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

Ariun Ishdorj, Helen H. Jensen, and Mary Kay Crepinsek

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Center for Agricultural and Rural Development
Iowa State University
Ames, Iowa 50011-1070
www.card.iastate.edu

Ariun Ishdorj is assistant professor at Texas A&M University; Mary Kay Crepinsek is senior researcher, Mathematica Policy Research, Inc.; Helen Jensen is professor at Iowa State University.

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For questions or comments about the contents of this paper, please contact Arjun Ishdorj, Texas A&M University, Agricultural Economics, 2124 TAMU, College Station, TX 77843-2124; Ph: 979-845-8491; E-mail: *aishdorj@tamu.edu*.

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ABSTRACT

School environment and policies affect children's healthy eating choices both at and away from school. We estimate their effect on fruit and vegetable intakes and control for the endogenous decision to participate in the National School Lunch Program. School meal participants consume more total fruits and vegetables, with relatively more at school and less away from school compared to nonparticipants. The policies had little effect on participation itself. Policies to restrict high fat milks or desserts for school lunch and selling competitive foods are associated with greater fruit and/or vegetable intake at school; some policies affected consumption of fruits and/or vegetables at home as well. Policies that encourage fruit and vegetable consumption can improve diets both at and away from school.

Ariun Ishdorj is an Assistant Professor, Texas A&M University; Mary Kay Crepinsek is Senior Researcher, Mathematica Policy Research, Inc.; Helen Jensen is a Professor, Iowa State University. We thank Katherine Ralston and participants at the AAEA/EAAE Food Environment Symposium for helpful comments and suggestions. This research was supported in part by the USDA Economic Research Service, FANRP Agreement Number 59-5000-7-0118.

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Introduction

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 ensuring 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 in order to improve longer term health outcomes. Although individual factors such as food preferences play an important role (Birch and Fisher 1998), there is an increasing awareness that children's eating behaviors are influenced by environmental factors as well (Story et al. 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).

Considering 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 et al. 2009a), schools are 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 offered and sold to students in school. In this regard, the U.S. Department of Agriculture's (USDA) two school meal programs, namely the National School Lunch Program (NSLP) and 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.

The NSLP is the second-largest government food-assistance program in the United States with the primary objective to “safeguard the health and well-being of the Nation’s children.” The program seeks to provide nutritious lunches at low-cost or for free to school children. Children from lower income families are eligible for free or reduced-price lunch, while children from families with higher income can receive a “full-price” lunch.[1] In 2011, 66% of the lunches served were provided free or at a reduced price (USDA 2011a). All public and non-profit private schools and residential child care institutions are eligible to participate in the NSLP. The NSLP provides lunches to 31.8 million children each school day, which costs the federal government $10.1 billion in cash payments and another $1.2 billion for USDA Foods (formerly known as commodity foods) (USDA 2011b). Similar to NSLP, the SBP was designed to ensure that all children have access to healthy, well-balanced meals on school days. In 2011, 12.1 million children participated in the program—84% of these children received free or reduced-price breakfasts costing the federal government over $3 billion (USDA 2011a and 2011c).

Recent national data show that school-age children consume only 40% of recommended vegetable intake, 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 (Hung et al. 2004; Cooper et al. 2012). Despite the increasing

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

knowledge about the health benefits of diets high in fruits and vegetables, school-aged children's diets are characterized by low intakes of vegetables and fruit (Cole and Fox 2008; Condon et al. 2009). In 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" that tend to be high in fat and sugar (Fox et al. 2009a; Hanks et al. 2012). Competitive foods are any foods or beverages which are sold or served to students outside of the school meal programs through venues such as a la carte sales, vending machines, school stores, and fundraisers. Unlike school meals, which must meet specified nutrition standards in order to receive USDA funding, competitive foods historically have not been required to meet federal nutrition standards.[2] During the 2004–2005 school year, the school year of our data, one or more sources of competitive foods were available in 75% of elementary schools, 97% of middle schools, and 100% of high schools (Fox et al. 2009a).

To date, 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 fewer desserts, snacks, and beverages other than milk and 100% fruit juice at lunch compared to nonparticipants (Gordon et al. 2007a; Condon et al. 2009; Gleason and Suitor, 2003). However, these studies did not adjust for the potential endogeneity of school meal program participation. Other recent studies have looked at the effects of the school meal programs on children's nutrition and health outcomes and have addressed the potential endogeneity of program participation, although they do not examine children's food intake per se

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

(Schanzenbach 2009; Bhattacharya et al. 2006; Gundersen et al. 2012; and Millimet et al. 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. They found that as children move to higher grade levels (from elementary to middle to high schools), their school environments become less healthy, and that this did not vary with 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 a 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 lunch increased fruit and vegetable intake.

More recently, Briefel et al. (2009b) 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 sugar-sweetened beverages and increased vegetable intake; however, they increased calories from low-nutrient energy-dense (LNED) foods in elementary schools (presumably, from foods brought from home). Daily fresh fruits and vegetables and no French fries in elementary school lunches reduced calorie intake from LNED foods, and increased cups of fruits and vegetables among students. Just, Lund, and Price (2012) found that offering more fruit and vegetables increased the fraction of children who ate at least one serving of fruit or vegetables on 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 environment and policies on children's intakes of fruits and vegetables by location of consumption. In addition to intake at school, we include intake of fruits and vegetables 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 to assess fruit and vegetable intake of the children by location. To address the potential endogeneity of school meal 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 decision to participate in the school meal program.

Methods and Data

Econometric Model

Our outcome variables of interest are the amount 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 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 a consumption of student i of good m (m=1,…,4), p_i is a student's participation decision, and x_{mi} is a vector of student, household, and school-level controls, and policies on a la carte foods, and other school environment related controls.

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

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

where

$$p_i^* = \begin{cases} 1 & if \quad p_i^* > 0 \\ 0 & if \quad p_i^* \le 0 \end{cases}$$

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 meal program may also make that student more likely to consume more fruits and vegetables 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 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 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 et al. (2008) used a similar model specification in evaluating the effectiveness of the WIC program.

Data Source

Our analysis makes use of the data from the third School Nutrition Dietary Assessment Study (SNDA-III) conducted for the Food and Nutrition Service (FNS) by Mathematica Policy Research, Inc. The SNDA-III is a nationally representative, cross-sectional study of the National School Lunch Program (NSLP) and School Breakfast Program (SBP) 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 meal 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 et al. 2007b). 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. Approximately three schools were selected per district—one elementary, one middle, and one high school. Students in grades 1 through 12 were randomly sampled within schools. Data for SNDA-III were collected from SFA directors, school food service managers and principals, students and their parents or guardians, and by direct observation of school food venues. Most important for our purposes, students completed an in-person 24-hour dietary recall interview. Specially trained field interviewers used the USDA Automated Multiple-Pass Method (AMPM) software (version 2.3, 2003, Agricultural Research Service, Beltsville, MD) to collect information on the types and quantities of food and beverages consumed on a typical school day (weekdays), and whether or not the food was eaten at school. Parents were interviewed in person or by telephone about child and family background characteristics. During the same week, school food service managers completed a self-administered food service operations survey and

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

a menu survey. The menu survey captured detailed information on the foods and portion sizes in federally-reimbursable school breakfasts (if available) and lunches over a typical five-day period. 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 were 130 SFAs; 397 schools with complete menu data for school lunches; and 2,314 students (aged 6 to 18 years) from 287 schools in 94 SFAs with data from both the 24-hour dietary recall and parent interview. Observations with non-missing or imputed values for the individual- and school-level control variables used in our analysis were 96% of the full sample. Thus, our final sample consists of 2,096 students attending 256 schools.

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 fruit and vegetables—we used the short-term measure of school meal 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. 2007a). The approach was the same for identifying SBP participants. However, in our estimation we decided to drop SBP participation from the list of explanatory variables since about 90% of SBP participants in our final sample were also participating in NSLP. Table 1 provides information on the total number of students in our sample, the number participating in the NSLP and SBP, and the proportions of each receiving 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. 2007a), and only slightly higher for lunch participation in elementary schools (74.4% vs. 72.6%) and middle schools (62.0% vs. 60.2%).

The main outcome variables, fruit and vegetable consumption at school and away from school, were derived from the students' dietary intake data. The 24-hour recall and school menu data were coded by trained nutritionists using version 1.0 of the USDA Food and Nutrient Database for Dietary Studies (FNDDS). In addition to energy and nutrient values from the FNDDS, the SNDA-III recall data include 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 fry 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 fruit at school, solid fruit away from school, vegetables except French fries at school, and vegetables except French fries away from school.

It is important to note that 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 et al.

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

2009a). Because most of the fruits and vegetables consumed away from school were consumed "at home", we use "at home" consumption as a term that covers all consumption away from school.

Dependent and Explanatory Variables

Reported fruit and vegetable intakes were examined separately for consistency with the current MyPyramid recommendations and new standards for school menu planning (IOM 2010; Federal Register, 2012). Fruit juice 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. 2009b) found very little evidence of a relationship between school food environment and practices and fruit and vegetable intake at school when juice and French fries were included. Table 2 provides a summary and mean values of the independent variables used in the analysis. The student and household-level control variables used in both the participation and consumption 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 (within the last 30 days) receives free or reduced price school lunches, based on parent report, is included in both the consumption and participation equations. The consumption model includes indicators for students' target day participation in the NSLP. The indicators for elementary, middle, and high school were included in both equations. We did not control for student's ages, because the correlation between age and elementary school was -0.82, and between high school and age was 0.74. Because the existing literature showed the evidence of difference in children's consumption behavior by school level (Briefel, et al. 2009a; Finkelstein, Hill, and Whitaker 2008; Fox, et al. 2009b) we included school level indicators as one of the control variables instead of age variable.

Table 3 provides a summary statistic for dependent variables. Students' mean intakes of vegetables with French fries excluded were 0.39 and 0.95 cup equivalents for at school and away from school, respectively, compared to 0.44 and 0.98 cups equivalent of total vegetables for at school and away from school, respectively. The mean intakes of fruits with fruit juices excluded at school and away from school (0.29 and 0.44, respectively) were also lower than mean intakes of total fruits at school and away from school (0.54 and 1.01 cup equivalents, respectively). French fries and fruit juices represent a relatively large portion of total vegetables and fruits consumed at school and away from school. As described previously, fruit juice and French fries were excluded from the measures of fruit and vegetable intake in our analysis.

The school-level controls include region,[5] urbanicity, and size (student enrollment). We also make use of eleven school food policies and practice variables that may affect school meal participation and students' dietary behaviors, as shown in Table 4. Two of those are based on information from school principals: whether or not nutrition education was provided in every grade in the school, and whether information was available on the nutrient content of USDA-reimbursable meals to parents. The next five variables characterize availability of competitive foods and beverages, based on the school principals' survey. 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 fruit or raw vegetables offered daily, (*c*) no French fries or similar potato products, and (*d*) no desserts. Finally, because school lunch participation

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

and school food policies and practices vary across school levels (Briefel et al. 2009b; Finkelstein, Hill, and Whitaker 2008), we include an indicator for elementary, middle, and high school in both the participation and consumption equations.

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 fruit or vegetables. We 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 the NSLP is likely to be higher because of the lower (time) costs of eating a school provided meal.[6] An adequate number of lunch lines, however, should not affect students' consumption of fruit or vegetables at or away from school, conditional on NSLP participation.

Results

In total, 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) 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.

[6]We observe a statistically significant negative correlation ($r=0.53$, $p<0.015$) between our instrument, long lunch lines, and school meal participation.

NSLP Participation

Table 5 reports the parameter posterior means, standard deviation, and probabilities of being positive from the NSLP participation equation. Our instrument appears to play an important role in 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 participation in the NSLP. Students who live in larger households, live in the Southeast, or attend schools with enrollment less than 1,000 students are more likely to participate in the NSLP. Also, children with parents with no high school education or high school degree are more likely to participate in NSLP compared to those whose parents have a college degree or above. Being Hispanic or black is associated with higher probability of school lunch participation. Children attending middle and high schools are less likely to participate in the school lunch program compared to children attending elementary school.

Participation varies among groups with different household structure 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 school meal programs, 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 the school lunch program if they are receiving free or reduced price meals. An important finding is that none of the school food environment and policy variables that were included has any effect on student's decision to participate in NSLP.

Fruit and Vegetable Consumption: Socio-economic Factors

Tables 6 and 7 present parameter posterior means, standard deviations, and probabilities of being positive from estimating the censored regressions for four variables of interest: solid fruit at school (i.e., not including juice), solid fruit 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 the NSLP tend to consume more fruits and vegetables at school compared to those who choose not to participate. This result suggests that the NSLP is effective in increasing fruits and vegetables intake of program participants. However, these findings are location specific, (i.e. students who eat school lunches consume fewer vegetables away from school) indicating that there may be some substitution effect 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. Receipt of 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 fruit at home. Hispanics, and students of races other than white, 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 (such as, a store, restaurant, or the student's home). However, fruits and vegetables consumed "away from school" rarely included those obtained at school.

With respect to availability of competitive foods and beverages in schools, we find that putting restrictions on sales of a la carte foods and beverages, and having no stores or snack bars selling foods and beverages, has 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 at home, indicating that this policy may lead to some substitution effect—the increase in fruit intake at school is associated with less fruit intake at home.

As reported in Table 4, about 85% of students in our sample had access to competitive foods and beverage through a la carte services, compared to only 20% of students through school stores and snack bars. A policy of no store or snack bar leads to increased consumption of fruit in school. At the same time, there is some indication this policy is associated with less fruit and vegetable intake at home.

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.

About 60% of students in our data attend schools that offer fresh fruits or raw vegetables in school lunches daily (Table 4). We found that a fresh fruit and vegetables policy at school leads to increased intake of fruits at home, but has no effect on children's fruit intake in school. Only 26% of students in our sample attended schools that did not offer French fries one or more days per week. This policy is associated with increased vegetable consumption at home, 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.

It is also useful to note that policies for no fundraising, no vending machines, providing fresh fruit and vegetables daily, and a policy of no desserts, have little effect on fruit intake in school. Policies of no store or snack bar, no fundraising, no a la carte sales or no vending machines, and no fries have little effect on consumption of vegetables in school.

Our findings from Tables 6 and 7 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 8 we report predicted mean cup-equivalents values for fruits and vegetables consumed by location and participation, and also report the total amount (combined school and away) of fruits and vegetables consumed by program participants and nonparticipants. Based on our calculations we find that in terms of cup equivalents, the amount of fruits (0.301) and vegetables (0.520) consumed at school were higher for lunch meal-program participants compared to nonparticipants (0.214 and 0.255 cups, respectively). Program participants consumed more fruit at school (by 0.087 cup equivalents) and more vegetables (by 0.271 cup equivalents) at school than nonparticipants. However, at the same time, participants consumed less of fruits and vegetables away from school compared to nonparticipants (by 0.063 and 0.099 cup equivalents, respectively). In a week, these amounts would translate into nearly a half-cup serving lower. These results are consistent with our earlier findings that there is some substitution going on 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, we find that both participants and nonparticipants consume relatively more of their fruits and vegetables away from school.

In order to examine the effect of program participation on total daily consumption of fruits and vegetables, we added the amount of fruits and vegetables consumed at school and away in our raw data, re-estimated the models separately for fruits and vegetables, and then calculated the predicted values. The results are reported in Table 8. The mean intake of fruits consumed per day by NSLP participants were 0.041 cup equivalents higher compared to nonparticipants. Similar patterns were observed for vegetables—participants consumed 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 meals program have higher intakes for both fruits and vegetables.

Discussion and Conclusion

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, in particular fruits and vegetables. Evidence presented in this analysis of recent data from a nationwide sample of schools supports their contribution to healthier food choices after accounting for potential endogeneity of participation in NSLP.

First, participation in the NSLP leads to increased consumption of both fruit and vegetables in school. Holding all other school policies and characteristics constant, there is evidence that fruit and vegetable consumption increases with the 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 NLSP participants, the vegetables at school substitute for vegetables acquired and eaten from away from school sources.

Despite this, the results also indicate the participants consume more fruits and vegetables in total compared to nonparticipants.

A second important finding is that school food environment and policies, such as not offering French fries or dessert one or more days per week, not offering high fat milk (whole and 2%), not offering a la carte food and beverages, or offering fresh fruits and raw vegetables daily, had no effect on children's decision to participate in school meal's program. 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 dietary standards for school meals. The evidence here suggests that the new nutrition standards for school meals that include increased offerings of fruits and vegetables, and restrictions on milk to lower fat offerings (Federal Register 2012), and policies that limit access to competitive foods will not discourage students from 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 in foods to appeal to these students may be needed to encourage their participation.

Third, some policies encourage fruit and vegetable selection in school while others discourage selection, although interpreting the reason for these effects is more difficult to address. Restrictions on competitive foods (no store or snack bar, no a la carte) increase fruit selection in school. Not offering high fat milk has a positive effect on both fruit and vegetable selection in school. A no dessert policy is associated with increased vegetable selection in school. Not offering French fries discourages selection of fruit in school but has no effect on vegetable selection 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 the policies complementary to increased selection of the 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 consumption of fruit (for no a la carte services) and vegetables (for no store or snack bar) at home. Offering daily fresh fruit and vegetables in school or making nutrition information available to parents increased fruit consumption at home, and providing no fries in school led to increased vegetable consumption at home (defined as intake that did not include fries). The opportunity to have a positive and complementary effect on consumption of fruits or vegetables amplifies the effect of school food policies on healthier food selection.

Although this paper has provided a number of useful findings, it is clear that there are many questions it cannot answer. Further work must be done to study the effect of participation in multiple food assistance programs. In addition, offering of some foods may lead to cross-product substitution effects within the school meal in total 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 for improving food choices through policies and the school environment.

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Table 1. Number of students participating in NSLP, SBP and receiving free/reduced price meals

				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	

Table 2. Explanatory variables and sample mean values

Variables	**Mean ***	**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
Mid-Atlantic	0.109	0.010
Midwest	0.177	0.011
Mountain-Plains	0.077	0.007
Northeast	0.084	0.008
Southeast	0.223	0.011
Southwest	0.149	0.009
Western	0.181	0.011
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<school enrollment<500	0.429	0.014
School enrollment>1000	0.259	0.011
Instrument		
Long lunch lines	0.710	0.013

* Weighted to be nationally representative of children in public schools that particpate in School Meals Programs

Table 3. Dependent variables and sample mean values

Variables	**All children**	
	Mean*	**Std Dev**
Fruit at school *(cup equivalent)*		
All fruit	0.537	0.020
Solid fruit (excluded fruit juice)	0.293	0.014
Fruit at away *(cup equivalent)*		
All fruit	1.010	0.043
Solid fruit (excluded fruit juice)	0.435	0.027
Veggies at school *(cup equivalent)*		
All vegetables	0.435	0.014
All vegetables (excluded French fries)	0.387	0.013
Veggies at away *(cup equivalent)*		
All vegetables	0.983	0.029
All vegetables (excluded French fries)	0.947	0.029

* Weighted to be nationally representative of children in public schools that particpate in School Meals Programs

Table 4. School food environment and policy variables (percentage of children)

Variables	**Description**	**Mean***	**Std Dev**
Nutrition education	Has nutrition education in every grade	0.58	0.013
Nutrient info 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 a la carte	No a la carte food and beverages except skim/1% milk	0.15	0.010
No vending machine	No vending machines	0.41	0.014
Vending, but not in cafteria	Vending machine, but not in food service area	0.31	0.012
No high fat milk	High fat milk not offered	0.43	0.014
Daily fresh fruit/veggies	Fresh fruit and raw vegetables offered daily	0.57	0.014
No fries	French fries not offered 1 or more days per week	0.26	0.012
No dessert	Dessert not offered 1 or more days per week	0.23	0.011

* Weighted to be nationally representative of children in public schools that particpate in School Meals Programs

Table 5. Posterior means, standard deviations, and probabilities of being positive for NSLP participation

Variables	NSLP participation		
	E(·|y)	Std(·|y)	Pr(·>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**
Midwest	0.10	0.12	0.71
Mountain-Plains	-0.09	0.15	0.49
Northeast	-0.22	0.14	0.57
Southeast	**0.35**	**0.12**	**1.00**
Southwest	0.00	0.12	0.58
Western	**-0.32**	**0.13**	**0.04**
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<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 a 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 fruit/veggies	0.07	0.07	0.63
No fries	0.04	0.08	0.74
No dessert	0.04	0.07	0.82

Table 6. Posterior means, standard deviations, and probabilities of being positive for fruit consumption

	Fruit at school			Fruit away		
Variables	**E(·|y)**	**Std(·|y)**	**Pr(·>0|y)**	**E(·|y)**	**Std(·|y)**	**Pr(·>0|y)**
Intercept	**-0.56**	**0.23**	**0.01**	**-1.15**	**0.35**	**0.00**
Participation in NSLP	**0.14**	**0.06**	**1.00**	-0.10	0.09	0.40
Receive free/reduced price	-0.01	0.07	0.71	-0.07	0.11	0.57
Household size	**0.03**	**0.02**	**0.92**	0.02	0.03	0.67
Income	0.00	0.00	0.78	0.00	0.00	0.35
Hispanic	0.14	0.10	0.85	**0.36**	**0.15**	**1.00**
Black	0.05	0.09	0.62	0.20	0.13	0.18
Other race	-0.21	0.14	0.08	**0.50**	**0.19**	**1.00**
Middle school	**-0.53**	**0.09**	**0.01**	-0.11	0.13	0.69
High school	**-0.48**	**0.11**	**0.00**	**-0.32**	**0.17**	**0.04**
Female	**0.16**	**0.06**	**0.01**	0.06	0.08	0.48
Urban	-0.07	0.09	0.35	0.18	0.13	0.79
Midwest	0.11	0.12	0.35	**0.31**	**0.17**	**0.99**
Mountain-Plains	0.11	0.14	0.39	**0.68**	**0.21**	**1.00**
Northeast	**0.44**	**0.14**	**1.00**	**0.53**	**0.21**	**0.98**
Southeast	0.08	0.11	0.48	0.11	0.17	0.47
Southwest	0.01	0.12	0.85	**0.36**	**0.18**	**1.00**
Western	**0.25**	**0.13**	**1.00**	**0.71**	**0.19**	**1.00**
Parent: less than high school	**-0.26**	**0.08**	**0.00**	-0.20	0.12	0.05
Parent: high school or GED	**-0.13**	**0.08**	**0.06**	-0.03	0.11	0.79
School enrollment<500	**0.32**	**0.10**	**1.00**	0.21	0.15	0.96
1000<school enrollment<500	**0.22**	**0.08**	**0.98**	0.01	0.12	0.50
Nutrition education	-0.01	0.07	0.79	0.00	0.10	0.55
Nutrient info for parents	-0.06	0.06	0.32	**0.29**	**0.10**	**0.00**
No store or snack bar	**0.01**	**0.08**	**0.90**	-0.05	0.12	0.81
No fundraising	-0.08	0.06	0.15	-0.07	0.09	0.56
No a la carte	**0.13**	**0.08**	**0.91**	**-0.48**	**0.13**	**0.00**
No vending	0.04	0.10	0.71	0.15	0.15	0.80
Vending, but not in cafeteria	0.03	0.08	0.60	-0.05	0.11	0.77
No high fat milk	**0.18**	**0.07**	**1.00**	-0.02	0.10	0.74
Daily fresh fruit/veggies	0.03	0.06	0.63	**0.18**	**0.09**	**0.97**
No fries	**-0.12**	**0.07**	**0.05**	**-0.18**	**0.11**	**0.05**
No dessert	-0.09	0.07	0.23	0.06	0.10	0.66

Table 7. Posterior means, standard deviations, and probabilities of being positive for vegetable consumption

	Veggie at school			Veggie at away		
Variables	**E(·|y)**	**Std(·|y)**	**Pr(·>0|y)**	**E(·|y)**	**Std(·|y)**	**Pr(·>0|y)**
Intercept	0.02	0.12	0.41	**1.09**	**0.21**	**1.00**
Participation in NSLP	**0.41**	**0.03**	**1.00**	**-0.08**	**0.06**	**0.01**
Receive free/reduced price	-0.01	0.04	0.78	-0.03	0.06	0.42
Household size	0.00	0.01	0.49	0.00	0.02	0.64
Income	0.00	0.00		0.00	0.00	0.51
Hispanic	**-0.11**	**0.05**	**0.02**	-0.05	0.09	0.33
Black	**-0.10**	**0.04**	**0.03**	-0.05	0.08	0.24
Other race	**-0.11**	**0.07**	**0.07**	0.17	0.12	0.35
Middle school	0.03	0.05	0.76	0.06	0.08	0.76
High school	0.03	0.06	0.84	**0.21**	**0.10**	**0.96**
Female	-0.01	0.03	0.21	**-0.18**	**0.05**	**0.00**
Urban	0.02	0.04	0.44	-0.04	0.08	0.24
Midwest	-0.04	0.06	0.81	0.14	0.10	0.80
Mountain-Plains	0.02	0.07	0.43	-0.13	0.13	0.35
Northeast	**-0.24**	**0.07**	**0.00**	0.14	0.13	0.37
Southeast	0.04	0.06	0.20	0.09	0.10	0.26
Southwest	0.06	0.06	0.44	0.04	0.11	0.47
Western	-0.06	0.06	0.32	0.02	0.12	0.73
Parent: less than high school	0.00	0.04	0.78	-0.03	0.07	0.75
Parent: high school or GED	-0.01	0.04	0.80	-0.03	0.07	0.52
School enrollment<500	**0.14**	**0.05**	**0.95**	-0.01	0.09	0.24
1000<school enrollment<500	**0.10**	**0.04**	**0.94**	-0.07	0.07	0.15
Nutrition education	0.00	0.03	0.55	0.04	0.06	0.85
Nutrient info for parents	-0.04	0.03	0.21	-0.03	0.06	0.54
No store or snack bar	-0.04	0.04	0.68	**-0.17**	**0.07**	**0.01**
No fundraising	-0.04	0.03	0.39	-0.01	0.06	0.86
No a la carte	0.06	0.04	0.62	-0.03	0.08	0.41
No vending	0.01	0.05	0.45	0.03	0.09	0.81
Vending, but not in cafeteria	0.03	0.04	0.51	0.02	0.07	0.80
No high fat milk	**0.06**	**0.03**	**1.00**	**0.13**	**0.06**	**0.99**
Daily fresh fruit/veggies	-0.04	0.03	0.11	0.00	0.06	0.80
No fries	0.02	0.04	0.51	**0.09**	**0.07**	**0.98**
No dessert	**0.10**	**0.03**	**1.00**	**-0.17**	**0.06**	**0.01**

Table 8. Predicted values for fruits and vegetables consumption by location and NSLP participation.

	Fruit *(cup equivalents)*		**Vegetable *(cup equivalents)***	
	NSLP participants	**NSLP nonparticipants**	**NSLP participants**	**NSLP nonparticipants**
At school	0.3012	0.2138	0.5202	0.2491
	(0.165)	(0.132)	(0.080)	(0.057)
Away	0.4460	0.5092	0.9826	1.0818
	(0.172)	(0.191)	(0.151)	(0.161)
Total	0.7624	0.7219	1.4563	1.3276
	(0.266)	(0.252)	(0.167)	(0.170)

Standard errors are reported in parentheses