Do the National School Lunch and School Breakfast Programs Improve Children's Dietary Quality?

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Governmental programs aimed at children are used extensively throughout the United States for a variety of reasons, most notably to provide *nutritious* meals to children. Such programs include the National School Lunch Program (NSLP), National School Breakfast Program (NSBP), Women, Infant and Children (WIC), and food stamps (FTS). The NSLP and NSBP, however, are different from their counterparts in that WIC and FTS are only available for qualified persons, whereas, the NSLP and NSBP are available, at a slightly higher cost, to all children given that their school participates in the program. Due to the young age of participants, the NSLP and NSBP also play a pivotal role in helping to define students' long term healthy eating behaviors.

Since the inception of the NSLP in 1946, daily student participation has grown from 7.1 million to 30.1 million in 2006, with approximately 100,000 schools currently participating (Food and Nutrition Service-B, 2007; Bhattacharya, Currie, and Haider, 2004). With regards to the NSBP, daily participation has grown from 0.5 million children in 1970 to 9.7 million children in 2007, with approximately 78,000 schools participating (Food and Nutrition Service-A, 2007; Bhattacharya, Currie, and Haider, 2004). In addition to public schools, non-profit private schools and residential child care facilities may also take part in these programs. Based on the large number of students using the NSLP and NSBP daily, the influence of these programs on nutrition, both in consumption and in establishing life-long behaviors, could be considerable.

The effectiveness of the NSLP and NSBP has come under increasing scrutiny due to the drastic rise in childhood obesity. During the period 2003-2004, 17% of children ages 2-19 were considered overweight and another 34% were at risk of becoming overweight. In comparison, in 1999-2000, 14% of 2-19 year olds were overweight and 28% were at risk of becoming overweight (Ogden et al., 2006). From the above numbers we can see that in only three years there was a staggering 20% increase in the percentage of overweight children. Since obesity is rising and a large number of students eat at least one meal (lunch) and perhaps two meals (lunch and breakfast) at school each day, measuring the effectiveness of the NSLP and NSBP is extremely important in order to determine if the current guidelines are having an effect on healthy eating habits.

Therefore, there were several objectives of this paper. Our main focus was to reexamine the effect of NSLP and NSBP participation in influencing the dietary behavior of children both short term and long term using several dietary quality measures: nutrient intake of select vitamins and minerals along with several other dietary components (short term), the Healthy Eating Index (HEI) and its' component scores (short term), and blood levels of several dietary components (long term).[1] Nutrient intake levels along with blood levels have been previously utilized, with nutrient intake being the main indicator in past research. The HEI has also been previously used as a measure of dietary quality by Bhattacharya, Currie, and Haider (2004).

A thorough review of the literature by Bhattacharya, Currie, and Haider (2004, pp. 5-7) indicated that past studies examining the NSLP have found positive, negative, and no effects on children's outcomes. To further examine this issue, we evaluate the effect of both NSLP and NSBP on children's dietary outcomes. In addition to updating the evaluation of NSLP, our study differs in three ways from previous studies. First, we not only utilize HEI as a measure of dietary quality but also use the component scores (fat, saturated fat, meat, dairy, vegetable, fruit, grain, cholesterol, sodium, and variety) that make up the HEI. Second, we utilized propensity score matching to identify the affect, if any, that the NSLP has on child nutrition. Furthermore, we examined whether there is a residual benefit of NSLP participation. Third, we further

[1] Long term is meaning measured over a longer period of time as compared to short term measurements associated with a 24-hour recall.

separate participants/non-participants into more distinctive groups that not only more accurately accounts for participation in NSLP, but controls for NSBP participation. Our analysis allows for a better understanding of how the NSLP is influencing school aged children's dietary quality, while also allowing for viable policy recommendations to be made that will ultimately help childhood nutrition.

Literature Review

The literature examining the effectiveness of governmental food programs on children is quite extensive: Women Infant and Children's (WIC) program (Havas et al., 1998), food stamp program (Butler and Raymond, 1996; Devaney and Moffitt, 1991), and the NSLP and NSBP programs (Akin et al., 1983; Burghardt, Devaney, and Gordon, 1995; Devaney, Gordon, and Burghardt, 1995; Gleason, 1995; Gordon, Devaney, and Burghardt, 1995; Gleason and Suitor, 2003; Bhattacharya, Currie, and Haider, 2004). Most studies of this nature have utilized specific intake of certain nutrients to determine a program's effectiveness. For example, Gleason and Suitor (2003) examined the effect of the NSLP on intake of several vitamins and minerals, such as vitamin C and calcium. Their findings indicated that the NSLP provided a positive effect on several vitamins examined except vitamin C, which had a negative effect. A more recent study by Bhattacharya, Currie, and Haider (2004) utilized somewhat different measures to evaluate the NSLP and NSBP, namely the HEI and respondent specific serum levels.

However, as noted by Bhattacharya, Currie, and Haider (2004), several problems have arisen with these types of studies, including lack of exclusion restrictions within selection models and utilization of instrumental variables with poor predictive power. For example, failure to encompass exclusion restrictions within the first step of Heckman two-step type models may lead to collinearity problems depending on the correlation between the inverse mill's ratio and step two explanatory variables (Puhani, 2000). When acceptable exclusion restrictions cannot be found there are few alternatives. Estimation via ordinary least squares (OLS) without regard to the selection decision has been suggested. However, OLS estimates may be biased if the error term for program participation and food consumption are correlated (Gleason and Suitor, 2003),

Other problems associated with this type of analysis include a lack of an absolute indicator of treatment group, modeling of explanatory variables (e.g., body mass index) as exogenous to the dependent variable of interest, and failure to account for availability of the programs by grouping non-participants with and without access together into one treatment group. Problems associated with treatment assignment can occur when respondents are placed in a treatment group when no definitive information from the survey exists to place the respondent into the group. For instance, Burghardt et al. (1993) assigned respondents to the NSLP treatment group if they consumed three of the five meal pattern components from the cafeteria meal line. Gleason and Suitor (2003) made further refinements to the Burghardt et al. (1993) study by taking into account partial consumption of the food components. Even though Burghardt et al. (1993) verified their classification assumptions, in select cases their assumptions may be violated, thereby, creating a misclassification of students into wrong treatment groups. For instance, misclassification could occur if a student purchased their foods from the a la carte line, but met the criteria of the NSLP treatment. In order to minimize the potential for misclassification, a direct indicator of treatment group and "control" group is needed is required for unbiased results. Therefore we instituted more restrictive restrictions, discussed below, to be included in either the treatment or control group.

Numerous analytical techniques have been applied for the selection problem associated with this type of data, including: fixed effects modeling (Gleason and Suitor, 2003), Heckman type two-step procedures (Long, 1990), and difference-and-difference modeling (Bhattacharya and Currie, 2001; Bhattacharya, Currie, and Haider, 2004). The main issue with both the fixed effect difference-in-difference (FEDD) procedures is the need for at least two observations (days of food intake) per respondent if individual fixed effects need to be accounted for. Utilization of difference-in-difference with only one time period can be performed; however, any fixed effect associated with an individual may not be accounted for in the analysis. Other problems with the difference-and-difference approach utilized in previous works emanate from selection bias associated with a lack of randomization of respondents into treatment groups. Recent work by Bhattacharya, Currie, and Haider (2004), has addressed randomization of respondents into treatments when applying difference-and-difference modeling.

Given the plausibility of the FEDD it would seem to be a logical choice. However, finding a nationally representative survey with both demographic and two days of food consumption data, with the further restriction of providing accurate treatment groups is extremely difficult. At present, the NHANES survey tends to be the standard reference for this type of analysis. However, due to privacy concerns only one day of food intake is available for the survey years 1999-2000 and 2001-2002. The predecessor to NHANES was the NHANES-III, which gave two observations for each respondent, but the data is becoming outdated. The 2003-2004 and 2005-2006 surveys offer two consumption days, but identification of participation on the second day is an assumption that must be made.

Data

The National Health and Nutrition Examination Survey (NHANES)[2] dataset was used since it provides information on food intake, by individual food, and demographic information for each individual surveyed. We use data from survey years 1999-2000, 2001-2002, 2003-2004 and 2005-2006 in our analysis of nutrient intakes and blood levels; data from 1999-2000 and 2001-2002 survey years were utilized in HEI and component score analysis given 2003-2004 and 2005-2006 measures are not currently available. For the 1999-2000 and 2001-2002 survey years, only one day of consumption data is available. The NHANES responses were collected during random face-to-face interviews and a call-back 3-10 days later for day 2 dietary intakes. With regards to nutritional questions, a 24-hour recall was used to determine the type and amount of foods consumed, which was then analyzed for nutritional content.

As discussed earlier, accurately defining treatment groups is essential to reducing and eliminating biases. Separating children into appropriate treatment groups is often difficult given the survey instruments generally utilized. For instance, the NHANES surveys (1999-2006) ask children whether their school participates in the NSLP and NSBP, how often they actually utilize the programs, and if school is currently in session. In regards to the dietary intakes, for both days for 2003-2004 and 2005-2006, the day of the week is recorded. Given this information, it would be simple to look at whether school is in session and the day of the week to assign treatment membership for both dietary intake days. The likelihood of students being misclassified on the day one intake day is low, but plausible. However, given that season and

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[2] The demographics and health data used in this paper can be found at the National Center for Health's website: <http://www.cdc.gov/nchs/nhanes.htm>>.
The HEI and its' component scores can be found at the Center for Disease and Policy Promotion's website: <<http://www.cnpp.usda.gov/HealthyEatingIndex.htm>>
Further information regarding the calculations of the HEI and component scores can be found by referring to Basiotis et al. (2002) or by accessing the Center for Disease and Policy Promotion's website: <<http://www.cnpp.usda.gov/HealthyEatingIndex.htm>>

other factors are not given, we could be misclassifying students on the second recall date at an extremely higher degree since they could be in school on day one and on vacation on day two. The degree to which any misclassification occurs is unknown; therefore, we developed a new treatment scheme to lower the probability of misclassification. For this reason, we looked at only day one intakes to try to decrease biases associated with treatment misclassification.

Since a main goal of this paper was to address the effectiveness of the NSLP, only school-aged children attending school were used. Consequently, we used the age groups of 6-18 years in the analysis, consistent with Gleason and Suitor (2003). Children between 6-18 years of age that did not provide adequate 24-hour food recall information or had other key demographic information missing were eliminated from the sample. First, we only utilized children in school surveyed on a weekday. Second, those children passing the first test were further divided into groups based on school participation and child participation levels. In order to accurately isolate the program effects, treatment groups underwent another restriction for the NSLP comparisions by subdividing students who participated zero times and those participating five days a week. Those participating between one and four times per week were excluded from analysis since there was a chance of misclassification given the day they did not participate could have corresponded to the survey date.

Given the above criteria, treatment one included children that participated in the NSLP all days during the week and whose school did not serve NSBP (table 1). Treatment two included children whose school participated in the NSLP, but the child participated zero days per week and the school did not participate in the NSBP. The final treatment included schools that did not participate in the NSLP or NSBP. By comparing treatment one versus treatment two, we can isolate the effect of directly participating in NSLP, whereas in comparing treatment two versus treatment three, we can isolate the residual effect of no participation by child and school participation. Final treatments to determine the effect of the NSLP were then obtained with 684 children meeting all criteria.

However, given the prevalence of the NSLP program, the same criterion for NSBP evaluation two different methods were used to assign treatments to evaluate the effectiveness of the NSBP. Instead of imposing a five day participation rate as was done for NSLP treatment one, a three day participation rate was used. The degree of misclassification and any resulting bias is unknown; however, relaxation of this restriction was needed to obtain adequate sample size. Therefore, treatment four was made up of students participating in the NSBP more than three days per week and participating zero days in the NSLP. Treatment five included students that did not participate in either the NSLP or NSBP. Comparison of treatment four and treatment five will give us an idea of the NSBP impacts, however, the results should be interpreted carefully since misclassification could be present and the participation of NSLP and NSBP are not directly accounted for in the treatment design.

Our measures of dietary quality were nutrient intakes, blood levels and HEI and its' component scores. Nutrient intakes were compared to the Dietary Reference Intakes (United States Department of Agricultural) and were converted to percent Recommended Dietary Allowances (RDA) or percent adequate intakes for nutrients with no specific RDA (table 3). RDAs and adequate intakes were comparable to those of Gleason and Suitor (2003). In most cases RDA's were being exceeded by both all treatment groups.

According to You and Nayga (2005), the HEI provides a broad overview of the type, variety, and quantity of the foods consumed, especially in accordance with dietary recommendations. The HEI is calculated as the sum of all 10 component scores with a maximum score of 100. The component scores include: fat, saturated fat, meat, dairy, vegetable, fruit, grain, cholesterol, sodium, and variety. Meat, dairy, vegetable, grain, and fruit scores are based on conformity to the daily serving recommendations given by the USDA's Food Guide Pyramid. Fat and saturated fat scores are based on fat or saturated fat consumption as a percent of total food energy intake, while cholesterol, sodium, and variety are based on intakes of the component (You and Nayga, 2005). The component scores range from 0 to 10. Using fruit as an example, a fruit score of 10 implies that the respondent consumed the recommended daily serving of fruit, whereas a score of 0 means that the respondent did not consume any of the daily recommended serving of fruit. Scores between 0 and 10 are scored proportionately based on amount consumed and amount recommended. Evaluation of the treatment means for HEI and the component scores shows that each treatment group suffers from similar deficiencies but in varying magnitude (table 3).

A HEI score greater than 80 means that a person is consuming a "good" diet, whereas scores between 51 and 80 means that a person needs to "improve their diet" (Basiotis et al., 2002). The average HEI score of the U.S. population in 1999-2000 was 63.8, which is clearly in the "improve diet category." Further examination of the population based component scores indicates that the cholesterol and variety scores have the highest average component scores near 7.7, while dairy and fruit scores were the lowest at 5.9 and 3.8, respectively (Basiotis et al., 2002). The mean HEI for our overall sample (62.9) is very close to the population average reported by Basiotis et al. (2002) and the low fruit and dairy scores are also similar.

Other variables in our model included child specific demographics (gender, age, race), health characteristics of child (body mass index, average TV, computer and video game time per day, food consumption normal on day of survey, times eat-away-from-home per week, water intake on survey date, dietary supplement usage) and household demographics and health characteristics (income, size, reference person's age, reference person's education level, reference person's marital status, smoker in household). A description of each control variable can be found in table 4. These variables are similar to those of Gleason and Suitor (2003), with exceptions of region and season, which are no longer publicly available.

Empirical Model

In this study, we utilize the propensity score matching (PSM) technique to evaluate the effect of NSLP and NSBP on children's dietary outcomes. We then compare our results to other studies utilizing different techniques. The literature regarding propensity score matching is quite extensive. According to Rosenbaum and Rubin (1984), treatment groups may not be comparable since the differences associated with treatments is not from the different treatment regimes, but from underlying characteristics that impact choice of treatment. For example, participation in either NSLP or NSBP may be associated with students from different socioeconomic backgrounds even though schools that do not participate in these programs have been removed from analysis. Failure to adjust for the nonrandom nature of the treatment groups leads to biased estimates in small samples and inconsistent estimates for large samples (Foster, 2003).

To correct for selection bias, Rosenbaum and Rubin (1983, 1984) proposed utilizing propensity scores to adjust for non-randomization. The intuition behind propensity scores is to generate conditional probabilities of receiving a particular treatment given some explanatory variables (covariates) (Imbens, 2000). These scores are unbiased, consistent with the nonrandom nature of the data and allow for having a common base to compare control and treated units. The use of propensity scores to circumvent selection bias has been used in various disciplines, including: health care (Foster, 2003) and governmental program evaluation (Heckman and Hotz, 1989). To our knowledge, the use of propensity score matching has not been applied to test for the effectiveness of both the NSLP, while controlling for NSBP participation, and the NSBP using strict treatment requirement criterion.

We first evaluated the effectiveness of the NSLP by comparing treatment one and treatment two. Since both treatments do not have participation by school, the effects we obtain are associated with whether NSLP participation. It is expected that treatment one will have increased levels of nutrient intakes and HEI (and components) since schools are "forced" to follow governmental dietary guidelines which will lead to NSLP participating children having higher nutritional food. Second, we evaluated treatment two versus treatment three in order to test whether a student's nonparticipation in the NSLP when it is available has a benefit compared with a student that attends a school not participating in either the NSLP or NSBP. It is expected that a school participating will result in increased nutritional quality even if the student does not participate since schools will most likely be more informed about governmental health information and regulations and thereby offer more nutritional meals in a la carte. Finally, we compared treatments four and five to gain a better understanding of the NSBP's effectiveness. It is expected that participation in the NSBP will lead to increases in vitamins, minerals and the fruit component of the HEI.

The first step in propensity score matching is to obtain propensity scores using either probit or logit. Even though we use multiple treatment groups, Lechner (2002) showed that we get similar results using binary models instead of the more cumbersome multiple treatment modes. Therefore, we estimated the propensity scores using binary logit models. The propensity scores represent the probability of an individual being in a certain group. The binary logit model and propensity scores were estimated in Stata using the following formula:

$$\Pr ob(Y = 1 | X) = \frac{e^{\beta' X}}{1 + e^{\beta' X}} \qquad [1]$$

where, X represents the explanatory variables (Greene, p.667). The explanatory variables (and their summary statistics) used in the binary logit models are located in Table 3.

Next, matching based on the propensity scores was used to test whether program participation generated significant differences in our dependent variables. There are numerous ways to implement propensity score matching. We utilized several methods to implement and check the robustness of our matching and results were consistent across methods[3]. However, the final matching presented is based on radius matching with a caliper of 0.1 and common support. The common support insures that propensity scores used from the control group fit within the minimum and maximum propensity score from the treatment group. 500 replications were used to bootstrap standard errors for significance testing. For a detailed discussion of the various matching mechanisms, see Becker and Ichino (2002).

Heckman et al. 1997 recommends using "hit-or-miss" and pseudo-R^2 to measure the reliability of the propensity scores. The "hit-or-miss" criterion details how well our model correctly classifies students into the correct treatment, while the pseudo-R^2 is a relative measure of model variance estimation. In both cases, the higher the value, the better the model and better the propensity scores. Second, the propensity score matches also need to be validated by checking the balance of the matches and by checking the mean standardized bias, pseudo-R^2 and p-values associated with pre- and post-matching. In regards to these checks, mean standardized

[3] Matching methods used for robustness check included one-to-one nearest neighbor and kernel matching. Results of robustness checks are not provided given space limitations but are available from authors upon request.

bias should decrease after matching. Before matching, the pseudo-R^2 should be high and the p-value should be significant. However, after matching the pseudo-R^2 should be low and the p-value should be insignificant. A low pseudo-R^2 and insignificant p-value after matching indicates that good balance among the covariates.

Results and Discussion

In the following section the results associated with each treatment comparison is detailed. Of main concern is the effectiveness of the NSLP and NSBP in order to incorporate viable policy recommendations.

Treatment One vs Treatment Two

As noted earlier, validation of both propensity scores and matching is fundamental to obtaining reliable and unbiased results. The pseudo-R^2 for the logit model was 16% with a significant joint significance to the Wald test at the 0.01 level. The "hit-or-miss" test indicated that 69% of children were correctly classified. Based on these factors, we believe that the propensity scores are reliable. In regards to the matching checks, mean standardized bias decreased by 46% from 16.9 to 9.1 while the pseudo-R^2 post match significantly decreased and the model post-match became insignificant implying good balance within the matching. Based on comparison of the matching checks, the radius method was chosen since it consistently produced the largest mean standard bias reduction and balancing results. Based on the above results the propensity score matching results appear to be reliable.

Examination of Table 5 (nutrient vitamin and mineral intakes) indicates that when we only look at NSLP participation (treatment 1) versus no participation at child level, but participation at school level controlling for NSBP (treatment 2), those using NSLP have significantly higher intakes of several vitamins and minerals. In regards to vitamins, NSLP had a positive impact on Riboflavin, Vitamin B12, and Vitamin E (alpha-tocopherol) intakes with impacts ranging from 10% to 47% increases in RDA. For minerals, we see positive impacts on calcium, phosphorus and sodium intakes.[4] Also included were several other dietary components which had positive impacts including RDA carbohydrates, RDA dietary fiber, RDA total poly, total fat, total unsaturated fat, and energy. Also of note are the differences in sign and magnitude associated with the simple average differences and the propensity score results. Thereby, reliance on simple averages would have resulted in incorrect program effects.

Our results closely match those of Gleason and Suitor (2003) in regards to vitamin intakes with the major exception of vitamin C intake. However, results for mineral and other dietary components are mixed. Our results indicate that NSLP participation does not significantly affect zinc and magnesium intake but significantly affects calcium and phosphorus had significant effects. With regards to magnitudes, our results were quite similar to those of Gleason and Suitor (2003) with only small differences for those variables we found significant. For the variables that had mixed significance levels, our estimates were consistently higher and positive than those of Gleason and Suitor. Results on other dietary components cannot be directly compared with Gleason and Suitor (2003) since the variables were calculated in a slightly different way.

Interestingly, examination of Table 6 indicates that NSLP participation does not increase HEI and the majority of HEI component scores, except for the variety score.[5] These results are a little surprising since it was expected that quality of diet would be increased by NSLP participation. The lone exception in variety score could be due to students having to choose

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[4] Sodium has been adjusted for salt use in food preparation.
[5] In-depth analyses that are not included indicated significant effects for several component scores when the five-day participation requirement was not included.

three of five food groups thereby increasing variety whereas those not participating may concentrate on only one food source. For example, a NSLP participant might pick a meat, dairy, and fruit product, while the nonparticipant might only eat pizza from the a la carte line. However, the lack of impact of NSLP on HEI component scores is troublesome in that healthy eating measures are not being increased by the NSLP.

The results from the blood level examinations, table 6, also show that there is no long term effect of participating in the NSLP given the insignificant blood levels. Significance of these variables would have indicated that NSLP participants were/had developed different dietary habits.

Treatment Two vs Treatment Three

Validation of both propensity scores and matching is conducted on the propensity scores and matching results for treatment two (school participation but no child participation) versus treatment three (no school participation) comparisons. The pseudo-R^2 for the probit model was 16% with a significant joint significance to the Wald test at the 0.01 level. The "hit-or-miss" test produced a hit rate of 65% correctly classified into the appropriate treatment group. In regards to the matching checks, mean standardized bias decreased by 49% from 13.3 to 6.7 while the pseudo-R^2 post match again significantly decreased and the model post-match became insignificant implying good balancing of the covariates within the matching. The radius method was again chosen since it consistently produced the largest mean standard bias reduction and balancing results. As with the first treatment comparison, the above results on the propensity score matching appear to be reliable.

Examination of Table 5 (nutrient vitamin and mineral intakes) indicates that when we look at no NSLP participation by the child but participation at school level versus no participation at school level for NSLP, controlling for NSBP, children who do not participate in the NSLP in schools that participate do not have significant differences in intakes of almost all the vitamins and minerals from those children in schools which do not participate in the NSLP. The lone exception was Vitamin K, which can be found in large quantities in green leafy vegetables and some vegetable oils (Linus Pauling Institute). However, the effects of school NSLP participation are evident for RDA carbohydrates, total fat, total saturated fat, and energy with the NSLP having a negative impact on each. For instance, total saturated fat as a percent of RDA decreases by 6%.

Evaluating the effect on HEI scores in Table 6, results indicate that there is little impact of school participation in the NSLP on children who do not participate, except for the dairy component score which increased by 13%. The lack of increased dietary quality could be due to a student's freedom to choose through an a la carte line, thereby allowing for less nutritious foods to be consumed. The increased dairy consumption may be caused by removal of soda products from schools most likely to participate in the NSLP. However, this explanation is not definitive and the lack of a significant decrease in caffeine intake, as shown in table 5, tends to not validate this explanation.

In regards to blood levels, there again were no significant variables indicating that there is no impact of NSLP via school availability. This is not surprising given the lack of significance of direct NSLP participation.

Treatment Four vs Treatment Five

The final comparison was between treatments four and five. Given misclassification of treatment groups could be higher than that of the more specific treatments one through three, results should be interpreted with care. As with the other models, propensity score validation tests indicated reliable propensity scores and matches. Results are presented with only limited discussion due to the uncertainty of the findings.

Examining vitamins and minerals showed only one significant difference, Vitamin B_{12} which can be readily found in meat products and vegetables (Linus Pauling Institute). This is interesting because the expected result was for Vitamin C and other fruit related vitamins to be significantly positive. In regards to minerals there was only one mineral, sodium, that was insignificant. The HEI and component scores were also insignificant whereas the blood levels indicated positive significance for calcium, phosphorus, and potassium. What is interesting is that the positive significance of the these particular variables are highly related to commonly consumed breakfast foods (i.e. calcium = dairy products; potassium = banana and breakfast associated juices; phosphorus = dairy products and eggs). This finding provides a first step, but the relation to these variables and NSBP should be tested more in depth.

Final Considerations

The results from this paper are significant for several reasons. First, we attempt to correct estimation problems, namely treatment assignment, that is inherent with analyses of this type. Second, we expand the examination of the NSLP by not only accounting for student participation, but also accounting for school participation. Our results are similar to previous studies and lend credence to the fact the NSLP does affect student eating. However, the effect of NSLP on the quality of dietary nutrition is still up for debate given that HEI and most components were not significant. Hence, we can see that policies wanting to increase the impact of these programs should not only place their efforts on increasing certain vitamin and mineral types, but should also focus on efforts that increase overall dietary quality. For instance if focus is placed on increasing Vitamin A, then children may eat a lot of a certain type of food product and fail to eat other products to get a well rounded nutritional balance.

Furthermore, the increased nutrient levels but lower dietary quality result with NSLP participation may show that students may not be partaking in healthy meals but binging on unhealthy products that raise nutrient levels but do not address overall healthy eating. Since the NSLP goal is to provide a well-rounded quality diet, the focus should be on increasing overall healthy eating. Future research should more completely examine whether NSLP participation is exceeding maximum instead of recommended dietary needs for nutrients.

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Table 1.Treatment descriptions.

Treatment Number	Treatment Description
1	School participates in NSLP and child participates 5 days a week; school does not partiipate in NSBP
2	School participates in NSLP and child participates 0 days per week; school does not partipate in NSBP
3	School does not partipate in NSLP or NSBP
4	Child participates 0 days per week in NSLP; Child participates >3 days per week in NSBP
5	Child does not partipate in NSLP or NSBP

Table 2. Mean quality intake measures by treatment group.[a]

Intake	Treatment 1	Treatment 2	Treatment 3	Treatment 4	Treatment 5
Number of observations[b]	308	186	190	1403	1171
Vitamins (Percentage of RDA)					
Vitamin A	362	209	157	192	182
Vitamn C	234	170	167	167	218
Thiamin	199	179	189	181	198
Riboflavin	248	224	259	231	258
Niacin	195	175	186	166	166
Vitamin B_6	188	178	191	169	191
Vitamin B_{12}	290	246	313	252	293
Vitamn K	154	82	94	94	87
Vitamin E (alpha-tocopherol)	72	57	58	57	62
Minerals (Percentage of RDA)					
Calcium	91	75	90	78	77
Phosphorus	142	111	134	120	141
Magnesium	111	85	105	88	108
Iron	184	169	172	164	172
Zinc	157	131	154	138	161
Copper	187	150	172	153	173
Sodium[c]	256	221	240	236	245
Potassium	59	51	54	52	54
Other Dietary Components					
Carbohydrates (% of RDA)	257	223	228	231	224
Dietary Fiber (% of RDA)	55	47	51	48	48
Protein (% of RDA)	234	191	228	202	246
Total Poly Unsaturated Fat (% of RDA)	149	139	137	140	142
Total Fat (gm)	89	80	81	85.7	86.8
Total Saturated Fat (gm)	2459	2160	2205	150	148
Energy (kcal)	158	142	149	2318	2323
Total Sugars (gm)	31	27	28	29	29
Cholesterol (mg)	253	246	230	244	269
Caffeine (mg)	43	46	40	50	37

[a] Weighted according to NHANES analytic guidelines.

[b] The number of observations shown for each treatment represents the number for all years.

[c] Sodium has been adjusted for salt use in food preparation.

Table 3. Mean quality intake measures by treatment group.[a]

Intake	Treatment 1	Treatment 2	Treatment 3	Treatment 4	Treatment 5
HEI and Component Scores					
Fat Score	7.4	7.2	7.0	7.4	6.7
Saturated Fat Score	7.1	6.9	6.7	6.8	5.9
Sodium Score	5.1	5.8	5.6	6.1	6.2
Cholesterol Score	7.6	8.0	7.9	8.5	8.4
Grain Score	8.0	7.6	7.6	7.4	7.0
Fruit Score	5.2	4.2	3.8	3.8	3.7
Vegetable Score	6.3	5.2	5.3	5.1	5.0
Meat Score	6.3	6.1	5.8	5.4	6.0
Dairy Score	6.2	6.7	6.8	6.3	6.7
Variety Score	7.9	7.9	8.1	7.4	7.3
HEI	66.3	65.6	64.7	64.2	62.8
Blood Levels					
Total calcium (mmol/L)	2.4	2.4	2.4	2.4	2.4
Total cholesterol (mmol/L)	4.2	4.1	4.1	4.2	4.2
Total iron (umol/L)	17.4	16.2	18.0	15.8	14.5
Total phosphorus (mmol/L)	1.5	1.4	1.5	1.4	1.5
Total protein (g/L)	73.3	73.3	72.3	73.1	73.3
Total sodium (mmol/L)	138.8	138.9	138.9	138.9	139.1
Total potassium (mmol/L)	4.0	4.0	4.1	4.0	4.0

[a] Weighted according to NHANES analytic guidelines.

Table 2. Variables utilized as controls in the probit models and their definitions.

Variable	Definition
Year	Dummy variable indicating NHANES survey year
Gender	Dummy variable indicating gender
Age	Age in months of the child
Race	Race of the child
Household size	Household size of child's residence
Household income	Dummy variable of household income
Household reference married	Household reference is married
Total tv/computer time	Average time in hours that child watches tv, playes video games, and uses computer per day
Supplement usage	Used dietary supplement during last 30 days
Times eat away-from-home per week	Number of times, on average, child eats away-from-home per week
Household smoker present in household	Dummy variable indicating whether someone in child's household smokes
Body mass index	Body mass index of child
Water intake per day	Amount of water, any type, consumed on the survey date
Household reference age	Household reference's age
Household reference education	Dummy indicating household reference's education level
Food consumption	Dummy indicating whether child's food consumption on the survey date was normal

Table 5. Average treatment effects using simple differences and propensity score matching.[ab]

	Treatment 1 vs. Treatment 2				Treatment 2 vs. Treatment 3				Treatment 4 vs. Treatment 5			
Vitamins (Percentage of RDA)	SD[b]	p-value	PSM[c]	p-value	SD[b]	p-value	PSM[c]	p-value	SD[b]	p-value	PSM[c]	p-value
Vitamin A	-51.64	*0.48*	2.22	*0.97*	-152.60	*0.36*	16.15	*0.82*	-9.57	*0.77*	45.64	*0.10*
Vitamn C	-3.28	*0.87*	12.09	*0.63*	-63.55	*0.07*	0.48	*0.99*	51.30	*0.00*	29.47	*0.13*
Thiamin	9.78	*0.37*	12.60	*0.30*	-20.38	*0.13*	3.45	*0.81*	16.84	*0.00*	7.68	*0.60*
Riboflavin	34.84	*0.02*	30.34	*0.06*	-24.54	*0.12*	2.57	*0.89*	27.21	*0.00*	20.99	*0.18*
Niacin	10.73	*0.31*	7.45	*0.58*	-20.03	*0.09*	-12.53	*0.44*	27.21	*0.00*	0.11	*0.99*
Vitamin B_6	12.68	*0.33*	-3.49	*0.85*	-9.67	*0.50*	11.40	*0.48*	22.01	*0.00*	12.87	*0.30*
Vitamin B_{12}	67.88	*0.01*	47.44	*0.05*	-44.22	*0.36*	-14.10	*0.70*	41.48	*0.00*	45.58	*0.08*
Vitamn K	11.88	*0.27*	17.24	*0.15*	-71.70	*0.12*	-182.42	*0.07*	-6.87	*0.44*	-23.50	*0.21*
Vitamin E (alpha-tocopherol)	0.58	*0.92*	10.26	*0.10*	-14.44	*0.10*	-5.36	*0.53*	4.92	*0.12*	4.28	*0.33*
Minerals (Percentage of RDA)												
Calcium	15.12	*0.01*	13.88	*0.01*	-15.38	*0.03*	-6.20	*0.48*	15.13	*0.00*	14.92	*0.00*
Phosphorus	22.91	*0.00*	18.66	*0.05*	-31.50	*0.01*	-14.82	*0.21*	20.98	*0.00*	18.06	*0.05*
Magnesium	19.63	*0.00*	13.12	*0.17*	-26.14	*0.00*	-7.78	*0.38*	20.03	*0.00*	15.88	*0.02*
Iron	2.32	*0.86*	17.32	*0.19*	-14.56	*0.35*	14.70	*0.36*	7.43	*0.25*	20.50	*0.06*
Zinc	22.86	*0.02*	18.11	*0.15*	-26.56	*0.06*	-20.57	*0.23*	23.32	*0.00*	21.71	*0.04*
Copper	21.71	*0.08*	7.19	*0.68*	-36.46	*0.01*	-10.92	*0.48*	19.94	*0.00*	20.39	*0.03*
Sodium[d]	19.64	*0.08*	36.26	*0.01*	-35.20	*0.02*	-17.25	*0.34*	8.71	*0.25*	26.24	*0.14*
Potassium	3.10	*0.26*	6.14	*0.05*	-7.40	*0.06*	-4.93	*0.33*	2.25	*0.18*	6.33	*0.03*
Other Dietary Components												
Carbohydrates (% of RDA)	5.18	*0.60*	25.02	*0.03*	-33.51	*0.05*	-37.81	*0.09*	-6.94	*0.25*	3.04	*0.77*
Dietary Fiber (% of RDA)	3.84	*0.19*	9.34	*0.00*	-8.57	*0.05*	-5.96	*0.25*	-0.10	*0.95*	2.54	*0.36*
Protein (% of RDA)	36.23	*0.00*	21.30	*0.23*	-42.95	*0.00*	-19.39	*0.25*	43.67	*0.00*	37.91	*0.03*
Total Poly Unsaturated Fat (% of RDA)	-2.04	*0.83*	20.79	*0.04*	-9.17	*0.39*	-26.22	*0.11*	1.77	*0.76*	4.17	*0.64*
Total Fat	1.80	*0.64*	12.18	*0.01*	-9.73	*0.09*	-17.22	*0.05*	1.13	*0.76*	6.51	*0.18*
Total Saturated Fat	1.25	*0.36*	4.09	*0.02*	-3.55	*0.11*	-5.69	*0.06*	0.41	*0.68*	3.12	*0.08*
Energy	45.57	*0.60*	263.73	*0.01*	-299.50	*0.05*	-407.61	*0.06*	5.19	*0.95*	212.95	*0.02*
Total Sugars	7.10	*0.41*	9.91	*0.38*	-15.98	*0.16*	-11.05	*0.48*	-2.86	*0.58*	-1.26	*0.86*
Cholesterol	-16.64	*0.43*	9.03	*0.72*	-6.98	*0.79*	-17.21	*0.56*	25.06	*0.04*	39.16	*0.05*
Caffeine	-5.70	*0.43*	-8.01	*0.25*	3.31	*0.69*	-4.69	*0.63*	-13.03	*0.00*	-3.13	*0.40*

[a] Standard errors bootstrap with 500 replications.
[b] Weighted according to NHANES analytic guidelines.
[c] SD = simple difference (Treatment 1 - Treatment 2) or (Treatment 2 - Treatment 3).
[d] PSM = propensity score matching.
[e] Sodium has been adjusted for salt use in food preparation.

Table 6. Average treatment effects using simple differences and propensity score matching.[ab]

	Treatment 1 vs. Treatment 2				Treatment 2 vs. Treatment 3				Treatment 4 vs. Treatment 5			
HEI and Component Scores	SD[b]	p-value	PSM[c]	p-value	SD[b]	p-value	PSM[c]	p-value	SD[b]	p-value	PSM[c]	p-value
Fat Score	-0.17	*0.75*	-0.94	*0.12*	-0.15	*0.79*	0.28	*0.65*	-0.74	*0.01*	-0.15	*0.81*
Saturated Fat Score	-0.26	*0.65*	-0.13	*0.85*	-0.16	*0.81*	0.74	*0.40*	-0.88	*0.01*	0.80	*0.20*
Sodium Score	-0.12	*0.85*	-0.38	*0.62*	0.60	*0.41*	0.19	*0.85*	0.06	*0.84*	-0.66	*0.39*
Cholesterol Score	-0.03	*0.96*	0.02	*0.98*	0.38	*0.62*	0.03	*0.97*	-0.10	*0.73*	0.45	*0.63*
Grain Score	0.03	*0.94*	0.33	*0.52*	-0.40	*0.42*	-0.33	*0.59*	-0.47	*0.03*	0.46	*0.34*
Fruit Score	-0.45	*0.43*	0.98	*0.16*	-0.91	*0.22*	-0.41	*0.62*	-0.09	*0.80*	0.47	*0.49*
Vegetable Score	0.12	*0.83*	0.87	*0.19*	-1.12	*0.10*	0.40	*0.59*	-0.09	*0.74*	0.61	*0.45*
Meat Score	-0.30	*0.59*	-0.27	*0.82*	-1.65	*0.17*	0.28	*0.73*	0.61	*0.03*	-0.36	*0.59*
Dairy Score	0.06	*0.92*	0.68	*0.35*	0.53	*0.45*	1.36	*0.09*	0.43	*0.15*	0.35	*0.60*
Variety Score	0.20	*0.65*	1.16	*0.07*	0.00	*1.00*	-0.12	*0.85*	-0.06	*0.83*	0.26	*0.70*
HEI	-0.92	*0.62*	3.13	*0.20*	-0.74	*0.77*	2.43	*0.34*	-1.34	*0.28*	2.24	*0.34*
Blood Levels												
Total calcium (mmol/L)	0.01	*0.25*	-0.01	*0.55*	-0.01	*0.35*	0.00	*0.92*	0.02	*0.00*	0.03	*0.00*
Total cholesterol (mmol/L)	0.01	*0.94*	-0.16	*0.27*	-0.08	*0.54*	-0.13	*0.43*	0.01	*0.80*	0.04	*0.61*
Total iron (umol/L)	1.79	*0.09*	0.98	*0.40*	-1.22	*0.24*	-1.40	*0.22*	-1.26	*0.01*	0.10	*0.86*
Total phosphorus (mmol/L)	0.12	*0.00*	-0.02	*0.53*	-0.04	*0.24*	0.03	*0.28*	0.09	*0.00*	0.11	*0.00*
Total protein (g/L)	-1.08	*0.05*	-0.27	*0.64*	0.08	*0.89*	-0.28	*0.76*	0.15	*0.64*	0.06	*0.87*
Total sodium (mmol/L)	0.05	*0.86*	0.28	*0.40*	0.04	*0.88*	-0.17	*0.57*	0.22	*0.14*	0.23	*0.24*
Total potassium (mmol/L)	0.04	*0.23*	0.00	*1.00*	-0.02	*0.62*	0.04	*0.38*	0.05	*0.03*	0.06	*0.04*

[a] Standard errors bootstrap with 500 replications.
[b] Weighted according to NHANES analytic guidelines.
[c] SD = simple difference (Treatment 1 - Treatment 2) or (Treatment 2 - Treatment 3).
[d] PSM = propensity score matching.