effects of the NSLP and SBP on children's food and nutrient intake and health outcomes, with mixed results. Available research on the consumption of particular foods and beverages finds that NSLP participants consume more fruits, vegetables, and milk and consume fewer desserts, snacks, and beverages other than milk and 100% fruit juices at lunch compared to nonparticipants (Gordon et al. 2007; Condon, Crepinsek, and Fox 2009; Gleason and Suitor 2003). However, these studies did not adjust for the potential endogeneity of school meal program participation. Other recent studies that have examined the effects of the school meals programs on children's nutrition and health outcomes have addressed the potential endogeneity of program participation, although these studies have not examined children's food intake per se (Schanzenbach 2009; Bhattacharya, Currie, and Haider 2006; Gundersen, Kreider, and Pepper 2012; Millimet, Tchernis, and Husain 2010). Existing research also shows that for school-age children, broader aspects of the school food environment play an important role in their food and nutrient intake and weight status. Finkelstein, Hill, and Whitaker (2008) characterized school food environments and policies in three domains—school lunches, competitive foods, and other food-related policies and practices. These authors found that as children move to higher grade levels (from elementary, to middle to high schools), their school environments become less healthy; this did not vary according to the share of minority or low income students in the schools. Based on a sample of middle-school students in the upper Midwest, Kubik and colleagues (2003) found that à la carte availability was negatively associated with *total* daily intake of fruits and vegetables, and positively associated with the percentage of calories from fat and saturated fat. Snack vending machines were also negatively associated with total fruit intake, whereas fried potatoes offered in school lunches increased fruit and vegetable intake.

More recently, Briefel et al. (2009) used data from a national sample of school-age children to estimate the effects of school food environments and policies on children's dietary behaviors *at school*. Limitations on competitive foods in middle and high schools reduced calories from

²The Healthy, Hunger Free Kids Act of 2010 (P.L. 111-296) now gives the USDA the authority to establish nutrition standards for all foods offered or sold to students on school campuses during the school day.

sugar-sweetened beverages and increased vegetable intake; however, in elementary schools such limits increased calories from low-nutrient energy-dense (LNE) foods (presumably from foods brought from home). Daily fresh fruits and vegetables and no French fries in elementary school lunches reduced calorie intake from LNE foods and increased the consumption of fruits and vegetables among students. [Just, Lund, and Price \(2012\)](#) found that offering more fruits and vegetables increased the fraction of children who ate at least one serving of fruits or vegetables during a school day. However, relatively little research has been done on the influence of the school food environment and policies on children's and adolescents' eating behaviors or food choices, both in and outside of school.

The objective of our research is to assess the effects of school food environment and policies on children's intakes of fruits and vegetables by location of consumption. In addition to school intake, we include fruit and vegetable intake away from school (mainly at home), and evaluate whether intake at school substitutes for or supplements intake at home. We use data from the 2004-2005 School Nutrition Dietary Assessment Study-III (SNDA-III), which includes information on 2,096 school-age children and data from 256 schools throughout the country to assess fruit and vegetable intakes of the children by location. To address the potential endogeneity of school lunch program participation, we estimate a system of two equations specified jointly that includes: (a) the latent consumption of target foods (fruits and vegetables) by location of consumption and (b) the student's decision to participate in the school lunch program.

Methods and Data

Our outcome variables of interest are the amounts of: fruits consumed at school; fruits consumed away from school; vegetables consumed at school; and vegetables consumed away from school. There is a censoring problem associated with our outcome variables of interest. Specifically, 66%, 58%, 27%, and 12% of the respective observations are zero. To address the censoring we work with latent consumption, c_{mi}^* , and specify our model for students' consumption of fruits and vegetables at school and away from school as follows:

$$c_{mi}^* = x_{mi}\alpha + \gamma p_i + \varepsilon_{mi} \quad (1)$$

$$c_{mi} = \max\{0, c_{mi}^*\} \quad (2)$$

where c_{mi} is the consumption of student i of good m ($m = 1, \dots, 4$), p_i is a student's participation decision, x_{mi} is a vector of student, household and school level controls, as well as policies on à la carte foods and other school environment-related controls.

Participation in a school lunch program can be endogenous, and we account for this endogeneity by using an instrumental variables approach:

$$p_i^* = z_i\beta + \mu_i \quad (3)$$

where

$$p_i^* = \begin{cases} 1 & \text{if } p_i^* > 0 \\ 0 & \text{if } p_i^* \leq 0 \end{cases} \quad (4)$$

and z_i is a vector of instrument and individual, household, and school-specific characteristics. To account for the potential endogeneity of NSLP participation, we allow the errors of equations (1) and (3) to be correlated. That is, unobservables that make a student more likely to participate in the school lunch program may also make that student more likely to consume more fruits and vegetables, both at school and away from school. We choose to accommodate this type of correlation by including an individual-specific error term, u_{mi} in equation (1), and also by allowing this error to be correlated with the error term in equation (3). Thus, unobservable factors affecting NSLP participation will likely spill over and correlate with the fruit and vegetable intakes of students at different consumption locations.

Equation (1), with an individual-specific error term, u_{mi} and equation (3) now represent a standard two-equation treatment-response model using only observed, rather than potential outcomes. We estimate this model using Bayesian methods. For more on related posterior simulators for such models, see [Koop and Poirier \(1997\)](#), [Chib and Hamilton \(2000, 2002\)](#), [Poirier and Tobias \(2003\)](#), and [Chib \(2007\)](#). [Ishdorj, Jensen, and Tobias \(2008\)](#) used a similar model specification for evaluating the effectiveness of the Special Supplemental Nutrition Program for Women, Infants and Children (WIC) program.

Data Source

Our analysis utilizes the data from the third School Nutrition Dietary Assessment Study (SNDA-III) conducted for the USDA Food and Nutrition Service (FNS) by Mathematica Policy Research, Inc. The SNDA-III is a nationally representative, cross-sectional study of the NSLP and the SBP that was conducted in 2005. As part of its ongoing assessment of program performance, the FNS sponsored SNDA-III to provide comprehensive and up-to-date information on the characteristics of the school meals programs, the school food policies and environments that affect the programs, the foods and nutrients in school lunches and breakfasts, and the role of school meals in students' diets ([Gordon, Crepinsek, Nogales, and Condon 2007](#)). The study used a multistage sampling approach to sample public school food authorities (SFAs),³ schools in a random subset of those SFAs, and students attending those schools. Parents reported on child and family background characteristics, and students completed an in-person 24-hour dietary recall interview for a "target day" of interview. During the same week, school food service managers completed a self-administered food service operations survey and a menu survey. Surveys of SFA directors and principals provided additional information on the school food environment and food policies, as well as school demographic characteristics.

The final sample sizes for SNDA-III included 2,314 students (aged 6 to 18) from 287 schools in 94 SFAs, with data from both the 24-hour dietary recall and parent interviews. Observations with non-missing or imputed values for the individual- and school-level control variables used in our analysis constituted 96% of the full sample. Thus, our final sample consisted of 2,096 students from 256 schools.

³A school food authority is the local administrative unit for the federal school meal programs, and may represent one or more school districts.

Table 1 Number of Students Participating in NSLP, SBP, and Receiving Free/Reduced Price Meals, School Year 2004-2005 (unweighted)

	Participation										
				Breakfast				Lunch			
	Total	Free/ Reduced		Total	Free/ Reduced		Total	Free/ Reduced			
	N	N	%	N	%	N	%	N	%	N	%
Elementary	664	335	51	147	22	117	80	488	74	287	59
Middle	717	339	47	114	16	92	81	447	62	246	55
High	715	272	38	80	11	57	71	321	45	173	54
Total	2096	946	45	341		266		1256		706	

With respect to participation in NSLP and SBP programs, SNDA-III data include measures of both “usual” and “target day” participation. Because the analysis described in this article examines a short-term outcome—consumption of fruits and vegetables—we used the short-term measure of school lunch program participation on a single day. It can be difficult for students to tell whether their food selections comprise a full reimbursable meal, and the tendency is to over-report participation in the meal programs. Therefore, students were classified as NSLP participants if they (a) self-reported lunch participation on the recall day, and (b) their 24-hour recall included a minimum number of food items offered in the reimbursable lunch as reported in the menu survey (Gordon et al. 2007). We used the same approach to identify SBP participants.

Table 1 provides information on the total number of students in our sample, the number participating in NSLP and SBP, and the proportions of each that receive free/reduced-price meals. The rates of NSLP and SBP participation in our sample (table 1) were nearly identical to the full SNDA-III sample for breakfasts and high school lunches (Gordon et al. 2007), and only slightly higher for lunch participation in elementary schools (74.4% vs. 72.6%) and middle schools (62.0% vs. 60.2%). Approximately 90% of SBP participants also participated in the NSLP.

The main outcome variables—fruit and vegetable consumption at school and away from school—were derived from the students’ dietary intake data and measured as cup-equivalent measures of fruit and vegetable intake.⁴ These measures were estimated by matching the 24-hour recall data to the Pyramid Servings Database for USDA Survey Food Codes (version 1.0) for (a) each discrete fruit and vegetable reported, such as raw apple, cooked broccoli, tossed salad, and orange juice; and (b) mixed dishes comprised mostly of vegetables, such as chef’s salad, stir-fried chicken and vegetables, chili with kidney beans, and vegetable soup. Using the food-level Pyramid Servings data and an indicator of whether the food was consumed at school, we were able to compute the total cup equivalents consumed by each student separately for solid fruits at school,

⁴One cup of fruit, ½ cup dried fruit, 1 cup 100% fruit juice, and 1 cup raw or cooked vegetable count as 1 cup equivalent of fruits or vegetables (Dietary Guidelines for Americans 2010).

solid fruits away from school, vegetables except French fries at school, and vegetables except French fries away from school.

Fruits and vegetables consumed "at school" may have been obtained from reimbursable school meals, "competitive" school food venues, or from sources outside the school (such as a store, restaurant, or the student's home). However, fruits and vegetables consumed "away from school" rarely included those obtained at school (Briefel, Wilson, and Gleason 2009). Most of the fruits and vegetables consumed away from school were consumed "at home."

Dependent and Explanatory Variables

Fruit juices and French fries were excluded from the measures of fruit and vegetable intake for two reasons: (a) our intent was to model fruit and vegetable intakes as more healthful eating behaviors; and (b) a previous study using SNDA-III data (Briefel et al. 2009) found very little evidence of a relationship between school food environment and practices and fruit and vegetable intake at school when juices and French fries were included. Table 2 provides a summary and the mean values of the independent variables used in the analysis. The student and household-level control variables used in both the participation and consumption

Table 2 Explanatory Variables and Sample Mean Values

Variables	Mean^a	Std. Dev.
Participation in NSLP	0.622	0.013
Receive free/reduced price	0.425	0.014
Household size	4.438	0.040
Income	17,399	3,097
Hispanic	0.221	0.011
White	0.174	0.010
Black	0.536	0.014
Other race	0.069	0.008
Elementary school	0.513	0.014
Middle school	0.206	0.009
High school	0.281	0.011
Female	0.510	0.014
Urban	0.785	0.010
Parent: less than high school	0.427	0.014
Parent: high school or GED	0.341	0.013
Parent: college graduate	0.231	0.012
2 parents, both employed	0.283	0.012
2 parents, one employed	0.352	0.013
Neither parent employed	0.056	0.006
1 parent, employed	0.149	0.010
1 parent, not employed	0.090	0.008
School enrollment ≤ 500	0.312	0.014
$1000 \leq$ school enrollment ≤ 500	0.429	0.014
School enrollment > 1000	0.259	0.011
Instrument		
Long lunch lines	0.710	0.013

^aWeighted to be nationally representative of children that participate in the NSLP.

Table 3 Dependent Variables and Sample Mean Values

Variables	All Children	
	Mean ^a	Std. Dev.
Fruits at school (<i>cup equivalent</i>)		
All fruits	0.537	0.020
Solid fruits (excluded fruit juices)	0.293	0.014
Fruits away from school (<i>cup equivalent</i>)		
All fruits	1.010	0.043
Solid fruits (excluded fruit juices)	0.435	0.027
Vegetables at school (<i>cup equivalent</i>)		
All vegetables	0.435	0.014
All vegetables (excluded French fries)	0.387	0.013
Vegetables away from school (<i>cup equivalent</i>)		
All vegetables	0.983	0.029
All vegetables (excluded French fries)	0.947	0.029

^aWeighted to be nationally representative of children that participate in the NSLP.

equations include gender, race/ethnicity, household size, and an indicator of the number of parents in the household and their employment status. An indicator denoting if the student currently (last 30 days) receives free or reduced-price school lunches, based on parental reports, is included in both the consumption and participation equations. The consumption model includes indicators for students' target day participation in NSLP. The indicators for elementary, middle and high school were included in both the participation and consumption equations because school lunch participation and school food policies and practices vary across school levels, and existing studies show evidence of differences in children's consumption behavior by school level (Briefel et al. 2009; Finkelstein, Hill, and Whitaker 2008; Fox, Hedley, Wilson, and Gleason 2009). We included school-level indicators as one of the control variables instead of the age variable because the correlation between student's age and school level was relatively strong (the correlation between age and elementary school was -0.82, and between age and high school was 0.74). Table 3 provides summary statistics for the dependent variables: fruits (at and away from school) and vegetables (at and away from school). As expected, the average levels of consumption are smaller when some items are excluded (e.g., fruit juices from the fruits, and French fries from the vegetables). French fries and fruit juices represent a relatively large portion of total vegetables and fruits consumed at school and away from school. In the subsequent analysis, fruit juices and French fries are excluded from the measures of fruit and vegetable intake.

The school-level controls include region,⁵ urbanicity, and size (student enrollment). We also make use of eleven school food policy and practice variables that may affect both school meals participation and students' dietary behaviors, as shown in table 4. The first of these variables is based on information from school principals—whether or not nutrition education was provided in every grade in the school. Food service managers

⁵These are the seven regions through which FNS administers the school meal programs: Northeast, Mid-Atlantic, Southeast, Midwest, Mountain Plains, Southwest, and Western.

Table 4 School Food Environment and Policy Variables (percentage of children)

Variables	Description	Mean ^a	Std. Dev.
Nutrition education	Has nutrition education in every grade	0.58	0.013
Nutrient information for parents	Nutrition information is available to parents	0.59	0.014
No store or snack bar	No store or snack bar selling foods or beverages	0.80	0.010
No fundraising	No fundraising activities selling sweet or salty snacks	0.38	0.013
No à la carte	No à la carte food and beverages except skim/1% fat milk	0.15	0.010
No vending machine	No vending machines	0.41	0.014
Vending, but not in cafeteria	Vending machine, but not in food service area	0.31	0.012
No high fat milk	Whole or 2% fat milk not offered	0.43	0.014
Daily fresh fruits/vegetables	Fresh fruits and raw vegetables offered daily	0.57	0.014
No fries	French fries not offered	0.26	0.012
No dessert	Dessert not offered	0.23	0.011

^aWeighted to be nationally representative of children that participate in the NSLP.

indicated whether information was available on the nutrient content of USDA-reimbursable meals for parents. The next five variables characterize the availability of competitive foods and beverages, based on on-site observation at the schools. The remaining four variables characterize healthful aspects of the reimbursable school lunch offered, based on the menu survey: (a) no whole or 2% fat milk, (b) fresh fruits or raw vegetables offered daily, (c) no French fries or similar potato products, and (d) no desserts.

To address the potential endogeneity of NSLP participation in the consumption model, we use an instrumental variable. An appropriate instrument should have the potential to influence the students' NSLP participation decision, but not their consumption of fruits or vegetables. We therefore chose an instrument that measures a child's opinion about the length of lunch lines in the cafeteria. In schools where the number of lines is inadequate (i.e., longer waiting time), students may choose to bring lunch from home or purchase items from a vending machine or snack bar as an alternative to the reimbursable meal. In contrast, if the number of lines is felt to be adequate (less waiting), student participation in NSLP is likely to be higher because of the lower (time) costs of eating a school-provided meal. An adequate number of lunch lines, however, should not affect students' consumption of fruits or vegetables at or away from school, conditional on NSLP participation. We tested for the endogeneity of the NSLP participation variable using a Hausman test. Based on this test, we rejected the null hypothesis that the school lunch program participation variable is exogenous at the 5% significance level, and proceeded to follow an instrumental variables approach to obtain consistent parameter estimates. We conducted the relevance of the instrument test, which indicated that the instrument we chose is valid (the F-statistic is 12.60).

Results

We estimated four systems of two equations—one system for each of the four food choice outcomes (fruits and vegetables at or away from school), and including the participation equation. We estimated the two-equation system of participation in NSLP and latent consumption using Bayesian methods. We ran the Gibbs sampler for 50,000 iterations and discarded the first 5,000 observations as the burn in.

NSLP Participation

Table 5 reports the parameter posterior means, standard deviations, and probabilities of being positive from the NSLP participation equation. Our instrument seems to play an important role in the NSLP participation decision, and the sign is consistent with our expectations. That is, students who think that lunch lines are generally long appear to be less likely to participate in NSLP, since the parameter posterior mean is negative, with very low probability of being positive (0.05).

As expected, characteristics of the students and their families influence NSLP participation. Students who live in larger households, live in the Southeast, and attend schools with enrollment less than 1,000 are more likely to participate in NSLP. In addition, children whose parents have no high school education or high school degree are more likely to participate

Table 5 Posterior Means, Standard Deviations, and Probabilities of Being Positive for NSLP Participation

Variables	NSLP Participation		
	E(\cdot y)	Std(\cdot y)	Pr($\cdot > 0$ y)
Intercept	-0.30	0.26	0.47
Receive free/reduced price	0.71	0.08	1.00
Household size	0.06	0.02	1.00
Hispanic	0.25	0.10	1.00
Black	0.16	0.10	0.95
Other race	0.12	0.14	0.59
Income	0.00	0.00	0.54
Middle school	-0.36	0.10	0.00
High school	-0.82	0.12	0.00
Female	-0.20	0.06	0.00
Urban	-0.33	0.09	0.00
Parent: less than high school	0.16	0.09	0.97
Parent: high school or GED	0.21	0.08	1.00
2 parents, one employed	-0.14	0.07	0.03
Neither parent employed	-0.14	0.14	0.26
1 parent, employed	0.05	0.10	0.66
1 parent, not employed	-0.16	0.11	0.11
School enrollment ≤ 500	0.03	0.10	0.97
$1000 \leq$ school enrollment ≤ 500	0.08	0.09	1.00
Long lunch lines	-0.13	0.07	0.05
Nutrition education	-0.07	0.07	0.41
Nutrient info for parents	0.06	0.07	0.20
No store or snack bar	-0.01	0.08	0.79
No fundraising	-0.05	0.07	0.87
No à la carte	-0.13	0.09	0.27
No vending	-0.02	0.11	0.78
Vending machine, but not in cafeteria	-0.09	0.08	0.51
No high fat milk	0.07	0.07	0.75
Daily fresh fruits/vegetables	0.07	0.07	0.63
No fries	0.04	0.08	0.74
No dessert	0.04	0.07	0.82

Note: Seven regional indicators were also included in the estimation for Northeast, Mid-Atlantic, Southeast, Midwest, Mountain Plains, Southwest, and Western regions.

in NSLP compared to students whose parents have a college degree or above. Being Hispanic or black is associated with a higher probability of school lunch participation. Children attending middle and high schools are less likely to participate in the NSLP than children attending elementary school.

Participation varies among groups with different household structures and parental employment. Compared to students with two employed parents, students living in households with two parents present and one employed are less likely to participate in the NSLP, reflecting the time constraint that employed parents may face in preparing their children's lunches. With regard to free/reduced-price meals, children are more likely to participate in their school lunch program if they are receiving free or reduced-price meals. An important finding is that none of the included

school food environment and policy variables has any effect on students' decision to participate in NSLP.

Fruit and Vegetable Consumption: Socio-economic Factors

Table 6 presents parameter posterior means and probabilities of being positive from estimating the censored regressions for four variables of interest—solid fruits at school (i.e., not including juice), solid fruits away from school, vegetables except French fries at school, and vegetables except French fries away from school. After controlling for the endogeneity of NSLP participation, we find that students participating in NSLP tend to consume more fruits and vegetables at school compared to those who choose not to participate. This result suggests that NSLP is effective in increasing the fruit and vegetable intakes of program participants. However, these findings are location specific, (i.e., students who eat school lunches consume fewer vegetables away from school), indicating that some substitution effect may be present.

Students in larger households with more educated parents consume more fruits at school. We observe some regional variation in students' intakes of fruits and vegetables by location of consumption.⁶ Receiving free or reduced-price meals has no effect on our intake variables of interest. Students attending smaller schools consume more fruits and vegetables at school and more fruits away from school. Compared to white students, Hispanics and students of other races consume more fruits away from school.

Fruit and Vegetable Consumption: School Food Environment and Policies

As noted earlier, fruits and vegetables consumed “at school” may have been obtained from reimbursable school meals, “competitive” school food venues, or from sources outside the school. Several aspects of the school food environment and specific policies do have an effect on the consumption of fruits and vegetables. With respect to the availability of competitive foods and beverages in schools, we find that putting restrictions on sales of à la carte foods and beverages and having no stores or snack bars selling foods and beverages have a positive effect on students' intake of fruits at school. However, restrictions imposed on à la carte foods and beverages in schools reduce the amount of fruits consumed away from schools, indicating that this policy may lead to some substitution, that is, the increase in fruit intake at school is associated with less fruit intake away from school. There is also some indication (although not statistically valid in the case of fruits) that a policy of no store or snack bar is associated with less fruit and vegetable intake at home. As reported in table 4, about 85% of the students in our sample had access to competitive foods and beverages through à la carte sales, while only 20% had such access through school stores and snack bars.

A no dessert policy is associated with increased vegetable (but not fruit) consumption in school, and lower intakes of vegetables away from school. In fact, somewhat surprisingly, a no dessert policy had little effect on fruit consumption at any location. Approximately 77% of students in sample schools were offered dessert with their school lunch.

⁶These results are available upon request.

Table 6 Posterior Means and Probabilities of Being Positive for Fruit and Vegetable Consumption

Variables	Fruits at School		Fruits Away		Vegetables at School		Vegetables Away	
	E(\cdot y)	Pr(\cdot > 0 y)	E(\cdot y)	Pr(\cdot > 0 y)	E(\cdot y)	Pr(\cdot > 0 y)	E(\cdot y)	Pr(\cdot > 0 y)
Intercept	-0.56	0.01	-1.15	0	0.02	0.41	1.09	1
Participation in NSLP	0.14	1	-0.1	0.4	0.41	1	-0.08	0.01
Receive free/reduced price	-0.01	0.71	-0.07	0.57	-0.01	0.78	-0.03	0.42
Household size	0.03	0.92	0.02	0.67	0	0.49	0	0.64
Income	0	0.78	0	0.35	0		0	0.51
Hispanic	0.14	0.85	0.36	1	-0.11	0.02	-0.05	0.33
Black	0.05	0.62	0.2	0.18	-0.1	0.03	-0.05	0.24
Other race	-0.21	0.08	0.5	1	-0.11	0.07	0.17	0.35
Middle school	-0.53	0.01	-0.11	0.69	0.03	0.76	0.06	0.76
High school	-0.48	0	-0.32	0.04	0.03	0.84	0.21	0.96
Female	0.16	0.01	0.06	0.48	-0.01	0.21	-0.18	0
Urban	-0.07	0.35	0.18	0.79	0.02	0.44	-0.04	0.24
Parent: less than high school	-0.26	0	-0.2	0.05	0	0.78	-0.03	0.75
Parent: high school or GED	-0.13	0.06	-0.03	0.79	-0.01	0.8	-0.03	0.52
School enrollment \leq 500	0.32	1	0.21	0.96	0.14	0.95	-0.01	0.24
1000 \leq school enrollment \leq 500	0.22	0.98	0.01	0.5	0.1	0.94	-0.07	0.15
Nutrition education	-0.01	0.79	0	0.55	0	0.55	0.04	0.85
Nutrient info for parents	-0.06	0.32	0.29	0	-0.04	0.21	-0.03	0.54
No store or snack bar	0.01	0.9	-0.05	0.81	-0.04	0.68	-0.17	0.01
No fundraising	-0.08	0.15	-0.07	0.56	-0.04	0.39	-0.01	0.86
No à la carte	0.13	0.91	-0.48	0	0.06	0.62	-0.03	0.41
No vending	0.04	0.71	0.15	0.8	0.01	0.45	0.03	0.81
Vending, but not in cafeteria	0.03	0.6	-0.05	0.77	0.03	0.51	0.02	0.8

Continued

Table 6 Continued

Variables	Fruits at School		Fruits Away		Vegetables at School		Vegetables Away	
	E(\cdot y)	Pr($\cdot > 0$ y)	E(\cdot y)	Pr($\cdot > 0$ y)	E(\cdot y)	Pr($\cdot > 0$ y)	E(\cdot y)	Pr($\cdot > 0$ y)
No high fat milk	0.18	1	-0.02	0.74	0.06	1	0.13	0.99
Daily fresh fruits/vegetables	0.03	0.63	0.18	0.97	-0.04	0.11	0	0.8
No fries	-0.12	0.05	-0.18	0.05	0.02	0.51	0.09	0.98
No dessert	-0.09	0.23	0.06	0.66	0.1	1	-0.17	0.01

Note: Seven regional indicators were also included in the estimation for Northeast, Mid-Atlantic, Southeast, Midwest, Mountain Plains, Southwest, and Western regions.

Approximately 60% of the students in our data attended schools that offer fresh fruits or raw vegetables in school lunches daily (table 4). We found that a fresh fruits and vegetables policy at school leads to increased intake of fruits away from school, but has no effect on children's fruit intake in school. Only 26% of the students in our sample attended schools that did not offer French fries. This policy is associated with increased vegetable consumption away from school, but reduced fruit consumption both at school and away from school. Not offering whole and 2% milk at school leads to higher intake of both fruits and vegetables at school and higher intake of vegetables away from school.

Policies not allowing fundraising, vending machines, and desserts, or offering fresh fruits and vegetables daily have little effect on fruit intake in school. Likewise, policies that do not allow stores or snack bars, fundraising, à la carte sales, vending machines, and French fries have little effect on vegetable consumption in school. Providing nutrition education to parents, however, does increase fruit consumption away from school.

Our findings in table 6 show that NSLP participants consume more fruits and vegetables at school and less away from school compared to nonparticipants, a result that suggests that some substitution between consumption at school and away from school may prevail. In table 7 we report predicted mean cup-equivalent values for fruits and vegetables consumed by location and participation status, and also report the total amount (combined school and away) of fruits and vegetables consumed by NSLP participants and nonparticipants. Based on our calculations we find that in terms of cup equivalents, the amounts of fruits (0.301) and vegetables (0.520) consumed at school were higher for lunch program participants compared to nonparticipants (0.214 and 0.250 cups, respectively). NSLP participants consumed more fruits at school (by 0.087 cup equivalents) and more vegetables (by 0.271 cup equivalents) at school than nonparticipants. If these consumption patterns were repeated throughout a school week, the differences in amounts would translate into slightly less than one more half-cup serving of fruits and more than 1.3 cups of vegetables for NSLP participants. However, at the same time, participants consumed less fruits and vegetables away from school compared with nonparticipants (lower by 0.063 and 0.099 cup equivalents, respectively).

Table 7 Predicted Values for Fruit and Vegetable Consumption by Location and NSLP Participation

	Fruits (<i>cup equivalents</i>)		Vegetables (<i>cup equivalents</i>)	
	NSLP Participants	NSLP Nonparticipants	NSLP Participants	NSLP Nonparticipants
At school	0.3012 (0.165)	0.2138 (0.132)	0.5202 (0.080)	0.2491 (0.057)
Away from school	0.4460 (0.172)	0.5092 (0.191)	0.9826 (0.151)	1.0818 (0.161)
Daily total	0.7624 (0.266)	0.7219 (0.252)	1.4563 (0.167)	1.3276 (0.170)

Note: Standard errors are reported in parentheses.

During a school week, the differences in amounts would translate into nearly a half-cup serving lower for vegetables and a bit less than a half-cup serving for fruits. These results are consistent with our earlier findings that some substitution exists between consumption at school and away from school. Although school lunch participation was associated with increased intakes of fruits and vegetables at school, in general, consumption away from school makes an important contribution to the day's intake. We find that both participants and nonparticipants consume relatively more of their fruits and vegetables away from school.

To examine the effect of program participation on total daily consumption of fruits and vegetables, we summed the amounts of fruits and vegetables consumed both at school and away, re-estimated the models separately for fruits and vegetables, and then calculated the predicted values. The results on total consumption are reported in table 7. The mean intake of fruits consumed per day by NSLP participants was 0.041 cup equivalents higher compared to nonparticipants. Similar patterns were observed for vegetables—participants consumed a daily total of 1.456 cup equivalents of vegetables compared to 1.3276 cup equivalents consumed by nonparticipants. Thus, our findings provide evidence that children who participate in the NSLP have higher daily intakes of both fruits and vegetables (excluding juice and French fries) than do nonparticipants.

Discussion and Conclusions

Both the federally-supported school lunch program and state and local school policies have an important role to play in encouraging school-age children to consume healthier foods, particularly fruits and vegetables. Evidence presented in this analysis of recent data from a nationwide sample of public schools supports these policies' contributions to healthier food choices, after accounting for the potential endogeneity of NSLP participation.

First, NSLP participation leads to students' increased consumption of both fruits and vegetables in school. Specifically, with all other school policies and characteristics held constant, fruit and vegetable consumption increases with program participation. At the same time, the results suggest that the increased consumption of vegetables at school may come at the expense of reduced consumption away from school. That is, for NSLP participants, the vegetables consumed at school may substitute for a portion of the vegetables acquired and eaten from outside-of-school sources. Despite this, the results also indicate that participants consume more fruits and vegetables, in total, compared to nonparticipants.

A second important finding is that the school food environment, and policies such as not offering French fries or dessert, not offering high-fat milk (whole and 2%), not offering à la carte food and beverages, or offering fresh fruits and raw vegetables daily all had no effect on children's decisions to participate in school meal programs. Thus, policies to improve nutrition in school meals do not discourage children's participation in NSLP. This finding has important implications as schools work to adopt new nutrition standards for school meal programs. The evidence here suggests that the new nutrition standards for school meals, which include increased offerings of fruits and vegetables, restrictions on milk to

skim/nonfat or 1% lowfat offerings (USDA 2012), and policies that limit access to competitive foods are all unlikely to discourage students from consuming school meals. We found that a majority of household- and student-level variables do affect the program participation decision. However, the results for both program participation and food intake vary by grade level. Students in middle and high school are less likely to participate in the school meal program. Targeted improvements regarding foods that appeal to these students may be needed to encourage their participation.

Third, some policies encourage fruit and vegetable consumption in school, while others discourage consumption, although interpreting the reason for these effects is more difficult to address. Restrictions on competitive foods (no store or snack bar; no à la carte) increase fruit consumption in school. Not offering high-fat milk has a positive effect on both fruit and vegetable consumption in school. A no dessert policy is associated with increased vegetable consumption in school. Not offering French fries discourages fruit consumption in school but has no effect on vegetable consumption in school. As the new meal standards are implemented, more frequent and varied fruits and vegetables will become part of the reimbursable meals. It is important to identify policies complementary to increased consumption of fruits and vegetables.

Finally, there is some evidence that policies directed to in-school consumption of fruits and vegetables can have an effect on consumption that takes place outside of school. Some food policies that limit competitive foods lead to decreased home consumption of fruits (for no à la carte services) and vegetables (for no store or snack bar). Offering daily fresh fruits and vegetables in school or making nutrition information available to parents, increased fruit consumption at home. Moreover, providing no French fries in school led to increased vegetable consumption at home (defined as intake that did not include French fries). The opportunity to have a positive and complementary effect on fruits or vegetables consumption amplifies the effect of school food policies on healthier food consumption.

Although this paper has provided a number of useful findings, it is clear that many questions remain unanswered. Further work must be done to study the effect of participation in multiple food assistance programs. In addition, offering some foods may lead to cross-product substitution effects within the school meal overall that are not fully accounted for in the analysis. Cross-sectional data used in this study limit the ability to assess the long-run effect of NSLP participation and school food environment and practices. However, despite these limitations, new evidence presented here indicates the potential to improve food choices through policies and the school environment.

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