DISCUSSION PAPER SERIES

IZA DP No. 4427

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September 2009

Forschungsinstitut
zur Zukunft der Arbeit
Institute for the Study
of Labor

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ABSTRACT

Do Means-Tested School Lunch Subsidies Change Children's Weekly Consumption Patterns?*

This article examines whether the means-tested component of the National School Lunch Program changes beneficiaries' dietary patterns by taking advantage of variation across public school districts in the financing of and demand for lunch and nutrition programs. Using data on fifth grade public elementary school children in the Early Childhood Longitudinal Study-Kindergarten (2003-2004), we find significant increases in weekly rates of consumption amongst fully and partially subsidized children. Our estimates also suggest that the increase was for items known to be a rich source of vitamins and minerals that are essential for children's health and development. The effects are larger for fully subsidized children relative to partially subsidized children, which suggests the nominal price of school lunch is a binding constraint for certain children on the margin of eligibility for the subsidies. To the extent that children from low-income households experience undernourishment with greater frequency, policy discussion focusing exclusively on the link between obesity and program participation is overlooking positive effects on those who are directly subsidized.

JEL Classification: I38

Keywords: National School Lunch Program, dietary patterns, subsidies

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* An earlier version of this paper circulates as “Does the National School Lunch Program Change Children's Weekly Consumption Patterns?"

I INTRODUCTION

Beneficiaries of the means-tested component of the National School Lunch Program (NSLP) account for approximately 60% of the lunches it funds and 50% of all participants. Having been in effect since 1946, the NSLP now provides over eight billion dollars of federal funding (a small percentage of which is matched by state governments) for the provision of low-cost lunches. Currently, more than 30 million students take advantage of this program each school day in nearly 95,000 public and nonprofit private schools and residential child care institutions.[1] The additional school lunch subsidies provided to students from eligible low-income households (beneficiaries) make up a sizeable portion of the total cost of the program; and this component arguably has the most potential to impart health benefits, in particular, for young children.

Limited accessibility to nutritious meals poses a severe threat to children's development and growth by impairing the body's ability to resist infection which, in turn, exacerbates negative effects of undernourishment. A central objective of the NSLP is to help prevent undernourishment among children by relaxing household resource constraints and expanding access to domestic agricultural products. Currently, a student is eligible for a partially subsidized (price is less than or equal to 40 cents) or fully subsidized school lunch when their household income is below 185% or 130% of the federal poverty guidelines, respectively (U.S. Congress, 2004).[2] To the extent that children from low-income households experience undernourishment with greater frequency, subsidization of nutritious foods high in essential vitamins and minerals is required to maintain immunological functions and prevent impaired

[1] See http://www.fns.usda.gov/pd/slsummar.htm for a summary of the program's participants and lunches served since 1969. The initial National School Lunch Act was passed in 1946 in response to the increased demand for military servicemen during World War II and the extent to which potential soldiers had health limitations related to nutritional status. The NSLP funds school lunches in every public school that children attend in our sample.

[2] Congress established uniform national guidelines and criteria in the determination of eligibility beginning fiscal year 1971. See Gunderson (1971) for a comprehensive history of school food assistance programs in Europe and the U.S. prior to 1971.

growth and development (Scrimshaw and SanGiovanni, 1997).

The recent policy discussion in the United States, however, has acquired a different emphasis. There has been an increasing amount of research investigating the role of federal food and nutrition programs in the increasing national trend in obesity.[3] While analyzing the inter-relationships between children's anthropometric measurements and welfare program participation is informative, from a policy standpoint, it is important to understand how these programs can change body size through intermediary mechanisms such as consumption patterns. The NSLP is a primary focal point for examining potential links between program participation and individual diet composition.[4] Given the vast reach of the program and its potential to improve children's health and development, we investigate: *How the NSLP means-tested subsidies change children's weekly consumption patterns.*

In general, regressing a behavioral outcome of interest on an indicator variable for the child's beneficiary status will not give the causal effect of the subsidy. The "take-up" of welfare is likely to be correlated with other important determinants of individual patterns of behavior; some of which are observable and some of which are plausibly unobservable.

[3]See Currie (2003) for a thorough overview of food and nutrition programs in the U.S. and summary of the empirical evidence. For recent careful empirical studies of program and participation effects see Schanzenbach (2008) and Millimet et al. (2008) for estimates of the effects of the NSLP on children's prevalence of obesity; Hinrichs (2008) for estimates of the effects of the NSLP on a number of adult health and education outcomes; Dunifon and Kowaleski-Jones (2003) for effects on children's probability of having health limitations; Bhattacharya et al. (2006) for estimates of the effects of the availability of the School Breakfast Program on a number of nutritional outcomes and Millimet et al. (2008) for effects of participation on children's prevalence of obesity; Gibson (2003) for estimates of the effects of the Food Stamp Program on adults' prevalence of obesity and their body mass indices; Hofferth and Curtin (2005) for evidence that food programs do not contribute to overweight among low-income children.

[4]The literature typically classifies students as NSLP participants if they purchase a school lunch provided through the program at the full or subsidized price. Gleason and Suitor (2003), for example, analyze the impact that NSLP participation has on children's diet composition. They study lunchtime and 24 hour dietary intakes and find it increases participants' consumption of several key vitamins and minerals and dietary fat while decreasing that of added sugars. Similarly, Gordon et al. (2007b) provide more recent estimates of differences in dietary intakes and food consumption between NSLP participants and nonparticipants. They only report the sample means by participation status for consumption of various categories of food and beverages. In their regression-adjusted estimates of mean dietary intakes, no measure of children's body weights is included in the model and participation is assumed exogenous. No analytical distinction is made for those participants receiving means-tested subsidies in either of these studies.

For example, in this paper variation in appetites alone could result in children who have a high preference for consumption selecting into the NSLP with greater frequency; all else being equal, households with children with smaller appetites could be less likely to enroll in the program even if they do meet the eligibility criteria. For these and similar lines of reasoning, estimates of the effect of the NSLP subsidy are likely to be confounded with other factors which differ between beneficiaries and non-beneficiaries. Research investigating causes of obesity has found considerable evidence documenting complex interrelationships between individual activity patterns, appetite, body weight and metabolism; thus, posing a threat to the identification of the causal effects.[5] In order to account for these omitted and difficult to measure factors, we include reliable measures of body weight and height in our specification of children's weekly rate of consumption to control for differences in appetites and metabolism.

A second threat to identification in this context, however, is that the frequency of consumption and the types of foods consumed can change an individual's basal metabolic rate which, in turn, can also affect body weight directly.[6] Relying on the inclusion of all variables affecting individual consumption rates, body size, and take-up of the NSLP subsidy is a tenuous solution because children's appetites and metabolism are the product of many environmental and genetic factors.[7] We identify the effects of children's beneficiary status on their weekly rates of consumption by taking the following steps. First, we utilize a large, nationally representative sample of fifth grade children attending public elementary schools in the U.S. surveyed in the Early Childhood Longitudinal Study-Kindergarten (ECLS-K) dur-

[5]See Bhargava et al. (2008) for recent findings on the effects of children's activity patterns on body weights and body mass indices; Prentice et al. (1989) find metabolism alone cannot explain obesity and discuss the importance of accounting for interrelationships between energy intake, energy expenditure and body size.

[6]The basal metabolic rate is the minimum daily amount of energy required to sustain life. See Johnstone et al. (2005) for recent evidence on factors, such as fat-free body mass, which explain variation in these rates across individuals.

[7]Escobar (1999) and Birch and Fisher (1998) provide a nice qualitative overview of the developmental and environmental factors affecting food preferences and patterns of food consumption from early ages onward.

ing the 2003-2004 school year (the consumption survey was not introduced until the sixth round preventing us from taking advantage of any time variation). The extensive information compiled in the study enables us to incorporate several variables into our specification which are likely to influence weekly consumption rates, appetites, and metabolism such as the average amount of time children spend watching television during a typical day, the number of weekly physical exercise periods which exceeded twenty minutes, as well as a number of other individual, household, and environmental factors. Second, we match information on school district finance characteristics and construct "instrumental variables" which measure cross-sectional variation in the per student funding of and demand for nutrition and lunch programs within the school district in which a child attends school. We use these additional variables to identify the effect of beneficiary status and body weight on children's weekly rates of consumption separately from other variation in take-up and body weight that is left unexplained in our specification; relationships not closely examined in previous research. Third, to assess the robustness of our identification strategy and main results, we further incorporate measures of food availability within the zip code in which children's households are located such as the per capita level of supermarkets, convenience stores, full-service restaurants, limited-service restaurants, and the ratio of supermarkets to convenience stores. This enables us to ascertain the extent to which our identification strategy is strictly measuring differences across individuals in their access to food sources near home or the socioeconomic characteristics of their local communities.

Overall, the results suggest that NSLP means-tested subsidies change children's weekly rate of consumption for certain types of food and beverages. We find the weekly rate of consumption increases for fruit, green salad, and 100% fruit juice, and decreases for all types of milk (the measure for milk is somewhat flawed, in that, it conflates the frequency of all types of milk consumption into one survey question). In contrast, we find no statistically significant effect on children's weekly rate of consumption for carrots, potatoes, other veg-

etables, or sweetened beverages suggesting, in part, household reallocation in response to the subsidy.

In general, coefficient estimates for beneficiary status are biased toward zero if we ignore the endogeneity of beneficiary take-up. The selection bias indicates that these particular children are less likely to have above-average rates of consumption in the absence of the subsidy program. Further disaggregating NSLP beneficiary status into partially subsidized and fully subsidized categories of eligibility highlights disparate effects between the two. Though the precision of the estimated effects is weakened overall, the coefficient for partially subsidized lunch is generally smaller than that for fully subsidized lunch. Although the coefficients are not statistically different from one another, this finding is consistent with the hypothesis that the nominal price of school meals is a *binding* constraint for certain children on the margin of eligibility for the means-tested subsidies. To our knowledge this is the first study to analyze differences in consumption patterns between these distinct categories of low-income children.

We find a similar pattern when further controlling for zip code characteristics measuring food availability. The statistical significance of the estimated effect of the subsidies is weakened for the weekly rate of green salad consumption and strengthened for the weekly rate of carrot consumption. However, the negative effect on milk consumption is only evident for those children receiving a partial subsidy. Moreover, the causal effect of body weight on weekly rates of consumption is not significant at the conventional level once the bidirectional relationship is accounted for and, in particular, once we control for specific differences in food availability near children's homes.[8] These factors do explain some of the variation in

[8]We estimate a significant effect of body weight on children's weekly consumption of green salad and sweetened beverages, which are at odds with estimates obtained when endogeneity is ignored. We further test for the validity of combining height and weight as in the standard body mass index (body weight divided by the square of body height) and find it is generally not supported by the data in this context. This is not particularly surprising given that weight is much more likely than height to vary in response to recent changes in weekly rates of consumption.

children's weekly consumption patterns, however, they do not completely explain the effect of the NSLP subsidies. These relationships have not been previously investigated in this literature.

We outline a conceptual framework for our analysis in Section II, and describe the data sources we utilize here in Section III. Section IV outlines the empirical framework and estimation strategy. An important component of the estimation is the rigorous treatment of beneficiary take-up as well as the potential correlation of children weights to unobserved factors. Section V presents the results and explores the robustness of the findings to omitted zip code food availability characteristics. Section VI concludes and discusses policy implications.

II CONCEPTUAL FRAMEWORK

Economic theory suggests that in-kind commodity transfers can change consumption patterns depending on individual preferences. In the context of welfare assistance targeted toward children, the specification developed in Becker (1974) suggests the transfer can stimulate a reallocation of resources within households; however, the extent of the response is contingent upon the preferences of the "head" of the family and household resource constraints. If, on the one hand, the subsidies received through a child's participation in the NSLP result in a reallocation of household expenditure away from children's consumption by the full "value" of the subsidy then we would expect no change in observed consumption patterns due to the food and beverages provided by the program itself. On the other hand, however, there is the possibility that previous levels of household expenditure are only partially displaced or are not displaced at all in response to the subsidy.[9] In this case, there is scope for the means-tested component of the NSLP program to change the composition of

[9]Long (1991) find households reduce expenditure on food by 61 cents for each additional dollar of NSLP benefits; Jacoby (2002) find no intrahousehold reallocation of calories for children in response to a school feeding program; Hoynes and Schanzenbach (2007) find the Food Stamp Program increases overall food expenditures and reduces out-of-pocket expenditures on food.

food and beverages consumed by children from low-income households on a weekly basis (or an even longer time horizon).

NSLP And Households' Consumption Decisions

Households' consumption decisions have been found to respond directly to welfare assistance. Hoynes and Schanzenbach (2007) recently estimate that the marginal propensity to consume food is slightly larger for in-kind transfers as opposed to cash transfers. It is difficult to disentangle whether this response is due to the constraints imposed by in-kind welfare programs, or as Becker (1974) illustrate, the individual preferences of the household decision maker.[10] Overall, the evidence suggests a marginal propensity to spend on food in the range of \$0.17 and \$0.47, and substantially less than one (Currie, 2003). To gain perspective on the economic impact of the NSLP subsidies on household budgets, for our time period, the maximum reimbursement rate paid to schools located in the contiguous U.S. through the NSLP is \$2.36 per meal (U.S. Department of Agriculture, 2003). This would amount to about a \$50 transfer per month to a household for each fully subsidized child. If this transfer was viewed by the head of the family as equivalent to a cash transfer then spending on food would increase by a minimum of about nine dollars per month. It is an empirical question whether households reallocate food resources to other members or whether children experience a net increase in consumption. If the household is currently experiencing food shortages, the findings of Bhattacharya et al. (2003) suggest adult members might benefit more from the additional resources because the hierarchical organization of families is such that children are protected from economic shocks.

[10]The matter is complicated further by the fact that certain households are simultaneously receiving assistance from more than one program. In our full sample, for example, about 11% of households received food stamps in the previous 12 months and 94% of these households had children participating in the NSLP. Similarly, about 4% of households received aid through the Temporary Assistance for Needy Families program in the previous 12 months and 92% of these households had children participating in the NSLP. Simultaneous participation in multiple welfare programs is another reason why treating NSLP beneficiary take-up as exogenous is problematic in this context.

III THE DATA

The empirical analysis uses data assembled from a variety of sources. This section gives a brief summary of the data sources, the variables utilized, and how we construct certain measures from data not included in the ECLS-K.

ECLS-K

The ECLS-K is an ongoing longitudinal study that began in the fall of 1998 by observing nearly 20,000 children in kindergarten enrolled in over 1,200 schools throughout the U.S.; however, attrition due to geographical relocation resulted in approximately 11,000 children remaining in the study from kindergarten through 5th grade. The locatable students were followed for a random 50% of the schools (Tourangeau et al., 2006). We strictly focus on the fifth grade round because this was the first round which surveyed children directly about their consumption of various types of food and beverages consumed in the previous week. Due to missing observations on individual data and the availability of school district finance characteristics, complete data were analyzed on 6,530 children in the fifth grade who attended schools in nearly 700 different public school districts located in 40 states during school year 2003-2004.[11]

The consumption outcomes we analyze are based on children's own response to survey

[11]Demographic characteristics of the sample in the analysis were similar to the full sample covering all children from kindergarten through the 5th grade. Certain kinds of sampling weights (differential probabilities of selection at each sampling stage) based on aggregate non-response and other variables such as children's age, gender, ethnicity, and geographical location are available in the ECLS-K data; however, they were not utilized in the modeling as they are formulated under the assumption of non-missing data in both the ECLS-K survey and the additional data sources we match and incorporate into our specification. Wang et al. (1997), using several bootstrap methods, provide evidence that ignoring the possibility of unobserved group effects arising from the multi-stage sampling design mainly affects the estimate of the constant term. Additionally, it is not clear which of the available weights provided in the sixth round of the ECLS-K would be appropriate and have a logical interpretation as there are child weights, parent weights, and child-parent-teacher weights to choose from; none of which account for missing values for key characteristics of children and their households in our specification, strictly public school children, or the missing values for school district finance characteristics.

questions regarding the food they consumed during the previous seven days. The responses range one through seven corresponding to answers of none, 1-3 times, 4-6 times, 1 time per day, 2 times per day, 3 times per day, or 4 or more times per day, respectively. There are eight specific categories of consumption: 1. Fruit such as apples, bananas, oranges, berries, or other types of fruit, and does not include fruit juice; 2. Green salad; 3. Carrots; 4. Potatoes which does not include "french fries", fried potatoes, or potato chips; 5. Other vegetables not including green salad, potatoes, or carrots; 6. Milk including all types of milk such as cow's milk, soy milk, or any other kind of milk, and whether it was in a carton, cup, glass, or with cereal; 7. 100% Fruit juice including only non-sweetened, 100% fruit juices such as orange juice, apple juice, or grape juice; 8. Sweetened beverages including soda pop, sports drinks, or fruit drinks that are not 100% fruit juice.

Additionally, information was collected on the attributes of children and their households. Parents were asked directly whether their child was currently receiving a full or partial NSLP subsidy. Children's heights and body weights were measured using a Shorr Board and digital scale, respectively; duplicate measures were taken and we use the mean values.[12] The highest parental education level achieved was assessed as a categorical variable that ranges one through nine corresponding to answers of 8th grade or below, 9th-12th grade, high school diploma/GED, vocational program, some college, bachelor's degree, graduate/professional school with no degree, master's degree, doctorate or professional degree, respectively. Annual household income was assessed as a categorical variable that ranges one through 13 corresponding to answers of <5, 5-10, 10-15, 15-20, 20-25, 25-30, 30-35, 35-40, 40-50, 50-75, 75-100, 100-200, >200 in US $1000, respectively.[13] Other variables we include in our specification are number of siblings, the number of days per week the child exercises for

[12]A Shorr Board vertical stadiometer (Shorr Production, Olney, MD); measures standing height to the nearest 0.1 cm.

[13]Finer measures of household income were not extensively surveyed after the base round in 1998. For example, only 14% of households in our full sample reported a specific value for their total annual household income; 35% and 2% of NSLP beneficiaries and non-beneficiaries, respectively.

periods longer than 20 minutes, the average number of minutes per day the child watches television, the age in months of the child, and gender. Lastly, we construct an indicator variable measuring whether a child had been diagnosed by a professional to have a disability such as difficulty with eyesight or in hearing and understanding speech, or other impairments resulting in developmental disorder or delay.

School District Finance Characteristics

We utilize the National Center for Education Statistics seven digit local education agency identifiers to match data from the Common Core of Data, School District Finance Survey for fiscal year 2003. School district revenues from federal, state, and local sources allocated for specific expenditures related to meals served in schools within the district are used to construct instrumental variables for children's body weights and take-up of the NSLP means-tested subsidies. Specifically, we construct three per student revenue measures for each school district in the sample. The federal revenues are those allocated for Child Nutrition Act (CNA) programs such as the NSLP, School Breakfast Program, Special Milk Program, and Ala Carte Program. It does not include the monetary value of commodities which have been donated to the school districts. The state revenues are those allocated by the state government for CNA program matching payments.[14] The local revenues are the reported gross receipts from the sale of school breakfasts, lunches, and milk from students, teachers, and adults, and do not include revenues from state or federal funds (Berry and Cohen, 2006).

[14] As of fiscal year 1956 states were required to match three dollars for each federal dollar received through the NSLP; states with per capita incomes below the national average had matching rates reduced by the percentage difference (Gunderson, 1971). With the passage of the CNA, the a minimum state contribution could not be less than 30% of the administrative cost for all programs funded through the act (U.S. Congress, 108th, 2004).

Zip Code Characteristics

We utilize the zip code location of children's households to match data from the U.S. Census Bureau 2004 Zip Code Business Patterns Survey. Variables which reflect the availability of food and beverages close to a child's home are used to construct per capita measures for each child who lives in a zip code included in the survey universe. These are included in expanded specifications of children's weekly rates of consumption to ascertain the extent to which our identification strategy is strictly measuring differences across individuals in their access to food sources near home or the socioeconomic characteristics of their local communities. Establishments are classified according to the North American Industry Classification System and we utilize data on the number of supermarkets (#445110), convenience stores (#445120), full-service restaurants (#722110), and limited-service restaurants (#722211). Per capita measures are constructed using zip code population data come from the Census 2000 Summary File 1.

IV EMPIRICAL FRAMEWORK

The baseline specification for children's weekly rate of consumption is postulated in equation (1):

$$Outcome_{ij} = \alpha_1 + \beta_{11} nslp_{ij} + \beta_{12} ln(weight)_{ij} + \beta_{13} ln(height)_{ij} + \mathbf{X}_{ij}\Gamma_1 + u_{1ij} \qquad (1)$$

where i indexes each child in the sample, j indexes the public school district in which the child attends elementary school, $nslp$ is an indicator for partial or full NSLP beneficiary status, $ln(weight)$ is children's body weights in pounds expressed in natural logarithms, and $ln(height)$ is children's body heights in inches expressed in natural logarithms.[15] We include

[15]The extent of the household income effect for fully subsidized beneficiaries depends primarily on school attendance; and for partially subsidized beneficiaries it depends on attendance as well as whether their

these measures of body size to assess how well children are nourished and to control for the unobserved serving sizes corresponding to children's reported weekly rates of consumption. To a certain extent, these measures also control for differences in children's appetites and metabolism.[16] Body weights are treated endogenously in the estimation due to its short-run, more immediate relationship with consumption and nutrient intake. Body height is a long-run measure of nutritional status and health shocks occurring in early stages of development. These measures are typically compared against national standards based on age and gender to gain perspective on the physiological development of children, and are often combined as the ratio of weight to squared height to construct a body mass index (Cole, 1991). As Bhargava (1994) suggest, we can test the validity of this restrictive transformation; the null hypothesis is, $2 \cdot \beta_2 + \beta_3 = 0$, and can be tested using a Chi-square statistic distributed with one degree of freedom.[17]

X is a vector of potentially confounding variables. We include the natural logarithm of parental education level due to its complex interrelationship with children's health and height (Thomas et al., 1991), and its potential to affect food choice, serving sizes, and preparation methods. Annual household income and the number of siblings control for potential resource constraints affecting children's consumption.[18] The number of days per

household is able to finance the remaining cost of school lunch. Sample means of the number of days a child was absent during the school year for beneficiaries and non-beneficiaries are close at 6.9 and 6.0, respectively, but statistically different from one another at conventional levels of significance; data on school absence was only available for 5780 of the children in the full sample. Further, fully subsidized children had an average of 7.2 school day absences while partially subsidized children receiving had an average of 6.4 school day absences; and the difference is statistically significant. Absenteeism does not appear to explain our findings.

[16]The heights and weights of children's parents were not surveyed in the ECLS-K.

[17]We reject the null hypothesis of the body mass index transformation for the baseline specification at a 5% significance level for fruit, green salad, potatoes, and sweetened beverages; a 10% level for carrots and 100% fruit juice; and fail to reject the null hypothesis for other vegetables and milk.

[18]Utilizing a nonlinear specification of education and/or income in the specification, such as a series of dummy variables for different categories, showed slightly different magnitudes across categories which were not statistically different from one another. We find the same pattern of subsidy effects in either of the specifications. Given that the data do not suggest this restriction affects our main results and that the focus of this study is primarily on the effect of NSLP means-tested subsidies, we report only the estimates from specifications which assume the effect of moving across categories is equal.

week the child exercises for periods longer than 20 minutes and the average number of minutes per day the child watches television are included to control for behavioral factors affecting children's consumption, appetites, and metabolism (Dixon et al., 2007; Johnson, 2000). Lastly, we include variables measuring children's ages, gender, and disability status in the specification.

Identifying the Causal Effect: An Instrumental Variables Technique

As previously discussed, there is concern that NSLP beneficiary status is not randomly assigned, even if we control for household income and size, and that a number of genetic and environmental factors, which are difficult to measure, are likely to be correlated with children's body weights and weekly rates of consumption of food and beverages. To minimize bias we employ an instrumental variables estimation strategy. The first stage regressions are specified in equation (2) and (3):

$$nslp_{ij} = \delta_{11} federal_{ij} + \delta_{12} state_{ij} + \delta_{13} local_{ij} + \mathbf{Z}_{ij}\Lambda_1 + \varepsilon_{1ij} \quad (2)$$

$$ln(weight)_{ij} = \delta_{21} federal_{ij} + \delta_{22} state_{ij} + \delta_{23} local_{ij} + \mathbf{Z}_{ij}\Lambda_2 + \varepsilon_{2ij} \quad (3)$$

where Z is a vector of all exogenous variables in the specification including a constant term, $federal$ is school district revenues per student for all CNA programs, *state* is school district revenues per student for state government school lunch matching payments, and *local* is reported gross receipts from the sale of school breakfasts, lunches, and milk from students, teachers, and adults, and these receipts do not include revenues from state or federal funds.[19]

[19]Reduced-form effects for the full sample are jointly significant at a 1% level of significance for all categories of consumption except carrots which is significant at a 10% level and other vegetables which is insignificant. The same result holds at a 5% level for the limited sample discussed below except the category of potatoes is insignificant as well. For brevity, we do not report these results here and these results are available from the authors upon request. The fact that the reduced-form effects are significantly different from zero for all but one outcome measure provides additional credibility to our identification strategy; see Angrist and Krueger (2001) for more in-depth discussion.

We obtain consistent parameter estimates in this case by utilizing the heteroscedasticity-robust generalized method of moments (GMM) estimator available through Stata. We subsequently refer to this baseline specification, defined by equation (1), and the moment conditions implied in (2) and (3), as specification (1).

We are able to formally test our moment conditions and we fail to reject the null hypothesis that our instrumental variables are not significantly correlated with children's weekly rates of consumption; however, the economic intuition behind our identification strategy is straightforward. To consistently estimate the effect of NSLP beneficiary status we require at least one exogenous variable which is likely to affect an individual's take-up choice, conditional on household income and size, but not their weekly rates of consumption of food and beverages directly. Similarly, identification of the effect of children's body weights requires at least one explanatory variable which strictly affects consumption via weight loss or gain.

We propose the use of three distinct variables measuring the financing of and demand for lunch and nutrition programs within the child's public school district. The federal and state per student revenues included in equation (2) and (3) above represent federal funds allocated to school districts based on the CNA and the state matching requirement necessary to receive the federal funds. In contrast, the local per student revenues represent gross school meal sales revenue. Thus, holding constant a school district's meal sales, higher federal and state per student revenues imply a higher number of CNA program participants and subsidy beneficiaries per total students in the district.[20] The more classmates a child has who are beneficiaries can increase individual take-up by reducing the "welfare stigma" associated with welfare program participation.[21] Further, a larger share of funds received through CNA programs can induce school districts to conform more closely to the nutrition guidelines

[20]States are reimbursed with federal funds on a per meal basis for CNA programs; schools serving 40% or more of their school lunches as free or reduced-price are eligible for additional assistance. See U.S. Department of Agriculture (2003) for the specific reimbursement rates valid for our sample period.

[21]See Moffitt (1983) for theoretical and empirical evidence that the stigma from participation can stem primarily from the "act of welfare recipiency."

required by federal law which, in turn, can influence children's body weights depending on how frequently the children consume meals and snacks provided through their schools.

Similarly, holding CNA program expenditures constant, higher local per student revenues imply a higher overall demand for school meals in that district. For example, 37% of children in our full sample attend a school which offers "ala carte" meal items, and these are designed to increase individual demand. Moreover, school districts are granted considerable leeway in designing school meal menus, and these menus exhibit considerable variation in terms of nutrition and variety (see Gordon et al. (2007a) for the most recent and comprehensive evidence). The higher overall demand is for school meals, the greater the likelihood that children's body weights reflect the nutritional component of school meals and snacks. Because we do not observe in our data what the children are actually consuming at school during a typical week, we must rely on the effect of any consumption of food and beverages from school district related sources as operating through children's body weights. The identification strategy we propose and implement strictly allows for us to estimate the effect of NSLP means-tested subsidies on weekly rates of consumption for those individuals whose choice of take-up is influenced by variation in our instrumental variables (Imbens and Angrist, 1994). Thus, estimates on the larger side of what other related studies have found would not be all that surprising given that our framework is specifying the take-up choice as a function of how large the district's demand for school meals is relative to overall CNA program participation by their students.

Alternative Specifications

We further investigate whether the effect of NSLP beneficiary status varies according to whether a child is fully subsidized or partially subsidized. While the price is nominal at less than or equal to 40 cents, these children come from households with limited resources and households might not be able to afford the small cost. In the context of analyzing how

the means-tested component of the NSLP changes children's consumption it is important to distinguish between situations which are not knowable a priori. Our identification strategy permits one degree of freedom and we utilize it to estimate an expanded specification, specification (2):

$$\begin{aligned}
Outcome_{ij} &= \alpha_2 + \beta_{21} free_{ij} + \beta_{22} reduced_{ij} + \beta_{23} ln(weight)_{ij} + \beta_{24} ln(height)_{ij} + \mathbf{X}_{ij}\Gamma_2 + u_{2ij} \\
full_{ij} &= \delta_{31} federal_{ij} + \delta_{32} state_{ij} + \delta_{33} local_{ij} + \mathbf{Z}_{ij}\Lambda_3 + \varepsilon_{3ij} \\
partial_{ij} &= \delta_{41} federal_{ij} + \delta_{42} state_{ij} + \delta_{43} local_{ij} + \mathbf{Z}_{ij}\Lambda_4 + \varepsilon_{4ij} \\
ln(weight)_{ij} &= \delta_{51} federal_{ij} + \delta_{52} state_{ij} + \delta_{53} local_{ij} + \mathbf{Z}_{ij}\Lambda_5 + \varepsilon_{5ij} \qquad (4)
\end{aligned}$$

where we allow for NSLP beneficiary status to be defined by two dichotomous variables indicating whether a child is fully or partially subsidized, respectively.

Lastly, there is concern that children's weekly rates of consumption might depend on the density of food markets and restaurants in the area in which the child's household is geographically located, and that our school district finance characteristics might be correlated with these potentially relevant local factors. Large supermarkets, for example, typically charge lower prices and have a wider variety of selection relative to convenience stores. Moreover, the evidence suggests low-income households tend not to concentrate in suburban areas where prices are generally lower (Kaufman et al., 1997). To ascertain the extent to which our identification strategy is strictly measuring differences across individuals in their access to food sources near home or the socioeconomic characteristics of their local communities, we modify specification (1) and (2) to include a vector of zip code food availability characteristics and refer to the corresponding expanded specifications as (3) and (4), respectively. The additional explanatory variables are per capita levels of supermarkets, convenience stores, full-service restaurants, limited-service restaurants, and the ratio of supermarkets to convenience stores.

V RESULTS

Descriptive Statistics

The sample means of the consumption outcomes we analyze, the explanatory variables we utilize, and the instrumental variables and zip code food availability characteristics are reported in Table 1, 2 and 3, respectively. Mean values of children's weekly rates of consumption were similar between NLSP beneficiaries and non-beneficiaries. About 36% of the full sample are beneficiaries and about 73% of the beneficiaries are fully subsidized. Mean body weights are slightly higher for beneficiaries relative to non-beneficiaries, while mean parent education and household incomes were one standard deviation or more higher for non-beneficiaries. The average parent education level for beneficiaries was between three and four, i.e. high school diploma to vocational or technical school, and household income was between five to six, i.e. US$ 20,000-30,000. For non-beneficiaries, mean parent education was between five and six, i.e. some college to earned bachelor's degree, and household income was between nine and ten, i.e. US$ 40,000-75,000. Furthermore, beneficiaries had slightly more siblings, higher disability prevalence, lower physical exercise rates, and spent more time watching television than non-beneficiaries, on average. Lastly, as we expect and previously discussed, mean levels of federal and state school district revenues per student are higher for beneficiaries relative to non-beneficiaries, and vice versa for local school district revenues per student.

Results for Children's Weekly Consumption Patterns

We present the results from our specifications for children's weekly rates of consumption in Table 4-11. All measures of consumption are standardized to have mean zero and variance

one in the estimation to facilitate the interpretation of regression coefficients.[22] Due to space limitations, we only report the estimated coefficients for a subset of the explanatory variables, however, we can provide the others upon request. Specification (1) and (3) estimate specifications defined by equation (1), (2), and (3), where the difference between the two is the inclusion of zip code food availability characteristics shown in Table 3. Similarly, specification (2) and (4), defined in equation (4), disaggregate NSLP beneficiary status into full and partial subsidization categories, and differ only in the inclusion of the additional zip code characteristics.

The main findings are, first, NSLP subsidies increase children's weekly consumption of fruit, green salad, and 100% fruit juice, and decrease their consumption of all types of milk. The coefficient on beneficiary status can be interpreted as the number of standard deviations consumption of a given food group changes in response to a person moving from non-beneficiary to beneficiary status; thus reflecting the effect of the subsidy on weekly rates of consumption. We find beneficiaries have rates of consumption 1.24, 1.21, 1.35 standard deviations higher and 1.86 standard deviations lower, for each of the respective categories. In contrast, beneficiary status has no statistically significant effect on the consumption of carrots, potatoes, other vegetables, or sweetened beverages; although, the signs of the coefficients are positive for carrots and other vegetables and negative for potatoes and sweetened beverages. Household reallocation in response to the subsidy is a likely explanation for these insignificant effects.

Second, specification (2) shows how the effect of beneficiary status varies according to the degree of subsidization. Fully subsidized children have significantly higher rates of consumption of fruit, green salad, and 100% fruit juice, and lower rates of consumption of all types

[22]Results not reported here show a similar pattern of effects, in terms of coefficient sign and statistical significance, if we leave the outcomes in their original qualitative metric, or if we transform them into quantitative measures of weekly consumption by multiplying children's responses by the number of days in the week to obtain the approximate total number of servings per week.

of milk. In contrast, partially subsidized children are only found to have significantly lower rates of milk consumption; other rates of consumption are not statistically different from zero. While the precision of the estimated effects is considerably weakened under this specification, the smaller coefficients and larger standard errors for partially subsidized children relative to fully subsidized children suggests that the nominal price is a binding constraint for at least a fraction of these children. The result that the rate of milk consumption is significantly lower regardless of subsidization level is remarkable, and leads us to consider how characteristics of food availability near children's homes might change our estimates.

Third, if we do push further and specify zip code characteristics measuring food availability, the same qualitative pattern of NSLP beneficiary status effects remains for specification (3), however, the statistical significance is weakened for green salad consumption and strengthened for carrot consumption. Moving to specification (4) where we allow the effect of beneficiary status to vary according to subsidization level, we see that the precision of estimates is weakened even more relative to specification (2). This is not surprising given the substantial reduction in sample size due to the limited availability of zip code information. What is notable though, is that the unusual finding for beneficiary weekly rates of milk consumption is no longer statistically significant for fully subsidized children.[23]

Fourth, we do find a significant effect of body weights on children's weekly consumption of green salad and sweetened beverages, which are at odds with simple OLS estimates obtained when endogeneity is ignored. While the complete omission of body weight in a specification

[23]The measure of milk consumption is somewhat flawed in that it conflates the frequency of all types of milk consumption into one survey question. Our estimates suggest that partially subsidized children have (marginally) significantly lower rates of milk consumption. In contrast, the estimated coefficient for fully subsidized children is closer to and not statistically different from zero. This finding suggests that the population of children who are partially subsidized might not be consistently purchasing milk during school lunch. Further, it also implies that differences across individuals in their access to food and beverages near home explains part of the variation in children's weekly rates of milk consumption. Children with a higher ratio of supermarkets to convenience stores and a higher level of per capita full-service restaurants are found to have significantly lower rates of milk consumption. In contrast, children with a higher ratio of full-service to limited-service restaurants and a higher level of per capita limited-service restaurants are found to have significantly higher rates of milk consumption.

of consumption will likely lead to omitted variables bias, the bidirectional relationship must be acknowledged in the estimation. We further find children from higher income households have higher rates of of consumption for fruit, green salad, carrots, and 100% fruit juice. We also find that the effect of parent education is generally overestimated in specifications where endogeneity of our key variables is ignored, emphasizing the importance of accounting for inter-relationships if estimates are to provide policy guidance.

Results for First Stage Regressions

We test the joint significance of our instrumental variables in the first stage regressions and calculate tests of overidentifying restrictions where applicable; these results are shown in Table 12. Despite the small possibility that our instrumental variables are highly correlated with non-beneficiary weekly rates consumption, the tests of overidentifying restrictions provide reassurance that the correlations are very small and well within conventional size. The main implication for our analysis is that the data do not suggest the children are sorting, to any significant degree, across public school districts according to their weekly consumption patterns, which might otherwise confound our estimates of the effect of NSLP means-tested subsidies.

In first-stage regression results not reported here, the estimated coefficients on the federal, state, and local school district revenues per total student enrollment in the natural logarithm of children's body weights regression are 0.0002 (0.00003), −0.0003 (.0001), and 0.00003 (0.00004), respectively, with standard errors in parentheses. The R-square is 0.47. We see that children's body weights are positively associated with federal dollars per student provided for CNA programs. The estimated signs and statistical significance are very similar with zip code food availability characteristics included in the specification. For the beneficiary take-up regression in specification (1), where we make no distinction between full and partial subsidization, the estimated coefficients on federal, state, and local school

district revenues per total student enrollment are 0.0007 (0.0001), −0.0001 (.0003), and −0.0003 (0.0001), respectively; and the R-square is 0.54. Higher federal dollars per student provided for CNA programs is positively associated with beneficiary take-up. State matching dollars per student are negatively associated with take-up, however, the coefficient is not statistically different from zero when zip code food availability characteristics are included in the specification. Furthermore, in specification (2), the coefficient is negative and significant for fully subsidized beneficiaries and positive and significant for partially subsidized beneficiaries whether the zip code characteristics are included or not. Thus, partially subsidized take-up is positively associated with state dollars per total student enrollment, holding federal and local dollars per student constant. Assuming a positive relationship between consumption from school sources and take-up, all our first stage regression estimates are line with the economic intuition previously discussed in section IV.

VI DISCUSSION

In this study we estimate determinants of children's weekly rates of consumption for certain types of food and beverages, and evaluate the effect of the means-tested component of the NSLP in this context. Methodologically, we are careful to account for non-random beneficiary take-up and the bidirectional relationship between body weight and consumption choice. We use an instrumental variables estimation strategy to account for endogeneity by taking advantage of variation across public school districts in the financing of and demand for lunch and nutrition programs. The standard diagnostic tests and estimated first stage regression results support the validity of this estimating framework. Overall, our findings suggest that the policy component of the NSLP has a significant effect on beneficiaries' weekly consumption patterns.

We find NSLP subsidies increase children's weekly rate of consumption for fruit, green

salad, and 100% fruit juice, and decrease their weekly rate of consumption for all types of milk; a relationship not examined previously in the literature. Additionally, we find that accounting for food availability near a child's home does not completely explain the effect of the subsidies, but accounts for part of the variation in children's consumption patterns. For example, not including measures of food availability in our specification would lead to the erroneous conclusion that NSLP beneficiary status does not increase children's weekly rate of consumption for carrots. Similarly, the inclusion of this additional information indicates that fully subsidized children do not have significantly lower rates of milk consumption on a weekly basis, while partially subsidized children do.

The findings we present here are of significant interest because changes in dietary patterns have developmental and health benefits that are also well-documented in the health and nutrition literature. From a policy perspective, we find the changes in dietary patterns to be in accordance with the objective of ensuring adequate nourishment of children. In a recent large and expensive study, Gordon et al. (2007a) provide comparisons of the average rates of consumption for various categories of food and beverages consumed by NSLP participants and nonparticipants during lunch. We show that certain differences in children's dietary patterns persist at the weekly level for those children whose meal purchase is subsidized above and beyond the standard full price for NSLP school lunch participants; and that these differences are not completely offset by a reallocation of resources within households in response to the in-kind commodity transfer. Our findings of increased weekly rates of consumption for fruit and 100% fruit juice coincide with their findings and, taken together, suggest that the program is increasing the overall rate of consumption of vitamins A and C as well as calcium and iron for subsidized low-income children. To the extent that these are essential ingredients for maintaining immunological functions and preventing impaired growth and that children from low-income households experience undernourishment with greater frequency, we conclude the means-tested component of the NSLP is imparting positive

long-run effects on beneficiaries' health and development.

The effects we find are generally larger for partially subsidized children relative to fully subsidized children. We interpret this evidence as consistent with the hypothesis that the nominal price of school meals is a *binding* constraint for certain children on the margin of eligibility for the subsidy program. More research into the extent to which the nominal cost of school meals is a barrier to access for low-income children would likely prove informative for policymakers considering the future direction and overall effectiveness of the NSLP and other entitlement programs concerned with preventing undernourishment amongst children.

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TABLE 1

Sample means of weekly food and beverage consumption outcomes for children enrolled in fifth grade in public elementary schools from the ECLS-K by NSLP beneficiary status for the full and limited sample[a]

	Full Sample				Limited Sample[b]			
	NSLP Beneficiaries		Non-Beneficiaries		NSLP Beneficiaries		Non-Beneficiaries	
Dependent variables	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Fruit[c] (1-7)	3.52	1.85	3.27	1.63	3.56	1.87	3.26	1.63
Green salad (1-7)	1.85	1.24	1.87	1.10	1.87	1.27	1.88	1.09
Carrots (1-7)	2.02	1.47	2.01	1.28	2.04	1.46	1.97	1.26
Potatoes[d] (1-7)	1.82	1.15	1.72	0.89	1.77	1.14	1.70	0.89
Other vegetables[e] (1-7)	2.75	1.62	2.75	1.44	2.74	1.62	2.73	1.44
Milk[f] (1-7)	3.75	1.91	4.11	1.91	3.68	1.89	3.99	1.88
100% Fruit juice[g] (1-7)	2.83	1.77	2.65	1.57	2.88	1.79	2.66	1.57
Sweetened beverages[h] (1-7)	3.06	1.78	2.92	1.60	3.03	1.75	2.92	1.60
Observations	2350		4180		1620		2600	
Zip code characteristics	No		No		Yes		Yes	

Note: Sample means and standard deviations are reported.

Source: Children enrolled in fifth grade in public schools from the ECLS-K (2003-2004).

[a]Weekly consumption outcomes are based on children's response to survey questions regarding the food they ate or drank during the previous seven days; the responses range none, 1-3 times, 4-6 times, 1 time per day, 2 times per day, 3 times per day, or 4 or more times per day.

[b]Sample is limited due to the data availability of zip code food availability characteristics; see Table 3 for the limiting variables.

[c]Includes fruit such as apples, bananas, oranges, berries, or other types of fruit, and does not include fruit juice.

[d]Does not include "french fries", fried potatoes, or potato chips.

[e]Does not include green salad, potatoes, or carrots.

[f]Includes all types of milk such as cow's milk, soy milk, or any other kind of milk, and whether it was in a carton, cup, glass, or with cereal.

[g]Includes only non-sweetened, 100% fruit juices such as orange juice, apple juice, or grape juice.

[h]Includes soda pop, sports drinks, or fruit drinks that are not 100% fruit juice.

TABLE 2

Sample means of selected explanatory variables for children enrolled in fifth grade in public elementary schools from the ECLS-K by NSLP beneficiary status for the full and limited sample

	Full Sample				Limited Sample[a]			
	NSLP Beneficiaries		Non-Beneficiaries		NSLP Beneficiaries		Non-Beneficiaries	
Explanatory variables	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Fully subsidized (%)	72.9	–	0	–	73.9	–	0	–
Weight (lb)	102.98	31.63	96.60	27.56	102.35	31.82	96.41	27.58
Height (in)	57.69	3.04	57.74	2.94	57.60	3.04	57.65	2.94
Parent education category (1-9)	3.84	1.56	5.62	1.75	3.83	1.59	5.71	1.75
Household income category[b] (1-13)	5.48	2.47	9.96	2.02	5.52	2.45	10.01	2.04
Number of siblings (0-10)	1.86	1.29	1.35	0.93	1.84	1.27	1.35	0.94
Physical exercise >20 mins (d/week)	3.63	2.04	3.80	1.78	3.60	2.04	3.76	1.79
Watch television (min/d)	160.66	82.47	139.16	66.09	158.46	82.17	138.70	66.76
Age (months)	134.80	4.64	134.81	4.35	134.41	4.61	134.57	4.37
Male (%)	48.4	–	49.8	–	47.2	–	49.7	–
Disability[c] (%)	16.5	–	14.6	–	16.0	–	15.2	–
Observations	2350		4180		1620		2600	
Zip code characteristics	No		No		Yes		Yes	

Note: Sample means and standard deviations are reported.

Source: Children enrolled in fifth grade in public schools from the ECLS-K (2003-2004).

[a]Sample is limited due to the data availability of zip code food availability characteristics; see Table 3 for the limiting variables.

[b]Finer measures of household income were not extensively surveyed after the base round in 1998; thus, the only available information on annual household income is 13 categories in US $1000 (<5, 5-10, 10-15, 15-20, 20-25, 25-30, 30-35, 35-40, 40-50, 50-75, 75-100, 100-200, >200)

[c]Diagnosed by a professional to have a disability such as difficulty with eyesight or in hearing and understanding speech, or other impairments resulting in developmental disorder or delay.

TABLE 3

Sample means of instrumental variables and selected zip code characteristics for children enrolled in fifth grade in public elementary schools from the ECLS-K by NSLP beneficiary status for the full and limited sample

	Full Sample				Limited Sample			
	NSLP Beneficiaries		Non-Beneficiaries		NSLP Beneficiaries		Non-Beneficiaries	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Instrumental variables								
Federal revenue to school district for CNA programs[a] ($/student)	216.39	101.07	125.01	80.21	214.06	86.33	128.33	83.60
State revenue to school district for CNA programs[b] ($/student)	11.69	23.76	8.90	18.51	13.45	27.24	9.59	21.27
Local revenue to school district from school meal sales[c] ($/student)	101.78	62.03	148.23	66.58	96.60	57.66	141.33	65.28
Zip code characteristics								
Supermarkets per capita	–		–		0.0005	0.0083	0.0002	0.0001
Convenience stores per capita	–		–		0.0006	0.0207	0.0001	0.0001
Supermarkets per convenience stores	–		–		3.47	4.20	2.56	2.58
Full-service restaurants per capita	–		–		0.0020	0.0580	0.0008	0.0005
Limited-service restaurants per capita	–		–		0.0034	0.1118	0.0007	0.0004
Observations	2350		4180		1620		2600	
Zip code characteristics	No		No		Yes		Yes	

Note: Sample means and standard deviations are reported.

Sources: Revenue and student data are from the National Center for Education Statistics Common Core of Data, School District Finance Survey for fiscal year 2003; Zip code characteristics are constructed from U.S. Census Bureau data from the 2004 Zip Code Business Patterns Survey and the Census 2000 Summary File 1.

[a]Federal revenues are allocated for CNA programs such as the NSLP, School Breakfast Program, Special Milk Program, and Ala Carte Program.

[b]State revenues are allocated by the state government for CNA program matching payments.

[c]Local revenues are the reported gross receipts from the sale of school breakfasts, lunches, and milk from students, teachers, and adults, and do not include revenues from state or federal funds.

TABLE 4

OLS and GMM estimates for specifications of children's weekly consumption of fruit treating NSLP beneficiary status and children's body weights as exogenous and endogenous[a,b,c]

	Weekly consumption of fruit[d]							
	(1)		(2)		(3)		(4)	
Explanatory variables	OLS	GMM	OLS	GMM	OLS	GMM	OLS	GMM
NSLP beneficiary	0.19**	1.24**	–	–	0.17**	1.81**	–	–
	(0.04)	(0.43)			(0.05)	(0.71)		
Fully subsidized	–	–	0.22**	1.35**	–	–	0.20**	2.12**
			(0.04)	(0.56)			(0.06)	(0.97)
Partially subsidized	–	–	0.15**	1.00	–	–	0.12**	1.58*
			(0.05)	(0.83)			(0.06)	(0.88)
Ln(weight)	−0.04	−4.25*	−0.05	−4.76*	−0.002	−3.27	−0.003	−4.12
	(0.06)	(2.30)	(0.06)	(2.86)	(0.078)	(2.40)	(0.078)	(3.06)
Ln(height)	1.01**	15.85*	1.01**	17.70*	0.78*	12.21	0.79*	15.23
	(0.34)	(8.15)	(0.34)	(10.16)	(0.41)	(8.42)	(0.41)	(10.76)
Ln(Parent education category)	0.02	−0.06	0.02	−0.08	0.04	0.06	0.04	0.05
	(0.03)	(0.08)	(0.03)	(0.10)	(0.04)	(0.07)	(0.04)	(0.08)
Household income category	0.01	0.09**	0.01	0.09**	−0.001	0.14**	0.001	0.16**
	(0.01)	(0.03)	(0.01)	(0.04)	(0.008)	(0.06)	(0.008)	(0.08)
Observations	6530	6530	6530	6530	4220	4220	4220	4220
Zip code characteristics[e]	No	No	No	No	Yes	Yes	Yes	Yes

Note: Slope coefficients and robust standard errors are reported; ** Significant at 5-percent level; * Significant at 10-percent level.

[a]Data on children enrolled in fifth grade in public schools from the ECLS-K (2003-2004) were used in the estimation; weekly consumption outcomes are standardized to mean 0 and variance 1 in the estimation, for each of the respective samples.

[b]Regressions also include variables measuring age, gender, disability status, number of siblings, television watching, and physical exercise.

[c]Instrumental variables are federal, state, and local revenues allocated to each child's school district for meals; see Table 3.

[d]Includes fruit such as apples, bananas, oranges, berries, or other types of fruit, and does not include fruit juice.

[e]Per capita supermarkets, convenience stores, full-service restaurants, limited-service restaurants, and (supermarkets/convenience stores).

TABLE 5

OLS and GMM estimates for specifications of children's weekly consumption of green salad treating NSLP beneficiary status and children's body weights as exogenous and endogenous[a,b,c]

	Weekly consumption of green salad[d]							
	(1)		(2)		(3)		(4)	
Explanatory variables	OLS	GMM	OLS	GMM	OLS	GMM	OLS	GMM
NSLP beneficiary	0.04	1.21**	–	–	0.02	1.41*	–	–
	(0.04)	(0.51)			(0.05)	(0.76)		
Fully subsidized	–	–	0.06	1.61**	–	–	0.05	2.11*
			(0.04)	(0.76)			(0.05)	(1.21)
Partially subsidized	–	–	0.01	0.45	–	–	−0.03	1.07
			(0.05)	(1.09)			(0.06)	(1.03)
Ln(weight)	0.18**	−6.11**	0.18**	−7.99**	0.20**	−4.54*	0.20**	−6.60*
	(0.07)	(2.68)	(0.07)	(3.88)	(0.08)	(2.51)	(0.08)	(3.84)
Ln(height)	−0.13	22.12**	−0.12	28.82**	0.16	16.77*	0.17	23.99*
	(0.36)	(9.49)	(0.36)	(13.74)	(0.44)	(8.80)	(0.44)	(13.48)
Ln(Parent education category)	0.08**	−0.09	0.08**	−0.14	0.09**	0.04	0.09**	0.02
	(0.03)	(0.10)	(0.03)	(0.13)	(0.04)	(0.08)	(0.04)	(0.10)
Household income category	0.01	0.09**	0.01	0.11**	−0.001	0.11*	0.001	0.16*
	(0.01)	(0.04)	(0.01)	(0.05)	(0.008)	(0.07)	(0.008)	(0.09)
Observations	6530	6530	6530	6530	4220	4220	4220	4220
Zip code characteristics[e]	No	No	No	No	Yes	Yes	Yes	Yes

Note: Slope coefficients and robust standard errors are reported; ** Significant at 5-percent level; * Significant at 10-percent level.

[a]Data on children enrolled in fifth grade in public schools from the ECLS-K (2003-2004) were used in the estimation; weekly consumption outcomes are standardized to mean 0 and variance 1 in the estimation, for each of the respective samples.

[b]Regressions also include variables measuring age, gender, disability status, number of siblings, television watching, and physical exercise.

[c]Instrumental variables are federal, state, and local revenues allocated to each child's school district for meals; see Table 3.

[d]Includes only green salad.

[e]Per capita supermarkets, convenience stores, full-service restaurants, limited-service restaurants, and (supermarkets/convenience stores).

TABLE 6

OLS and GMM estimates for specifications of children's weekly consumption of carrots treating NSLP beneficiary status and children's body weights as exogenous and endogenous[a,b,c]

	Weekly consumption of carrots[d]							
	(1)		(2)		(3)		(4)	
Explanatory variables	OLS	GMM	OLS	GMM	OLS	GMM	OLS	GMM
NSLP beneficiary	0.11**	0.54	–	–	0.12**	1.08*	–	–
	(0.04)	(0.38)			(0.05)	(0.61)		
Fully subsidized	–	–	0.15**	0.77	–	–	0.18**	1.71*
			(0.04)	(0.56)			(0.06)	(1.00)
Partially subsidized	–	–	0.06	0.19	–	–	0.05	0.85
			(0.05)	(0.71)			(0.06)	(0.78)
Ln(weight)	−0.06	−3.73*	−0.06	−4.83*	0.03	−2.94	0.02	−4.76
	(0.06)	(1.95)	(0.06)	(2.81)	(0.08)	(1.96)	(0.08)	(3.11)
Ln(height)	−0.01	12.97*	−0.003	16.86*	−0.12	10.27	−0.10	16.67
	(0.34)	(6.92)	(0.341)	(9.97)	(0.42)	(6.90)	(0.42)	(10.93)
Ln(Parent education category)	0.02	−0.10	0.02	−0.13	0.02	−0.01	0.02	−0.03
	(0.03)	(0.07)	(0.03)	(0.09)	(0.04)	(0.07)	(0.04)	(0.08)
Household income category	0.02**	0.04	0.02**	0.05	0.01*	0.09*	0.02**	0.14*
	(0.01)	(0.03)	(0.01)	(0.04)	(0.01)	(0.05)	(0.01)	(0.08)
Observations	6530	6530	6530	6530	4220	4220	4220	4220
Zip code characteristics[e]	No	No	No	No	Yes	Yes	Yes	Yes

Note: Slope coefficients and robust standard errors are reported; ** Significant at 5-percent level; * Significant at 10-percent level.

[a]Data on children enrolled in fifth grade in public schools from the ECLS-K (2003-2004) were used in the estimation; weekly consumption outcomes are standardized to mean 0 and variance 1 in the estimation, for each of the respective samples.

[b]Regressions also include variables measuring age, gender, disability status, number of siblings, television watching, and physical exercise.

[c]Instrumental variables are federal, state, and local revenues allocated to each child's school district for meals; see Table 3.

[d]Includes only carrots.

[e]Per capita supermarkets, convenience stores, full-service restaurants, limited-service restaurants, and (supermarkets/convenience stores).

TABLE 7

OLS and GMM estimates for specifications of children's weekly consumption of potatoes treating NSLP beneficiary status and children's body weights as exogenous and endogenous[a,b,c]

	Weekly consumption of potatoes[d]							
	(1)		(2)		(3)		(4)	
Explanatory variables	OLS	GMM	OLS	GMM	OLS	GMM	OLS	GMM
NSLP beneficiary	0.05	−0.26	–	–	0.004	−0.28	–	–
	(0.04)	(0.44)			(0.051)	(0.56)		
Fully subsidized	–	–	0.07	−0.77	–	–	0.04	−0.52
			(0.05)	(0.72)			(0.06)	(0.78)
Partially subsidized	–	–	0.02	0.64	–	–	−0.04	−0.18
			(0.05)	(1.01)			(0.06)	(0.63)
Ln(weight)	−0.02	5.24**	−0.02	7.72**	0.07	2.17	0.07	2.87
	(0.07)	(2.34)	(0.07)	(3.71)	(0.09)	(1.81)	(0.09)	(2.44)
Ln(height)	0.18	−18.45**	0.18	−27.26**	−0.28	−7.65	−0.27	−10.10
	(0.35)	(8.27)	(0.35)	(13.15)	(0.45)	(6.34)	(0.45)	(8.58)
Ln(Parent education category)	−0.05	0.15*	−0.04	0.22*	−0.04	0.01	−0.04	0.02
	(0.04)	(0.09)	(0.04)	(0.13)	(0.05)	(0.06)	(0.05)	(0.07)
Household income category	−0.01	−0.01	−0.01	−0.03	−0.01	−0.03	−0.01	−0.05
	(0.01)	(0.04)	(0.01)	(0.05)	(0.01)	(0.05)	(0.01)	(0.06)
Observations	6530	6530	6530	6530	4220	4220	4220	4220
Zip code characteristics[e]	No	No	No	No	Yes	Yes	Yes	Yes

Note: Slope coefficients and robust standard errors are reported; ** Significant at 5-percent level; * Significant at 10-percent level.

[a]Data on children enrolled in fifth grade in public schools from the ECLS-K (2003-2004) were used in the estimation; weekly consumption outcomes are standardized to mean 0 and variance 1 in the estimation, for each of the respective samples.

[b]Regressions also include variables measuring age, gender, disability status, number of siblings, television watching, and physical exercise.

[c]Instrumental variables are federal, state, and local revenues allocated to each child's school district for meals; see Table 3.

[d]Does not include "french fries", fried potatoes, or potato chips.

[e]Per capita supermarkets, convenience stores, full-service restaurants, limited-service restaurants, and (supermarkets/convenience stores).

TABLE 8

OLS and GMM estimates for specifications of children's weekly consumption of other vegetables treating NSLP beneficiary status and children's body weights as exogenous and endogenous[a,b,c]

	Weekly consumption of other vegetables[d]							
	(1)		(2)		(3)		(4)	
Explanatory variables	OLS	GMM	OLS	GMM	OLS	GMM	OLS	GMM
NSLP beneficiary	0.07*	0.16	–	–	0.03	0.52	–	–
	(0.04)	(0.30)			(0.05)	(0.50)		
Fully subsidized	–	–	0.11**	0.42	–	–	0.07	0.95
			(0.04)	(0.42)			(0.05)	(0.75)
Partially subsidized	–	–	0.01	−0.20	–	–	−0.02	0.38
			(0.05)	(0.52)			(0.06)	(0.58)
Ln(weight)	−0.05	0.37	−0.05	−0.92	−0.02	−0.17	−0.02	−1.50
	(0.06)	(1.53)	(0.06)	(2.10)	(0.08)	(1.62)	(0.08)	(2.34)
Ln(height)	0.35	−1.15	0.35	3.45	0.60	1.12	0.61	5.80
	(0.34)	(5.43)	(0.34)	(7.47)	(0.42)	(5.67)	(0.42)	(8.22)
Ln(Parent education category)	0.11**	0.13**	0.11**	0.10	0.11**	0.15**	0.11**	0.13**
	(0.03)	(0.06)	(0.03)	(0.07)	(0.04)	(0.06)	(0.04)	(0.06)
Household income category	0.003	0.01	0.01	0.03	−0.01	0.04	−0.004	0.07
	(0.006)	(0.02)	(0.01)	(0.03)	(0.01)	(0.04)	(0.008)	(0.06)
Observations	6530	6530	6530	6530	4220	4220	4220	4220
Zip code characteristics[e]	No	No	No	No	Yes	Yes	Yes	Yes

Note: Slope coefficients and robust standard errors are reported; ** Significant at 5-percent level; * Significant at 10-percent level.

[a]Data on children enrolled in fifth grade in public schools from the ECLS-K (2003-2004) were used in the estimation; weekly consumption outcomes are standardized to mean 0 and variance 1 in the estimation, for each of the respective samples.

[b]Regressions also include variables measuring age, gender, disability status, number of siblings, television watching, and physical exercise.

[c]Instrumental variables are federal, state, and local revenues allocated to each child's school district for meals; see Table 3.

[d]Does not include green salad, potatoes, or carrots.

[e]Per capita supermarkets, convenience stores, full-service restaurants, limited-service restaurants, and (supermarkets/convenience stores).

TABLE 9

OLS and GMM estimates for specifications of children's weekly consumption of milk treating NSLP beneficiary status and children's body weights as exogenous and endogenous[a,b,c]

	Weekly consumption of milk[d]							
	(1)		(2)		(3)		(4)	
Explanatory variables	OLS	GMM	OLS	GMM	OLS	GMM	OLS	GMM
NSLP beneficiary	−0.07*	−1.86**	–	–	−0.03	−1.03**	–	–
	(0.04)	(0.41)			(0.05)	(0.53)		
Fully subsidized	–	–	−0.06	−1.91**	–	–	−0.01	−0.52
			(0.04)	(0.56)			(0.05)	(0.76)
Partially subsidized	–	–	−0.08*	−1.79**	–	–	−0.05	−1.22*
			(0.05)	(0.71)			(0.06)	(0.64)
Ln(weight)	−0.21**	3.69*	−0.21**	3.91	−0.22**	−0.18	−0.22**	−1.73
	(0.06)	(2.18)	(0.06)	(2.86)	(0.08)	(1.74)	(0.08)	(2.43)
Ln(height)	1.50**	−12.26	1.50**	−13.06	1.66**	1.55	1.66**	6.99
	(0.33)	(7.72)	(0.33)	(10.12)	(0.41)	(6.10)	(0.41)	(8.51)
Ln(Parent education category)	0.08**	0.09	0.08**	0.10	0.07*	−0.01	0.07*	−0.03
	(0.03)	(0.08)	(0.03)	(0.10)	(0.04)	(0.06)	(0.04)	(0.06)
Household income category	0.01**	−0.15**	0.01**	−0.15**	0.01*	−0.08*	0.01*	−0.05
	(0.01)	(0.03)	(0.01)	(0.04)	(0.01)	(0.05)	(0.01)	(0.06)
Observations	6530	6530	6530	6530	4220	4220	4220	4220
Zip code characteristics[e]	No	No	No	No	Yes	Yes	Yes	Yes

Note: Slope coefficients and robust standard errors are reported; ** Significant at 5-percent level; * Significant at 10-percent level.

[a]Data on children enrolled in fifth grade in public schools from the ECLS-K (2003-2004) were used in the estimation; weekly consumption outcomes are standardized to mean 0 and variance 1 in the estimation, for each of the respective samples.

[b]Regressions also include variables measuring age, gender, disability status, number of siblings, television watching, and physical exercise.

[c]Instrumental variables are federal, state, and local revenues allocated to each child's school district for meals; see Table 3.

[d]Includes all types of milk such as cow's milk, soy milk, or any other kind of milk, and whether it was in a carton, cup, glass, or with cereal.

[e]Per capita supermarkets, convenience stores, full-service restaurants, limited-service restaurants, and (supermarkets/convenience stores).

TABLE 10

OLS and GMM estimates for specifications of children's weekly consumption of 100% fruit juice treating NSLP beneficiary status and children's body weights as exogenous and endogenous[a,b,c]

	Weekly consumption of 100% fruit juice[d]							
	(1)		(2)		(3)		(4)	
Explanatory variables	OLS	GMM	OLS	GMM	OLS	GMM	OLS	GMM
NSLP beneficiary	0.12**	1.35**	–	–	0.10**	1.43**	–	–
	(0.04)	(0.39)			(0.05)	(0.64)		
Fully subsidized	–	–	0.16**	1.84**	–	–	0.13**	2.02**
			(0.04)	(0.63)			(0.05)	(1.03)
Partially subsidized	–	–	0.07	0.44	–	–	0.07	1.15
			(0.05)	(0.93)			(0.06)	(0.85)
Ln(weight)	−0.10	−3.76*	−0.10	−6.15*	−0.08	−3.13	−0.08	−4.90
	(0.06)	(2.07)	(0.06)	(3.23)	(0.08)	(2.14)	(0.08)	(3.29)
Ln(height)	0.42	13.37*	0.42	21.84*	0.41	11.06	0.41	17.32
	(0.33)	(7.34)	(0.33)	(11.44)	(0.40)	(7.51)	(0.40)	(11.55)
Ln(Parent education category)	0.003	−0.04	0.01	−0.11	−0.01	−0.01	−0.01	−0.03
	(0.035)	(0.08)	(0.04)	(0.11)	(0.04)	(0.07)	(0.04)	(0.09)
Household income category	0.001	0.11**	0.004	0.12**	−0.001	0.11**	0.001	0.15*
	(0.006)	(0.03)	(0.006)	(0.04)	(0.008)	(0.06)	(0.008)	(0.08)
Observations	6530	6530	6530	6530	4220	4220	4220	4220
Zip code characteristics[e]	No	No	No	No	Yes	Yes	Yes	Yes

Note: Slope coefficients and robust standard errors are reported; ** Significant at 5-percent level; * Significant at 10-percent level.

[a]Data on children enrolled in fifth grade in public schools from the ECLS-K (2003-2004) were used in the estimation; weekly consumption outcomes are standardized to mean 0 and variance 1 in the estimation, for each of the respective samples.

[b]Regressions also include variables measuring age, gender, disability status, number of siblings, television watching, and physical exercise.

[c]Instrumental variables are federal, state, and local revenues allocated to each child's school district for meals; see Table 3.

[d]Includes only non-sweetened, 100% fruit juices such as orange juice, apple juice, or grape juice.

[e]Per capita supermarkets, convenience stores, full-service restaurants, limited-service restaurants, and (supermarkets/convenience stores).

TABLE 11

OLS and GMM estimates for specifications of children's weekly consumption of sweetened beverages treating NSLP beneficiary status and children's body weights as exogenous and endogenous[a,b,c]

	Weekly consumption of sweetened beverages[d]							
	(1)		(2)		(3)		(4)	
Explanatory variables	OLS	GMM	OLS	GMM	OLS	GMM	OLS	GMM
NSLP beneficiary	0.01	−0.15	–	–	−0.02	−0.36	–	–
	(0.04)	(0.45)			(0.05)	(0.67)		
Fully subsidized	–	–	−0.004	−0.47	–	–	−0.04	−0.74
			(0.044)	(0.70)			(0.05)	(1.01)
Partially subsidized	–	–	0.02	0.32	–	–	0.01	−0.24
			(0.05)	(0.90)			(0.06)	(0.80)
Ln(weight)	−0.08	5.69**	−0.08	7.25**	−0.07	4.53**	−0.07	5.71*
	(0.06)	(2.34)	(0.06)	(3.59)	(0.08)	(2.19)	(0.08)	(3.34)
Ln(height)	0.26	−20.19**	0.26	−25.71**	0.20	−15.93**	0.20	−20.08*
	(0.34)	(8.27)	(0.34)	(12.71)	(0.43)	(7.67)	(0.43)	(11.73)
Ln(Parent education category)	−0.16**	0.07	−0.16**	0.11	−0.11**	0.03	−0.11**	0.04
	(0.03)	(0.09)	(0.03)	(0.12)	(0.04)	(0.08)	(0.04)	(0.09)
Household income category	−0.004	0.01	−0.01	−0.005	−0.01	−0.02	−0.01	−0.05
	(0.006)	(0.04)	(0.01)	(0.048)	(0.01)	(0.06)	(0.01)	(0.08)
Observations	6530	6530	6530	6530	4220	4220	4220	4220
Zip code characteristics[e]	No	No	No	No	Yes	Yes	Yes	Yes

Note: Slope coefficients and robust standard errors are reported; ** Significant at 5-percent level; * Significant at 10-percent level.

[a]Data on children enrolled in fifth grade in public schools from the ECLS-K (2003-2004) were used in the estimation; weekly consumption outcomes are standardized to mean 0 and variance 1 in the estimation, for each of the respective samples.

[b]Regressions also include variables measuring age, gender, disability status, number of siblings, television watching, and physical exercise.

[c]Instrumental variables are federal, state, and local revenues allocated to each child's school district for meals; see Table 3.

[d]Includes soda pop, sports drinks, or fruit drinks that are not 100% fruit juice.

[e]Per capita supermarkets, convenience stores, full-service restaurants, limited-service restaurants, and (supermarkets/convenience stores).

TABLE 12
Instrumental variables diagnostic tests

	Specification			
	(1)	(2)	(3)	(4)
F statistics[a]				
NSLP beneficiary	90.8**	–	32.8**	–
	[< 0.0001]		[< 0.0001]	
Fully subsidized	–	76.8**	–	28.0**
		[< 0.0001]		[< 0.0001]
Partially subsidized	–	7.9**	–	8.4**
		[< 0.0001]		[< 0.0001]
Ln(weight)	9.4**	9.4**	8.3**	8.3**
	[< 0.0001]	[< 0.0001]	[< 0.0001]	[< 0.0001]
χ^2 statistics[b]				
Fruit	0.1	–	0.3	–
	[0.723]		[0.566]	
Green salad	1.1	–	1.2	–
	[0.293]		[0.274]	
Carrots	0.5	–	1.2	–
	[0.495]		[0.268]	
Potatoes	2.3	–	0.2	–
	[0.131]		[0.624]	
Other vegetables	0.8	–	0.8	–
	[0.357]		[0.760]	
Milk	0.02	–	1.0	–
	[0.899]		[0.324]	
100% Fruit juice	2.5	–	1.0	–
	[0.116]		[0.313]	
Sweetened beverages	0.6	–	0.3	–
	[0.440]		[0.558]	
Observations	6530	6530	4220	4220
Zip code characteristics	No	No	Yes	Yes

Note: P-values are reported in brackets; ** Significant at 5-percent level.
[a]F statistics test the null hypothesis that the instruments are jointly insignificant; df=(3,6520) for (1) and (2); df=(3,4200) for (3) and (4).
[b]Chi-square statistics are Hansen J test of overidentifying restrictions; df=(1).