Junk Food in Schools and Childhood Obesity: Much Ado About Nothing?

Ashlesha Datar* and Nancy Nicosia

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Abstract

There is a growing belief among policymakers and the general public that competitive foods in schools are a significant contributor to the childhood obesity epidemic. Numerous policy initiatives are underway at the local, state and federal level to regulate the availability of competitive foods in schools. However, the existing empirical evidence motivating these efforts is limited and rarely addresses the potential endogeneity of the school food environment. In this paper, we estimate the causal effect of competitive food availability on children's body mass index (BMI) and other food- and school-related outcomes using an instrumental variables approach on a national sample of children. We find that competitive food availability generates in-school purchases of junk foods, but contrary to common concerns, there is no significant effect on children's BMI. Nor do we observe significant changes in overall consumption of healthy and unhealthy foods, and in physical activity. Finally, our results find no support for broader effects of junk foods in school on social/behavioral and academic outcomes.

*Corresponding author, RAND Corporation, 1776 Main Street, P.O. Box 2138, Santa Monica, CA 90407, Email: datar@rand.org This research was funded by grants from the Robert Wood Johnson Foundation's Healthy Eating Research Program, the Bing Center for Health Economics at RAND, and the RAND Labor and Population Program. All opinions are those of the authors and do not represent opinions of the funding agencies. We are grateful to Darius Lakdawalla, Neeraj Sood, Roland Sturm for their helpful comments, and to Carlos Dobkin and Eric Meijer for helpful discussions. We are also grateful to Le Wang for sharing his STATA code to estimate quantile regression instrumental variables models. All remaining errors are our own.

1. Introduction

The prevalence of childhood obesity in the US is at an all-time high with nearly one-third of all children and adolescents now considered overweight or obese (Ogden et al 2008). Considerable attention has been focused on schools in an attempt to identify policy levers that will help reverse the obesity epidemic. In particular, the availability of "competitive foods" in schools, defined as foods and beverages available or sold in schools outside of the school lunch and breakfast programs, has been a much debated issue.

Competitive foods are sold through a la carte lines, vending machines, school canteens/stores, and fundraisers and, in contrast to the federally-reimbursable school meal programs, there are no federal nutritional standards for foods sold through these venues. As a result, competitive foods account for much of the variation in the food environment across schools. On the one hand, opponents question the nutritional value of competitive foods, and indeed, the available evidence suggests that competitive foods are higher in fat compared with foods sold as part of the school meal programs (Gordon et al 2007b, Harnack et al 2000, Wechsler et al 2000, Story, Hayes & Kalina 1996). On the other hand, supporters argue that revenues from these food sales provide much-needed funding for schools, especially in times of budgetary pressures. For example, during 2005-2006, middle and high schools earned an average of $10,850 and $15,233, respectively, from a la carte sales alone.[1] In addition, nearly a third of high schools and middle schools earned between $1,000-$9,999 during that same year, another ten percent earned between $10,000-$50,000, and a small number earned in excess of

[1] Estimates are based on the 2005 School Nutrition and Dietary Assessment Study (SNDA-III), but response rates were low for some revenue categories (Gordon et al 2007a). Competitive food availability and revenues were less common in elementary schools though as many as 47% of elementary schools have pouring rights contracts.

$50,000 per year. These figures are substantial and may be supplemented by additional revenue from on-site school stores and pouring contracts with beverage companies.

Competitive foods availability is a long-standing issue in the policy debate. Legislation and regulations targeting competitive foods have been proposed for decades. U.S. Department of Agriculture (USDA) regulations had been comprehensive, but in 1983, a successful lawsuit by the National Soft Drink Association limited the scope of these regulations to food service areas during meal hours. In recent years, several states, school districts, and individual schools have enacted competitive food policies that are more restrictive than federal regulations.[2] For example, two of the largest school districts in the nation, New York City Public School District and Los Angeles Unified School District, imposed a ban on soda vending in schools in 2003 and 2004, respectively. Many others have followed suit with similar bans or stricter regulation of competitive foods.

Despite the growing support for competitive food regulation, it is hard to deny opponents' claims that the evidence against competitive foods is limited. Existing research does show that competitive food availability in schools is associated with a decline in nutritional quality of meals consumed at school (Cullen et al 2000, Cullen & Zakeri 2004; Templeton, Marlette & Panemangalore 2005).[3] However, less is known about the effects on overall diet quality (consumed in and out of school) and children's weight. The literature does provide some evidence of substitution of caloric intake across meals and location among adults (Anderson and Matsa 2009), but the evidence is less clear regarding children. Only Kubik and colleagues have examined 24 hour dietary recall (2003) and BMI (2005), however these studies are generally based on

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[2] Competitive food policies differ widely in the types and stringency of restrictions they apply.
[3] Other studies have examined the effects of price reductions and increases in availability and promotion of low-fat foods in secondary schools on sales and purchases of these foods (French et al 2004, 2001, 1997a, 1997b, Jeffery et al 1994) as well as their consumption (Perry et al 2004) within experimental settings and have found positive effects.

small local samples and do not address the potential endogeneity of the school food environment.[4] An exception is Anderson and Butcher (2006), who use national data on adolescents to examine whether school food policies such as the availability of "junk foods", "pouring rights" contracts, soda and snack food advertisements, and school events have an impact on adolescent obesity. [5] In the absence of a single data source containing information on school food policies and BMI, the authors use a two-sample instrumental variables (IV) approach to estimate the effects of school food policies on adolescent BMI. Using county, state, and regional characteristics as instruments that capture budgetary pressures on schools, they find that a 10 percentage point increase in the proportion of schools in the county that offer junk foods leads to a 1 percent increase in BMI. This effect is primarily driven by adolescents with an overweight parent, which the authors interpret as a measure of family susceptibility to weight gain. Their results for the other school policies, pouring rights contracts, and food and beverage advertisements are smaller and less precise. The IV approach constitutes an innovation over the literature, but the authors acknowledge that their results may be undermined by a weak first stage.

Our paper adds to the limited existing literature by attempting to isolate the causal effect of competitive food availability on children's food consumption and BMI using data on a national sample of fifth graders from the Early Childhood Longitudinal

[4] Kubik et al (2003) find that a la carte availability in school is negatively associated with overall intake of fruits and vegetables and positively associated with total and saturated fat intake among 7th graders attending 16 schools in Minneapolis-St Paul. Using the same data, Kubik et al (2005) show that practices such as the use of competitive foods as rewards and incentives for students are positively associated with higher body mass index (BMI).

[5] "Junk Food Available" means that students can buy chocolate, candy, cakes, ice cream, or salty snacks (that are not fat free) from a machine or school store. "Pouring Rights" contract means the school has agreed to sell one brand of soft drinks, often in exchange for a percentage of sales or other incentive packages. "Soda or Snack Food Advertisements" means that advertisements are allowed at least at one type of school related activity or in one or more places at the school—for example, on a school bus, at a school sporting event, on school grounds, or school textbooks etc.

Study – Kindergarten Class (ECLS-K).[6] We leverage the well-documented fact that competitive foods are significantly more prevalent in middle and high schools relative to elementary schools (Finkelstein, Hill and Whitaker 2008).[7] Exogenous variation in competitive food availability across schools is identified using the grade structure in the child's school. We argue that a fifth grader attending a combined (e.g. K-8, K-12) or middle school (e.g. 5-8) is more likely to be exposed to competitive foods compared to a fifth grader in an elementary school (e.g. K-5 or K-6), but that the school's grade structure has no direct effect on a child's weight. First-stage regressions, overidentification tests, checks for peer effects, and "placebo" regressions on children's outcomes in kindergarten indicate that the instruments are valid and strong predictors of competitive food availability.

We find that competitive food availability generates in-school purchases of junk foods, but contrary to common concerns about these foods, there is no statistically or economically significant effect on BMI. While our IV estimates tend to be less precisely estimated, Hausman tests can not reject the consistency of OLS estimates that are precisely estimated. In-school purchases of junk food typically provide up to an additional 22 calories per day among children who have access to competitive foods and 62 calories per day among children who purchase these foods at school.[8] The caloric contribution of such foods among children who purchase amounts to 3.5 percent of the estimated daily caloric requirements for a moderately active fifth grader and less than a

[6] In a recent paper, Fernandes (2008) also used data from the Early Childhood Longitudinal Study to examine the correlation between soft drink availability and in-school and overall consumption of soft drinks among fifth graders and found a small positive association. However, the study did not address the endogeneity of school food environment and was only restricted to examining soda consumption.

[7] According to the SNDA-III, as many as 97% of high schools and 82% of middle schools had vending machines compared to only 17% of elementary schools. About 60% of high schools, 50% of middle schools, and 37% of elementary schools had fundraising activities involving sale of sweet or salty snacks (Gordon et al 2007b).

[8] The difference in caloric contribution of in-school purchases is lower for children with access to junk foods relative to children who actually purchase these foods at school because up to half of those who have access choose not to purchase.

quarter of their daily discretionary calorie allowance.[9] It is not surprising, therefore, that competitive foods do not appear to significantly increase BMI. Ancillary regressions of students' eating behavior provide evidence to support this finding. The *total* amount of soda and fast food, consumed in- and out-of-school, is not significantly influenced by competitive food availability, which is consistent with substitution between in-school and out-of-school consumption. In general, we also find no deleterious effects on the total consumption of various healthy foods. Our evidence suggests that the lack of impact on BMI is not likely explained by compensatory changes in children's physical activity. Finally, we examine whether junk food adversely affects social/behavioral and academic outcomes in fifth grade and find that no evidence of detrimental effects on these outcomes.

The remainder of this paper is organized as follows. Section 2, describes our data and relevant analysis variables. In Section 3, we describe our empirical strategy, which implements an instrumental variables approach and leverages longitudinal information on BMI to identify the causal impact of competitive food availability. In Section 4, we discuss our results for children's BMI and test the robustness of our results. We also present ancillary regressions examining the effects of competitive food availability on food consumption and physical activity. We end this section with an examination of broader effects of competitive food availability on children's social/behavioral outcomes and academic performance in fifth grade. Finally, Section 5 concludes with the policy implications of our findings.

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[9] See Dietary Guidelines for Americans 2005 for information on estimated daily caloric needs by age and gender <http://www.health.gov/dietaryguidelines/dga2005/document/html/chapter2.htm#table3> accessed 22 August 2008. Discretionary calories are those calories that can be used 'at your discretion' after basic nutrition needs are met without exceeding energy requirements. It is the difference between an individual's total energy requirement and the energy (calories) they consume to meet nutrient requirements. According to the Dietary Guidelines for Americans 2005, the discretionary calorie allowance for a 2000 calorie diet is 267 calories.

2. Data

We use data on fifth graders from the Early Childhood Longitudinal Study – Kindergarten Class (ECLS-K). The ECLS-K is a panel dataset on a nationally representative cohort of kindergarteners in the U.S. who entered school in fall 1998. The study surveyed this cohort in kindergarten, first, third, and fifth grades collecting information from children and their parents, teachers, and schools on children's cognitive, social, emotional, physical development, and their home, classroom, and school environments.[10] However, information on the school's food environment and children's food consumption was collected only in the fifth grade. Our analysis sample includes approximately 10,000 children attending the fifth grade in public and private schools in the 2003-04 school year. Below, we describe the key variables for our analyses. Descriptive statistics of all the variables used in the analyses are provided in Tables 1 and 2.

2.1. Dependent Variables

Body Mass Index (BMI): A distinct advantage of the ECLS-K is that it collected height and weight measurements from children at kindergarten entry and at each subsequent data collection round. These data are superior to self- or parent-reported height and weight data that may introduce non-random measurement error. The height and weight measurements are used to compute children's BMI, defined as weight in kilograms divided by height in meters squared. We use log of BMI in fifth grade as the

[10] The ECLS-K sample was freshened in the first grade therefore the sample of children in the fifth-grade round represents the cohort of children who were in kindergarten in 1998–99 or in first grade in 1999–2000.

dependent variable in the regressions. The average BMI in our sample of fifth graders is 20.4.[11]

Junk Food Purchase in School: The fifth grade child food consumption questionnaire collected information on children's junk food purchase in school during the pervious school week. These questions asked about the frequency (times per week) of purchase of sweets (candy, ice cream, cookies, brownies or other sweets), salty snack food (potato chips, corn chips, Cheetos, pretzels, popcorn, crackers or other salty snacks), and sweetened beverages (soda pop, sports drinks or fruit drinks that are not 100 percent juice). Table 2 panel A shows the frequency distribution of in-school junk food purchases. A large majority of the children did not purchase junk food in school during the reference week - 77 percent for sweets, 84 percent for salty snacks, and 88 percent for sweetened beverages – in large part because the majority of students did not have the opportunity to do so (see Section 2.2). Conditional on availability in school, about half the sample purchased any of these foods at least once a week. Further, among those who did purchase, the modal response was 1-2 times per week – 68 percent for sweets, 72 percent for salty snacks, and 70 percent for sweetened beverages.

Total Consumption of Selected Foods and Beverages: The child food consumption questionnaire asked about the "total consumption" of two unhealthy and seven healthy foods/beverages during the past 7 days. The two unhealthy items included – (a) soda pop/sports drinks/fruits drink that are not 100 percent juice (hereafter, referred to as "soda"), and (b) fast food. The seven healthy food items included – (a) milk, (b) 100 percent fruit juices, (c) green salad, (d) potatoes[12], (e)

[11] We also estimate separate models for whether the child is obese in fifth grade, defined as BMI greater than the 95th percentile for age and gender on the Center for Disease Control (CDC) growth charts. About 20 percent of our sample is obese.
[12] The "potatoes" category excluded French fries, fried potatoes, and potato chips.

carrots, (f) other vegetables, and (g) fruits. Children were asked to include in their responses foods they ate at home, at school, at restaurants, or anywhere else (See Appendix 3 for exact language of the questions). Table 2, panel B shows the frequency distribution of total consumption of these food groups. In the unhealthy foods category, the percentage of children not consuming any soda or fast foods during the previous week was 16 and 29 percent, respectively. Children consumed soda more frequently than fast food. In the healthy foods category, green salad, carrots and potatoes were consumed most infrequently with 45-49 percent children never consuming them in the past 7 days. The modal response for the other healthy food groups was 1 to 3 times in the past 7 days.

2.2. Competitive Food Availability

Information on competitive food availability in schools was collected only in the fifth grade wave of the ECLS-K. This information was obtained from two sources - school administrator and child questionnaires (See Appendix 3 for exact language of the questions). The school administrator questionnaire asked about the presence of alternate competitive food outlets, including vending machines, school stores, canteens, snack bars, and a la carte lines. The school administrators were also asked about the availability of specific food items during school hours through any of the venues. These items included candy, high-fat salty snacks, low-fat salty snacks, high-fat baked goods, low-fat baked goods, ice cream, milk, fruits/vegetables, bottled water, 100 percent juice, and soda pop or other beverages that are not 100 percent juice. The child food consumption questionnaire asked if sweets, salty snacks, and sweetened beverages could be purchased at the school during school hours. Based on these questions we constructed three alternate measures of competitive food availability in the school.

1. **School Administrator-Reported Junk Food Availability**: equals 1 if students can purchase any of the following - candy, chocolate, foods containing sugar, salty snacks, ice cream or frozen yogurt, or sweetened beverages (soda pop, sports drinks, or fruit drinks that are not 100 percent juice) - and zero otherwise. About 61 percent of the sample reported junk food availability in school based on the school administrator report.

2. **Child-Reported Junk Food Availability**: equals 1 if child reports that foods containing sugar, salty snacks, or sweetened beverages can be purchased at school during school hours. About 72 percent of the children reported junk food availability in their school.

3. **Competitive Food Outlet**: equals 1 if any of the following competitive food outlets are present in the school - vending machines, school stores, canteens, snack bars, and a la carte lines – and 0 otherwise. About 60 percent of the sample had any competitive food outlet, based on school administrator reports.

The first two measures capture the availability of junk foods in school regardless of their source whereas the third measure captures the presence of unregulated food and beverage outlets in schools regardless of the type of food they sell. This distinction is useful for two reasons. First, even though competitive food venues have been largely blamed for junk food availability these foods may also be available as part of school meals. And second, unregulated outlets in schools may not always (or only) sell junk foods. The first two measures should capture the same availability, but there is disagreement for a quarter of the sample.[13] This discrepancy could result from differences in survey timing of the school administrator and child questionnaires, recall

[13] About 18 percent of the children report junk food being available in their school but the school administrator reports otherwise, and about 7 percent of the children report no junk food availability in their school even though the school administrator reports otherwise.

problems, or due to differences in perceptions about whether foods sold during fundraising activities should be included in the response.[14]

3. Empirical Approach

3.1. Econometric Model

The relationship between competitive food availability and child outcomes in fifth grade can be estimated using the following linear regression model.

(1) $Y_{ik} = \beta_0 + \beta_1 CF_k + \beta_2 X_{ik} + \beta_3 S_k + \varepsilon_{ik}$

where, Y_{ik}, denotes fifth grade BMI (or other outcomes) for child *i* in school *k*, CF_k is a measure of competitive food availability in the child's school, X_{ik} and S_k are the vectors of individual/family (gender, race/ethnicity, mother's education, household income) and school characteristics (private/public, percent minority, enrollment, urbanicity, state/region), respectively, and ε_{ik} is the error term. The parameter of interest is β_1. Obtaining an unbiased estimate of β_1 is challenging because the school food environment is not exogenous to the outcomes of interest. Schools that serve high-fat, energy-dense competitive foods may differ on many observable and unobservable factors that are correlated with children's weight and dietary behavior. In particular, the decision to offer competitive foods in schools may be influenced by a variety of factors including budgetary pressures, demands of the student population, parental involvement, and state/district policies. These factors could independently influence children's weight as well. For example, budgetary pressures may induce schools to scale back or eliminate physical education programs, which might increase children's weight. As a result, coefficient estimates from the ordinary least squares (OLS) estimation of Equation 1 would be biased.

[14] School administrators were not asked about foods sold at fundraising events, but children were asked about availability of specific foods anywhere in the school.

3.2. Addressing Endogeneity of Competitive Food Availability in Schools

We address the endogeneity of competitive food availability using state fixed effects and state fixed effects with IV models. We also control for children's BMI at school entry (kindergarten) to account for any pre-exposure differences in BMI across children. [15]

Our first specification is similar to Equation 1, but adds state fixed effects (θ_s) and baseline (kindergarten) BMI ($BBMI_{iks}$) (Equation 2).

(2) $Y_{iks} = \beta_1 CF_{ks} + \beta_2 X_{iks} + \beta_3 S_{ks} + \beta_4 BBMI_{iks} + \theta_s + \varepsilon_{iks}$

States differ markedly in terms of obesity prevalence in their populations as well as the policy environment geared towards combating obesity. State fixed effects control for state-specific time-invariant unobserved heterogeneity that may be correlated with school food environments and children's weight. The child's baseline BMI at kindergarten is included to address some of the endogeneity issues that can bias OLS estimates such as student demand for competitive foods, genetic susceptibility, and sorting. [16]

The specification in equation (2), however, may still not result in unbiased estimates if within-state variation may be endogenous even after the inclusion of baseline BMI. For example, districts may choose to set more or less restrictive policies than the state requires due to differences in budgetary pressures. To isolate the exogenous component, we construct instrumental variables for within-state variation in competitive food availability using information on the grade span in each child's school.

[15] The ECLS-K also provides BMI measured in the third grade, which we include as a sensitivity analysis.
[16] Because competitive food availability data are collected only in fifth grade, we do not know the length of exposure – that is, whether the child has had competitive foods available throughout elementary school or whether a change in the school attended or a change in school policy altered exposure. Therefore, BMI in kindergarten is used as a control since it is measured prior to exposure to competitive foods in school.

Equation 3.1 represents the first-stage regression where competitive food availability is regressed on the grade span instrument, individual and school characteristics, baseline BMI, and state fixed effects. Equation 3.2 represents the second stage where children's BMI is regressed on the predicted availability of competitive foods from the first stage in addition to the common covariates.

(3.1) $CF_{ks} = \alpha_1 \text{ GradeSpan}_{ks} + \alpha_2 X_{ijs} + \alpha_3 S_{ks} + \alpha_4 \text{ BBMI}_{iks} + \theta_s + v_{iks}$

(3.2) $Y_{iks} = \beta_1 \hat{C}F_{ks} + \beta_2 X_{ijs} + \beta_3 S_{ks} + \beta_4 \text{ BBMI}_{iks} + \theta_s + \varepsilon_{iks}$

3.2.1. Instruments

Our sample consists of a single cohort of fifth graders attending schools with a variety of grade spans .Given that competitive food availability is significantly higher in middle and high schools compared to elementary schools, a potentially useful instrument for competitive food availability is whether the fifth grader is in a combined/middle school (i.e. defined as a school where the highest grade is seventh or higher) or whether the fifth grader is in an elementary school (i.e. highest grade is fifth or sixth). Our main instrument considers only the school type: elementary versus middle/combined (hereafter, middle/combined is referred to only as "combined"). Over 70 percent of our sample attends a elementary school defined as grades K-5 or K-6 (see Table 3). The remainder attend combined schools, mainly schools with grades K-8 (8 percent), grades K-12 (2 percent) and grades 5-8 (4 percent). In alternate regressions, we also leverage information on the lowest and highest grades in a child's school and conduct overidentification tests.

For grade structure to be a valid instrument for competitive food availability, it must be the case that having older peers in the school has no direct effect on children's weight. In other words, the presence of older students in the school should only affect the weight of younger students through the school's food environment.

Peers, defined broadly, have been shown to influence a wide range of adolescent behaviors and outcomes including substance abuse, academic achievement, social and behavioral outcomes, and food choices.[17] Of particular relevance to our identification strategy, however, is the literature examining a specific type of peer effect, namely, the effect of exposure to older or younger peers due to school grade span on adolescent behaviors and outcomes. The evidence to date is mixed. Using variation in school grade span to identify peer effects, Clark and Folk (2007) find that sixth graders who attend middle school are significantly more likely to smoke, drink, use drugs compared to sixth graders who attend elementary school. But Eisenberg (2004) finds that seventh and eighth graders who attend schools with older peers are no more likely to use substances relative to those who attend schools with younger peers.[18]

Other studies have directly examined the effect of grade span on academic performance and social/behavioral outcomes (Bedard and Do 2005; Cook et al 2008). This literature has primarily focused on whether middle school settings are better or worse than either elementary or combined school settings. A consistent finding is that sixth or seventh graders who attend middle school have poorer academic and behavioral outcomes compared to those who attend elementary or combined schools. However, we are not aware of any studies that compare achievement of a single cohort of children in a particular grade across elementary and combined schools. The exception is Rickles (2005), whose findings suggest inconsistent effects of grade span on achievement.

[17] This literature has examined peer effects on a wide range of outcomes including substance use (Clark and Folk 2007; Clark and Loheac 2007; Lundborg 2006; Eisenberg 2004; Case and Katz 1991; Gaviria and Raphael 2001), crime (Case and Katz 1991; Glaeser, Sacerdote, and Scheinkman 1996; Regnerus 2002), teenage pregnancy (Crane 1991; Evans, Oates and Schwab 1992), discipline (Cook et al 2008), and academic achievement (Hoxby 2000; Hanushek et al 2003; Cook et al 2008), and adolescent food choices (Perry, Kelder, Komro 2003; Cullen et al 2001; French et al 2004) and weight (Trogdon, Nonnemaker and Pais 2008).

[18] Clark and Loheac (2007) find that substance use behavior of students within the same school who are one year older influences adolescent substance use.

There is limited evidence on the influence of older peers on food choices.[19] Cullen and Zakeri (2004) compared changes in food consumption of fourth graders who transitioned to middle school in fifth grade and gained access to school snack bars to changes in food consumption of fifth graders who were already in middle school. Fourth graders who transitioned to middle school consumed fewer healthy foods compared with the previous school year, but it is not clear whether this was due to the presence of older peers or the change in school food environment.

The evidence described above suggests that any potential bias in our estimates is likely to be upward; fifth graders might emulate older peers who are more likely to consume junk foods in school and would therefore tend to be overweight, independent of the school food environment. As a result, an insignificant finding is unlikely to be undermined.

3.2.2. Checks for Instrument Validity

Identification in our models relies on the assumption that attending a combined school compared to an elementary school does not influence BMI except through changes in the availability of competitive foods. We demonstrate the validity of our instruments in a number of ways.

First, for each measure of competitive food availability, we report first-stage estimates from one exactly identified and one overidentified model (Table 4). The exactly-identified model uses an indicator for whether the child attends an elementary or combined school as the instrument. The over-identified model uses two continuous variables capturing the highest and lowest grade levels in the child's school as instruments. The first-stage estimates shown that presence of higher grades in the

[19] To our knowledge, there are no studies that have examined the influence of younger peers on food choices and weight.

school significantly increases the likelihood of competitive food availability. The F-statistics on the instruments are larger than 20 in all cases. Moreover, the overidentification tests do not reject the exogeneity of the instruments.

Despite this strong support, we might be concerned that there is some selection that would confound our instrument. We test for differences in BMI and other child outcomes in kindergarten across elementary and combined schools (Table 5 Panel A). Because kindergarten outcomes are determined prior to exposure to the school food environment, such comparisons would allow us to test for selection into elementary versus combined schools. This exercise is conducted separately for public and private school samples because combined schools are much more likely to be private. For both public and private school students, we find no differences in unadjusted means of children's kindergarten BMI across elementary versus combined schools. There are slight differences in other kindergarten outcomes: slightly higher reading (public and private) and math scores (private only), and slightly fewer internalizing behavior problems (private only). There are also statistically significant differences in individual, family and school characteristics, but no overall pattern that would appear to threaten validity of the IV approach (Table 5 Panel B). When we control for these covariate differences in a regression context, we find that the slight differences that appeared in the unadjusted means of kindergarten outcomes disappear (Table 6). These results suggest that, conditional on observed background characteristics, the instrument is uncorrelated with pre-exposure BMI, social/behavioral outcomes and test scores.

Another potential concern is that attending a combined school might generate peer effects on BMI and food consumption, independent of competitive food availability. We test for the presence of peer effects by regressing BMI and food consumption in fifth grade on the instrument and other covariates using only the sample of schools that do not offer any competitive foods (Table 7). The point estimates are very small and statistically insignificant despite being precisely estimated, thus indicating the absence of any peer effects on BMI and food consumption.

4. Results

We begin with our main results examining the effects of competitive food availability on BMI (Section 4.1). We first estimate basic models of BMI, then augment with state fixed effects and baseline BMI to address omitted variable bias and selection, and finally estimate the IV specifications. In Section 4.2, we examine the sensitivity of our main BMI results to alternate sample restrictions and report results from a falsification test. In Section 4.3, we describe results from ancillary regressions that explore the potential mechanisms underlying our BMI findings. In particular, we examine in-school and total consumption of selected foods and beverages and the availability of and participation in physical activity. Finally, in Section 4.4 we examine whether competitive food availability influences other school outcomes such as social-behavioral outcomes and academic achievement.

4.1. BMI

Our main results focus on whether the availability of competitive foods increases BMI among fifth graders (Table 8). We estimate BMI as a function of the three measures of competitive food availability at the child's school: 1) school administrator-reported availability, 2) child-reported availability, and 3) competitive food outlets. Column 1 shows the results of a basic OLS regression of BMI on competitive food availability as well as child, household, and school characteristics.[20] Consistent with the literature, the OLS regression yields a statistically significant increase in BMI for two of the three measures of availability, although the point estimates are small. The inclusion

[20] In all models, we estimate robust standard errors clustered at the school level.

of state fixed effects (Column 2) and a “baseline” BMI measured when the children were in kindergarten (Column 3) eliminates the significant coefficient for all measures of competitive food availability.[21] These fully-specified OLS models have very small, precisely estimated, and statistically insignificant point estimates that call into question the hypothesized relationship between competitive food availability and increases in children’s BMI.

However, the coefficients from these models may be biased if competitive food availability is related to unobserved determinants of children’s BMI. For example, districts with a large population of students at risk for obesity may have adopted more stringent competitive food policies that reduce the availability of junk foods in school. In this situation, OLS regression on cross-sectional data may show no significant relationship or even a negative relationship between junk food availability in school and student BMI. Another potential problem with the OLS estimates is that they might suffer from attenuation bias due to the presence of measurement error in the competitive food availability measures.

To address these issues, we estimate Two Stage Least Squares (2SLS) regressions using two measures of grade span as instruments: (1) whether the fifth-grader attended a combined school with older peers in grades 7 and higher (Column 4) and (2) the lowest and highest grade level in the child’s school to measure the presence of younger and older peers (Column 5).[22] As discussed in the previous section, both instruments appear quite strong in the first stage with F-statistics exceeding 20 for each availability measure. The 2SLS point estimates are relatively larger compared to the

[21] In alternate models we included third grade BMI instead of kindergarten BMI as our measure of baseline BMI and our results remained the same.
[22] In the remainder of the sections, we report estimates only from the exactly-identified 2SLS models since these are less subject to weak instruments critique relative to over-identified models (Angrist and Pischke 2009).

OLS estimates but are less precisely estimated rendering them statistically insignificant as well. Even if the 2SLS estimates were statistically significant, they would represent a minor increase in BMI, generally less than 1 to 2 percent. Hausman tests that check for endogeneity of competitive food availability by comparing estimates from OLS regressions (Column 3) with those from 2SLS models (Columns 4 and 5) are unable to reject the null hypothesis that both OLS and 2SLS estimates are consistent. Without evidence to support endogeneity, the OLS estimates are preferred due to their greater precision. A final concern with our specification is that our first stage models do not account for the dichotomous nature of the treatment variable. Estimates from binary treatment effect IV models confirm that the effects of competitive food availability on BMI are neither substantive nor significant (Columns 6 and 7). These regressions provide strong evidence that there are no effects of competitive food availability on mean BMI in our sample.[23]

4.2. Robustness Checks

In this section, we report results from sensitivity analyses and falsification tests. For the sensitivity analyses, we re-estimate our BMI results with the exclusion of three particular groups (Table 9). First, because combined schools are much more likely to be private, our instruments may be capturing variation across public versus private schools students, even though the regressions control for private school attendance. We re-estimate OLS and 2SLS BMI regressions on a sample that excludes children who attend

[23] It may be the case that children who are overweight or at risk of overweight are more susceptible to the effects of competitive foods, but our analysis provides no support for heterogeneous effects. We test for heterogeneity by estimating the following regressions: (i) use an indicator for obesity status as the outcome variable instead of BMI, and (ii) estimate quantile regressions on BMI. Linear probability, 2SLS and bivariate probit regressions of obesity indicate that the effects are essentially zero, though the standard errors become large in IV specifications (Appendix 1). Likewise, the point estimates for the 10th, 25th, 50th, 75th, and 90th percentiles of BMI from the quantile regressions are very small (effectively, zero) and statistically insignificant though standard errors are larger in IV specifications.

private schools (Columns 1 and 2) and find that there are no effects on BMI. Second, we may be concerned that peer effects may be stronger among fifth-graders exposed to peers of high school age than among fifth-graders exposed to peers in middle-school grades. Because the presence of such peer effects may compromise instrument validity, we report estimates from models that exclude children attending schools with grades 10 or higher (Columns 3 and 4). Despite the restriction, we find no evidence of an effect of competitive food availability on BMI. Third, children who switch schools perhaps for unobservable reasons related to competitive food availability may bias our estimates. Columns 5 and 6 report estimates from models that exclude children who changed schools between kindergarten and fifth grade. These results also confirm no effects on BMI. The point estimates from the OLS and 2SLS regressions for all three sensitivity checks are essentially zero, though less precisely measured in the 2SLS models.[24]

For our falsification test, we examined whether competitive food availability in the fifth grade influenced children's BMI in kindergarten (Table 10). Since BMI in kindergarten is measured prior to exposure to competitive foods, any effects of availability on BMI in kindergarten would suggest unobserved heterogeneity. However, both OLS and 2SLS point estimates are close to zero, although the 2SLS estimates are less precise, suggesting that unobserved heterogeneity is unlikely to be a concern.

4.3. Effects of Competitive Food Availability on Food Consumption and Physical Activity

The lack of a significant finding on BMI in Section 4.1 raises questions regarding how the energy balance equation is affected by competitive food availability. While we

[24] Hausman tests cannot reject the consistency of OLS estimates in any of our sensitivity checks.

cannot measure the energy intake and expenditure explicitly with these data, we can examine how competitive food availability influences general food consumption patterns and physical activity in order to enrich our understanding of the null finding for BMI. Unlike BMI, consumption and physical activity are self-reported measures and so are subject to measurement error. We report OLS estimates that are precisely estimated and, given the inability to reject consistency of OLS in Section 4.1, these estimates may be preferred. We also estimated 2SLS models, which produced point estimates that were larger than OLS estimates, but the standard errors were large enough that we could not rule out either null or large effects, thus rendering these regressions uninformative. As an alternative, we report estimates from reduced form regressions to provide some sense of the relationship between the outcomes and our instrument (attendance in combined school). The reduced form regressions have the advantages of being unbiased and providing evidence of whether a causal relationship exists in the regression of interest. [25,26]

In-School Purchases and Overall Consumption

One potential explanation for our null finding on BMI may be that availability does not impact overall food consumption. This may happen for different reasons. First, children may simply not take advantage of having junk food available in the school. Second, children may not change their *total* consumption of junk food because junk food purchased in school simply substitutes for junk food brought from home. Or third, children may not change their overall consumption during the day, but simply substitute

[25] To get a sense of the 2SLS point estimates, one can divide the reduced form estimates reported in the Tables 10-13 with the first-stage estimates reported in Table 4.
[26] The value of reduced form regressions has been highlighted by Angrist and Krueger (2001) and, more recently, Chernozhukov and Hansen (2008) formally show that the test for instrument irrelevance in the reduced form regression can be viewed as a weak-instrument-robust test of the hypothesis that the coefficient on the endogenous variable in the structural equation is zero.

between junk food consumed in-school and out-of-school. Similar forms of substitution across meals and locations have been documented among adults in a study of eating behavior in restaurants (Anderson and Matsa 2009). In this case, however, the monitoring of overall consumption may be augmented by parental oversight.

Unfortunately, we cannot completely separate out these possible explanations because the ECLS-K does not provide us with full information about the daily dietary intake of each child. However, we do have information about in-school consumption of foods with sugar, salty snacks, and sweetened beverages for those children with in-school availability. We also have total (in-school plus out-of-school) consumption of soda, fast food, and a variety of healthy foods for all children in the sample. We can use this information to gain some insight into the underlying eating behaviors and lend support for our BMI findings.

Not surprisingly, our analysis of in-school consumption of competitive foods does confirm that children purchase junk food when it is available (Table 10). The OLS estimates show a significant relationship for purchases of all types of junk food when competitive foods are available in schools (Panel A, Columns 1 through 3).[27] The reduced form estimates reported in Panel B also show a positive and significant relationship between our instrument, combined school attendance, and in-school junk food purchase. To get a sense of the additional calories such purchases contribute, we multiplied the increase in the probability of purchase estimated in Panel A by the median number of times that food was purchased among children who purchased at least once, times the calories per unit.[28] Summing across the three junk food groups yields 94

[27] Even though the in-school purchase variables capture the frequency of consumption, we dichotomize these variables to capture whether or not any purchase was made and estimate linear probability models. This is because much of the variation in junk food purchases at school occurs on the extensive margin (See Table 2).
[28] The median number of times an item is purchased in school among children who purchase at least once is 1.5 times (1-2 times per week). For calories per unit, we assume that purchase of a

additional calories per week from in-school junk food purchases when the school administrator reports that children have access to competitive foods. The corresponding numbers for the child-reported junk food availability and competitive food outlet measures are 155 and 76 calories per week, respectively. The caloric contribution of in-school purchases is much higher (435 calories per week, or 65 calories per day) among children who actually purchase these foods (as opposed to merely having them available). These 65 additional calories per day is a small amount given that the recommended daily intake of calories for a twelve-year old child is 2000 calories per day. In fact, this represents less than a quarter (23 percent) of the daily discretionary calorie allowance (267 calories) for a moderately active fifth grader.

It is possible that children, either due to satiation or parental monitoring, may substitute in-school purchases for snacks brought from home or eaten at home. We cannot explicitly test the nature of potential substitution for each of these snack food categories. We can, however, examine the total intake of soda and fast food consumed in and out of school. Soda is of particular interest because it is the only item for which children were asked about both their in-school (Table 11) and total consumption (Table 12) separately. Fast food, on the other hand, is only one particular type of junk food and does not correspond exactly to the in-school snack food consumption categories. We find that competitive food availability does not significantly increase children's total consumption of soda or fast foods (Table 12).[29] In fact, the OLS results show consistently negative estimates with occasional significance.[30]. Reduced form estimates

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salty snack adds 140 calories (typical calories from a bag of potato chips), purchase of a sweet adds 200 calories (typically calories from a candy bar), and purchase of a soda adds 150 calories.

[29] The total consumption variables are not dichotomized in these regressions because there is variation on the intensive margin. The number of times that the food or beverage item was consumed during the last 7 days was used as the dependent variable.

[30] In alternate specifications, we estimated models for total consumption of junk and healthy foods using negative binomial regressions with a binary treatment variable to account for the count-data distribution of the total consumption variable and the binary nature of the junk food availability

shown in Panel B, Table 12 confirm that there is no relationship between attendance in combined school and total consumption of soda and fast food. The fact that children who consume soda and other junk food in schools show no evidence of an increase in total consumption of soda and fast food provides some additional support for the substitution hypothesis.

While BMI is a widely-used measure, it does not capture nutritional changes. Just because children are not gaining weight does not mean that their diets are not adversely affected by competitive food availability. If children are consuming junk food in lieu of healthy foods such as fruit, there may still be concerns about their nutrition. Table 13 looks at whether children with in-school availability of competitive foods consume less milk, green salad, carrots, potatoes, other vegetables, and fruit. We examine consumption of each of these items separately and find that this is not the case. Only regressions estimating the consumption of “other vegetables” and “fruits” on children’s reports of availability show decreases in the OLS regressions, but this is not the case for the two other measures of availability. Moreover, reduced form regressions also show no significant relationship between the instrument and total consumption of the healthy foods.

Physical Activity

The absence of any effects of junk food availability on BMI despite the in-school purchases of junk food also raises questions regarding potential compensatory measures by schools and parents to promote greater availability and participation in physical activity. For example, funds from competitive food sales may be used to fund playgrounds or pay for physical education instructors. Another possibility is that parents

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variable. Our results remained qualitatively the same. These results are available from the authors upon request.

or children may decide to increase children's physical activity to balance junk food intake. If physical activity is greater, then we may find no change in BMI despite an increase in caloric intake. Table 14 reports results from OLS and reduced form models. Panel A Column 1 shows the association with teacher-reported minutes per week of physical education instruction that the child receives in school from OLS models. We find no impact of competitive food availability on the school's offering of minutes per week of physical education. Column 2 shows the relationship with parents' reports of their children's physical activity, measured as the number of days per week that the child received exercise that causes rapid heat beat for 20 continuous minutes or more. Again, we find no evidence of compensating effects on physical activity in the OLS regressions. The reduced form estimate for availability of physical education is also insignificant (Panel B, Table 14). For parent-reported physical activity, the reduced form estimates suggest a potential increase, but this is small relative to the mean and only significant at the 10 percent level. Overall, the regressions do not provide evidence of increased physical activity among children who were exposed to junk foods in school.

4.4. Social/Behavioral and Academic Outcomes

While BMI and obesity have been the prime focus of debates on competitive food availability, consumption of junk foods might also influence other school outcomes. For instance, despite limited empirical support, it is widely believed that high sugar levels in sweetened foods and drinks can cause children's energy levels to spike in the short-term and then crash, leading to behavior problems and possible negative consequences for academic achievement.[31] In this section, we examine whether access to competitive foods in school has any effects on children's social-behavioral outcomes and academic

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[31] A meta-analytic study found that sugar had no significant effect on behavior and cognition of children (Wolraich, Wilson & White 1995)

achievement. As in the previous section, our 2SLS specifications generate larger estimates and standard errors, making them statistically insignificant. Therefore, we report OLS and reduced form estimates.

We examine three measures of children's social and behavioral outcomes in school are based on the teacher-reported Social Rating Scale (SRS) administered in each wave (See Appendix 4 for details). The externalizing scale rates the frequency of negative behaviors such as arguing, fighting, getting angry, acting impulsively and disturbing ongoing activities. The internalizing behavior problem scale considers whether the child exhibits anxiety, loneliness, low self-esteem, and sadness. The third measure rates positive behaviors such as self-control and interpersonal skills. We include the baseline social-behavioral outcome score as an additional control in all models.[32] Table 15 Columns 1-3 report results for social-behavioral outcomes in fifth grade. Availability of competitive foods does not appear to be significantly related to externalizing or internalizing behavior problem, nor is it significantly related to self-control and interpersonal skill scores. There is some evidence in the reduced form regressions that attendance in a combined school is positively associated with increased externalizing behavior problems, but the effect is very small. However, this finding may simply reflect peer effects on behavior problems, independent of competitive food availability.

Because social/behavioral problems can potentially affect children's academic performance, we also examine the effect of competitive food availability on math and reading test scores in fifth grade (Table 15, Columns 4 and 5). These test score were obtained from individually-administered math and reading assessments at each data collection point (see Appendix 4 for details). Baseline (kindergarten) test score is

[32] Unlike the math and reading scores in the ECLS-K, changes in teacher ratings of social-behavioral skills over time cannot be interpreted as gains/losses. Therefore, we only the baseline score as a means to control for any preexisting differences between children who have competitive food access in school versus those who do not.

included as an additional control in all models. Neither of the two measures of competitive food availability that are based on school administrator reports are significantly associated with math or reading test scores in fifth grade. Only child reported competitive food availability appears to be positively related to math and reading test scores. The magnitudes of the point estimates, however, are small (4-8 percent of a standard deviation) suggesting no substantive effects on test scores. The reduced form estimates also confirm the lack of relationship between combined school attendance and test scores. The general finding is that there appears to be no substantive deterioration in children's social-behavioral or academic outcomes as a result of their exposure to competitive foods.

5. Conclusion

There is a growing concern among policymakers and educators that junk food availability in schools is a significant contributor to the childhood obesity epidemic. Between 2003 and 2005, approximately 200 pieces of legislation were introduced in US state legislatures to establish nutritional standards in schools or to address the availability or quality of competitive foods (Boehmer et al 2007). At the federal level, legislation was passed in 2004 requiring local education agencies to develop a "wellness policy" by 2006 that included nutrition guidelines for all of the foods available in schools. More recently, there has been debate in the US Congress over enacting an amendment to the farm bill that would further restrict the sale of unhealthy foods and beverages in Schools (Black 2007).

But it is unclear that the available evidence on competitive foods is sufficiently compelling to warrant such a concerted response. In this paper, we attempt to address several of the issues undermining previous research efforts. We analyzed national data on a sample of elementary school children and examined whether competitive food availability in fifth grade affected children's BMI. While estimates from naïve models suggest a positive association between competitive foods in school and BMI, estimates from models that control for observed and unobserved sources of heterogeneity (including baseline BMI) find no statistically significant relationship between competitive food availability and BMI, regardless of how we measure competitive food availability.

Additional regressions reveal that while availability does result in the purchase of junk foods, the calorie contribution of such purchases is not large - less than a quarter of the daily discretionary calorie allowance for children in this age group. Moreover, there is no evidence of any significant change in total (in- plus out-of-school) consumption of soda, fast food, and healthy foods raising the possibility that in-school purchases substitute for junk food taken from or eaten at home. The null-finding with respect to BMI does not appear to be due to compensatory changes in the children's opportunities for and participation in physical activity.

We noted that our null-finding is consistent with either minimal intake of junk food in school or substitution. Because we do not know how long each child is exposed to junk food in schools, we calculate the potential impact on children's BMI using our estimate of the increase in calories and a range of years for potential exposure. If we conservatively assume one year of exposure to junk food availability in school, then this is equivalent to 1.6 pounds of weight gain or 1.6 percent of the median child's weight assuming that the extra 22 calories is additive.[33] Our estimates would not be able to identify such a small impact, but it is also not substantive. However, if we assume that children are exposed during the entire five years of elementary school, this intake

[33] The median child in our sample weights 97 pounds in fifth grade. We estimated an average of 155 junk food calories consumed weekly during the school year which translates into 1.6 pounds per year. The weight gain calculation is 22 calories per school day*180 school days divided by 3500 calories (per pound), which results in 1.6 pounds per year or 1.6 percent of the median child's weight. See: http://text.lsuagcenter.com/en/food_health/nutrition/weight_management/As+Few+As+100+Calories+A+Day+Affects+Weight+Gain+Or+Loss.htm.

translates into 8 pounds or 8 percent of body weight. The fact that our regressions do not identify such a large impact on BMI given the precision of our OLS and 2SLS estimates provides further evidence of substitution.[34]

Finally, we examine whether junk food availability has broader effects by estimating effects on social-behavioral and academic outcomes in school. We find no evidence of any substantive detrimental effects on these outcomes.

These findings have important implications in the current economic environment. The economic and housing crises facing the nation threaten state and local funding sources that public schools rely on. Indeed, half of states are projecting budget shortfalls that threaten staffing, compensation, extracurricular activities, and policy initiatives such as mandated limits on class size.[35] A number of schools subsidize their funding with revenue from the sale of competitive foods on site. In light of findings from this paper, certain policy measures, such as outright bans on competitive food sales, might appear premature and even detrimental to schools because they remove a key source of discretionary funds. Competitive food revenues fund a variety of school enrichment programs including athletics, student council, and other school activities and clubs, in addition to covering food service costs (Gordon et al 2007a). As described earlier, these revenues can be quite substantial, earning tens of thousands of dollars per year for many schools. In comparison, the average (adjusted) non-instructional per-pupil spending in public schools was about $322 in 2002.[36]

[34] If we focus only children who purchase, the estimated weight gain is 4.5 pounds per year of exposure (based on 62 calories per day). This is a large amount that should impact the distribution of BMI, but our quantile regressions provide no support for an impact on the distribution of BMI.
[35] "Schools expect budget cuts as economy sours: State problems, decline in property values eat away at district funds". Available at: http://www.msnbc.msn.com/id/23116409/ (Accessed February 10, 2008).
[36] National Center for Educational Statistics http://nces.ed.gov/pubs2007/npefs13years/tables/table_13cCT.asp?referrer=table (Accessed February 10, 2008).

Additional research is necessary to fully understand the potential consequences before costly legislation is implemented. There are clearly other nutritional and health outcomes (e.g. diet quality, dental caries) that may be influenced by junk food intake that we were not able to examine with our data. Moreover, we should further our limited understanding of the consequences of competitive food regulations on school finances and the extent to which these financial consequences could be mitigated by the sale of more nutritious alternatives or through alternative financing mechanisms.

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Tables

Table 1: Descriptive Statistics

Variable	Mean
BMI in grade 5	20.38 (4.36)
BMI in kindergarten	16.37 (2.19)
Junk food availability in school	
Junk food in school (School admin)	0.61
Junk food in school (Child)	0.72
Competitive food outlet in school	0.60
Attends a combined school	0.29
Male	0.51
White	0.60
Black	0.11
Hispanic	0.18
Asian	0.07
Private school	0.20
Mother's education	
Less than high school	0.10
High school diploma	0.31
Some college	0.29
Bachelor's degree or more	0.29
Household income	
< $15,000	0.11
≤ $15,000 Income < $25,000	0.12
≤ $25,000 Income < $35,000	0.13
≤ $35,000 Income < $50,000	0.16
≤ $50,000 Income < $75,000	0.19
≥ $75,000	0.30
Percent minority in school	
<10%	0.32
10% to less than 25%	0.18
25% to less than 50%	0.18
50% to less than 75%	0.09
75% or more	0.23
Total school enrollment	
0-149	0.04
150-299	0.19
300-499	0.34
500-749	0.29
750 & above	0.15
Urbanicity	
Central city	0.36
Suburb	0.36
Town or rural	0.28

Notes: N=9,378. Means are unweighted. Standard deviation in parentheses.

Table 2: In-School and Total Food Consumption Among Fifth Graders in the ECLS-K

Purchase of Junk Food at School (%)	Soda	Salty Snacks	Sweets
a. Did not buy any at school during the last week	87.6	83.8	76.5
b. 1 or 2 times during the last week in school	8.7	11.7	15.9
c. 3 or 4 times during the last week in school	1.6	2.1	3.6
d. 1 time per day	1.7	1.8	2.9
e. 2 times per day	0.2	0.4	0.6
f. 3 times per day	0.1	0.1	0.1
g. 4 or more times per day	0.2	0.3	0.4

Total Consumption of Selected Junk and Healthy Foods (%)	Soda	Fast Food	Milk	Juice	Green salad	Potatoes	Carrots	Other vegetables	Fruits
a. Did not consume during the past 7 days	15.5	28.6	10.9	23.9	48.6	47.1	45.3	17.7	9.1
b. 1 to 3 times during the past 7 days	37.9	51.3	17.3	34.9	33.1	40.3	32.3	36.1	29.8
c. 4 to 6 times during the past 7 days	16.9	9.9	16.0	14.6	7.4	5.0	9.9	20.4	22.4
d. 1 time per day	11.5	5.4	14.0	10.9	6.9	5.0	5.8	12.6	13.2
e. 2 times per day	7.8	2.0	16.4	7.3	2.1	1.5	2.5	6.6	11.1
f. 3 times per day	3.7	0.8	11.4	3.7	0.7	0.5	1.4	2.9	6.1
g. 4 or more times per day	6.7	2.1	13.9	4.8	1.2	0.7	2.7	3.7	8.4

Notes: N=9,378. Percentages are unweighted. Figures in the top panel are not conditional on availability in school.

Table 3: Variation in Grade Span among Fifth Graders in the ECLS-K

Highest Grade-Level in School	Lowest Grade-Level in School: Pre-K or Kindergarten	1	2	3	4	5	6	Total
4	68	3	1	1	0	0	0	73
5	3,806	100	42	187	120	9	0	4,264
6	1,844	14	24	41	134	224	0	2,281
7	15	0	0	0	0	15	0	30
8	1,973	11	8	23	55	314	3	2,387
9	27	0	0	0	0	0	0	27
10	3	0	0	0	0	0	0	3
11	0	1	0	0	0	0	0	1
12	286	19	0	1	0	6	0	312
Total	8,022	148	75	253	309	568	3	9,378

Notes: “Combined” schools are defined as schools with highest grade equal to 7 or higher.

Table 4: First Stage Regression Estimates

	Dependent Variable		
	Junk food Available (School admin)	Junk Food Available (kid)	Competitive Food Outlet
Model 1			
Attends a combined school	0.195**	0.217**	0.224**
	[0.041]	[0.027]	[0.042]
Partial R-square of excluded instruments	0.02	0.03	0.03
F-statistic on excluded instruments	22.7; p=0.000	65.96; p=0.000	28.3; p=0.000
Model 2			
Highest grade level in school	0.045**	0.044**	0.049**
	[0.01]	[0.007]	[0.011]
Lowest grade level in school	0.036**	0.023**	0.039**
	[0.01]	[0.006]	[0.009]
Partial R-square of excluded instruments	0.04	0.03	0.04
F-statistic on excluded instruments	21.56; p=0.000	38.76; p=0.000	25.79; p=0.000
Overidentification test statistic	0.095; p=0.758	0.197; p=0.657	0.096; p=0.757
Observations	9378	9378	9378

Notes: Figures in brackets are robust standard errors clustered at the school level. Other covariates in the model include gender, race/ethnicity, kindergarten BMI, mother's education, income, private school dummy, categories for percent minority in school and school enrollment, and state and urbanicity dummies. + significant at 10%; * significant at 5%; ** significant at 1%.

Table 5: Comparison of Covariate Means by Attendance in Elementary Versus Combined/Middle School, by Private School Status

	Public School Sample		Private School Sample	
Covariate	5th grader in elementary school	5th grader in combined school	5th grader in elementary school	5th grader in combined school
A. OUTCOMES AT BASELINE (KINDERGARTEN)				
BMI in Kindergarten	16.38	16.43	16.08	16.34
Reading test score in Kindergarten	29.37	28.30*	35.01	33.40*
Math test score in Kindergarten	22.71	22.30	29.44	27.56*
Externalizing BP Score in Kindergarten	1.60	1.63	1.56	1.57
Internalizing BP Score in Kindergarten	1.53	1.54	1.42	1.49*
Self Control Score in Kindergarten	3.23	3.21	3.28	3.28
Interpersonal Skills Score in Kindergarten	3.16	3.13	3.23	3.24
B. 5th GRADE COVARIATES				
Male	0.51	0.50	0.46	0.50
Child's race/ethnicity: White	0.55	0.61*	0.82	0.75*
Black	0.12	0.13	0.03	0.05
Hispanic	0.20	0.15*	0.08	0.12*
Asian	0.08	0.04*	0.04	0.05
Other	0.05	0.06	0.03	0.04
Mother's Education: Less than high school	0.13	0.11*	0.01	0.01
High school diploma	0.34	0.37*	0.20	0.19
Some college	0.28	0.33*	0.30	0.31
Bachelor's degree or more	0.25	0.19*	0.50	0.49
Household Income < $15,000	0.13	0.14	0.01	0.02
≤ $15,000 Income < $25,000	0.14	0.13	0.03	0.03
≤ $25,000 Income < $35,000	0.14	0.15	0.05	0.07
≤ $35,000 Income < $50,000	0.17	0.20*	0.12	0.12
≤ $50,000 Income < $75,000	0.17	0.18	0.26	0.23
≥ $75,000	0.26	0.20*	0.53	0.52
School enrollment: 0-149 students	0.02	0.03*	0.12	0.09*
150-299	0.11	0.17*	0.53	0.43*
300-499	0.37	0.25*	0.35	0.30
500-749	0.32	0.35*	0.00	0.18*
750 & above	0.18	0.20	0.00	0.00
Minorities in school <10%	0.26	0.40*	0.52	0.49
10% to less than 25%	0.18	0.16	0.25	0.20*
25% to less than 50%	0.20	0.12*	0.17	0.13
50% to less than 75%	0.12	0.04*	0.03	0.04
75% or more	0.26	0.28	0.03	0.13*
Urbanicity: Central city	0.34	0.24*	0.43	0.54*
Suburb	0.40	0.27*	0.30	0.30
Town or rural	0.27	0.49*	0.27	0.15*
Region: Northeast	0.18	0.19	0.10	0.22*
Midwest	0.22	0.46*	0.43	0.32*

South	0.35	0.25*	0.29	0.25
West	0.26	0.09*	0.18	0.21
Observations	6343	1196	275	1564

Notes: * differences in means are statistically significant at the 5% level.

Table 6: Reduced Form Estimates of the Effect of Attending a Combined School on Baseline Outcomes

	Dependent Variable						
	Kindergarten BMI (1)	Kindergarten Reading Score (2)	Kindergarten Math Score (3)	Kindergarten Externalizing BP Score (4)	Kindergarten Internalizing BP Score (5)	Kindergarten Self Control Score (6)	Kindergarten Interpersonal Skills Score (7)
Attends a combined school	0.019	-0.405	-0.33	0.028	0.019	-0.005	0
	[0.070]	[0.392]	[0.334]	[0.023]	[0.021]	[0.026]	[0.026]
Observations	9378	7911	8400	9053	9010	9025	8996
Mean(std dev) of dept var	16.37(2.19)	30.08(10.04)	23.63(8.98)	1.60(0.60)	1.52(0.49)	3.23(0.60)	3.17(0.63)

Notes: Each estimate represents a separate regression. Other covariates in the models include gender, race/ethnicity, kindergarten BMI (not in model in Column 1), mother's education, income, private school dummy, categories for percent minority in school and school enrollment, and state and urbanicity dummies. Robust standard errors clustered at school level are shown in brackets. For reading, math, self control, and interpersonal skills, higher skills indicate better outcomes. For externalizing and internalizing behavior problems, higher scores indicate worse outcomes. + significant at 10%; * significant at 5%; ** significant at 1%.

Table 7: Effect of Attending a Middle or Combined School on BMI and Food Consumption Among Fifth Graders With No Access to Junk Foods

	Dependent Variable								
		Total Consumption							
	Log G5 BMI (1)	Soda (2)	Fast food (3)	Milk (4)	Green salad (5)	Carrots (6)	Potatoes (7)	Other vegetables (8)	Fruit (9)
Sample: Junk food availability (School Admin) = 0									
Attends middle/combined school	-0.001	-0.173	0.159	-0.532	-0.335	-0.121	-0.08	-0.54	-0.27
	[0.007]	[0.366]	[0.228]	[0.434]	[0.176]	[0.301]	[0.150]	[0.351]	[0.370]
Observations	3616	3616	3616	3616	3616	3616	3616	3616	3616
Sample: Junk food availability (Child) = 0									
Attends middle/combined school	-0.642	0.365	-0.938	0.125	0.156	-0.127	-0.075	0.021	-0.642
	[0.417]	[0.294]	[0.577]	[0.276]	[0.360]	[0.180]	[0.473]	[0.487]	[0.417]
Observations	2649	2649	2649	2649	2649	2649	2649	2649	2649
Sample: Competitive food outlet = 0									
Attends middle/combined school	0.224	0.242	-0.649	-0.271	-0.048	0.072	-0.122	-0.041	0.224
	[0.418]	[0.240]	[0.521]	[0.200]	[0.346]	[0.191]	[0.368]	[0.442]	[0.418]
Observations	3752	3752	3752	3752	3752	3752	3752	3752	3752

Notes: Each estimate represents a separate OLS regression. All models control for the full set of covariates. Robust standard errors clustered at school level are shown in brackets. + significant at 10%; * significant at 5%; ** significant at 1%

Table 8: Effects of Competitive Food Availability in School on 5th Grade BMI

	Log Grade 5 BMI						
	OLS1 (1)	OLS2 (2)	OLS3 (3)	2SLS1 (4)	2SLS2 (5)	Treatreg1 (6)	Treatreg2 (7)
Junk food available (sch admin)	0.011*	0.007	0.001	0.003	0.016	-0.013	0.009
	[0.005]	[0.005]	[0.003]	[0.020]	[0.017]	[0.027]	[0.017]
Hausman test				0.011	0.829		
p-value				0.915	0.362		
Junk food available (child)	0.006	0	0.001	0.003	0.018	0.003	0.014
	[0.005]	[0.005]	[0.003]	[0.018]	[0.020]	[0.017]	[0.016]
Hausman test				0.008	0.738		
p-value				0.927	0.390		
Competitive food outlet	0.014**	0.008+	0.005	0.003	0.015	-0.005	0.008
	[0.005]	[0.005]	[0.003]	[0.018]	[0.016]	[0.019]	[0.016]
Hausman test				0.013	0.467		
p-value				0.910	0.494		
Covariates							
Demographics	Y	Y	Y	Y	Y	Y	Y
State & urbanicity dummies	N	Y	Y	Y	Y	Y	Y
Baseline BMI	N	N	Y	Y	Y	Y	Y
Observations	9378	9378	9378	9378	9378	9378	9378
Mean(std dev) of BMI	20.38 (4.36)						

Notes: Robust standard errors clustered at school level are shown in brackets. Other covariates in the model include gender, race/ethnicity, kindergarten BMI, mother's education, income, private school dummy, categories for percent minority in school and school enrollment, and state and urbanicity dummies. + significant at 10%; * significant at 5%; ** significant at 1%.

Table 9: Effect of Competitive Food Availability on BMI with Alternate Sample Restrictions

	Public School Children Only		Drop Schools With Grades 9 or higher		Drop Children Who Changed Schools Between K-5	
	OLS3	2SLS1	OLS3	2SLS1	OLS3	2SLS1
Junk food (school admin)	0.003	0.004	0.001	0.006	0.001	-0.007
	[0.004]	[0.024]	[0.003]	[0.023]	[0.004]	[0.030]
Junk food (child)	0.002	0.005	0.001	0.005	0.002	-0.006
	[0.004]	[0.025]	[0.003]	[0.018]	[0.004]	[0.025]
Competitive food outlet	0.007+	0.003	0.005	0.005	0.004	-0.008
	[0.004]	[0.019]	[0.003]	[0.018]	[0.004]	[0.033]
Observations	7539	7539	9035	9035	6976	6976

Notes: OLS3 models include the full set of covariates; 2SLS1 models use attendance in middle/combined school as the instrument. Robust standard errors clustered at school level are shown in brackets. Hausman tests for consistency of OLS3 estimates could not be rejected in any case. The tests are not reported in the table. + significant at 10%; * significant at 5%; ** significant at 1%

Table 10: Effect of Competitive Food Availability in 5^{th} Grade on Kindergarten BMI

	Log of Kindergarten BMI	
	OLS3	2SLS1
Junk Food Available (School Admin)	0.005+	0.005
	[0.003]	[0.021]
Junk Food Available (Child)	-0.001	0.005
	[0.003]	[0.018]
Competitive Food Outlet	0.004	0.004
	[0.003]	[0.018]
Observations	9378	9378
Mean(std dev) of dept var	16.37(2.19)	

Notes: Each estimate represents a separate regression. All models include the full set of covariates. Robust standard errors clustered at school level are shown in brackets. + significant at 10%; * significant at 5%; ** significant at 1%

Table 11: Effects of Competitive Food Availability in School on Junk Food Purchases in School

	Dependent Variable (Purchased junk food in school)		
	Bought any foods with sugar	Bought any salty snacks	Bought any soda
	OLS3	OLS3	OLS3
Explanatory Variable	(1)	(2)	(3)
A. Competitive Food Availability Measure			
Junk food available (school admin)	0.175**	0.113**	0.079**
	[0.012]	[0.011]	[0.011]
Junk food available (child)	0.264**	0.191**	0.160**
	[0.009]	[0.008]	[0.007]
Competitive food outlet	0.111**	0.110**	0.087**
	[0.013]	[0.011]	[0.011]
B. Reduced Form Regression			
Attends a combined school	0.051**	0.066**	0.092**
	[0.017]	[0.017]	[0.018]
Observations	9378	9378	9378

Notes: Each estimate represents a separate regression. Dependent variables in columns (1)-(6) are dichotomous and capture whether any purchase of that item was made in school during the last week. All regressions include the full set of covariates. Robust standard errors clustered at school level are shown in brackets. + significant at 10%; * significant at 5%; ** significant at 1%

Table 12: Effect of Competitive Food Availability in School on Total Consumption of Selected Junk Foods

	Dependent Variable (Total Consumption)	
	Soda	Fast food
	OLS3	OLS3
Explanatory Variable	(1)	(2)
A. Competitive Food Availability Measure		
Junk food available (school admin)	-0.077	-0.057
	[0.188]	[0.119]
Junk food available (child)	-0.720**	-0.318**
	[0.177]	[0.115]
Competitive food outlet	-0.443*	-0.07
	[0.174]	[0.109]
B. Reduced Form Regression		
Attends a combined school	-0.193	-0.109
	[0.266]	[0.146]
Observations	9378	9378
Median of dept var	2	2
Mean (std dev) of dept var	6.14(7.58)	2.9(4.7)

Notes: Each estimate represents a separate regression. Dependent variable captures the number of times the food or beverage item was consumed during the last 7 days. All models include the full set of covariates. Robust standard errors clustered at school level are shown in brackets. + significant at 10%; * significant at 5%; ** significant at 1%

Table 13: Effect of Competitive Food Availability in School on Total Consumption of Selected Healthy Foods

	Dependent Variable (Total Consumption)					
	Milk	Green salad	Carrots	Potatoes	Other vegetables	Fruits
	OLS3	OLS3	OLS3	OLS3	OLS3	OLS3
Explanatory Variable	(1)	(2)	(3)	(4)	(5)	(6)
A. Competitive Food Availability Measure						
Junk food available (school admin)	-0.264	0.075	-0.212	-0.135	-0.285+	-0.314
	[0.219]	[0.105]	[0.132]	[0.084]	[0.156]	[0.202]
Junk food available (child)	0.351	0.004	-0.15	-0.159+	-0.324*	-0.683**
	[0.231]	[0.105]	[0.142]	[0.083]	[0.155]	[0.197]
Competitive food outlet	0.087	0.146	-0.067	-0.105	-0.189	-0.333+
	[0.214]	[0.096]	[0.126]	[0.077]	[0.144]	[0.184]
B. Reduced Form Regression						
Attends a combined school	-0.251	0.15	-0.073	-0.051	-0.006	-0.088
	[0.305]	[0.126]	[0.105]	[0.156]	[0.202]	[0.238]
Observations	9378	9378	9378	9378	9378	9378
Median of dept var	7	2	2	2	2	5
Mean(std dev) of dept var	10.72(9.40)	2.28(4.20)	2.97(5.53)	1.91(3.49)	5.19(6.36)	7.82(8.16)

Notes: Each estimate represents a separate regression. Dependent variable captures the number of times the food or beverage item was consumed during the last 7 days. All models include the full set of covariates. Robust standard errors clustered at school level are shown in brackets. + significant at 10%; * significant at 5%; ** significant at 1%

Table 14: Effect of Competitive Food Availability on Children's Physical Activity in Fifth Grade

	Dependent Variable	
	Parent-Reported Days/Week of Physical Activity	Minutes/Week of Physical Education Instruction in School
	OLS3	OLS3
	(1)	(2)
A. Competitive Food Availability Measure		
Junk food available (school admin)	0	0.788
	[0.050]	[1.757]
Junk food available (child)	-0.02	0.508
	[0.047]	[1.256]
Competitive food outlet	-0.005	-0.366
	[0.049]	[1.502]
B. Reduced Form Regression		
Attends a combined school	0.120+	3.013
	[0.072]	[2.753]
Observations	8653	9010
Mean(std dev) of dept var	3.7(1.9)	77.6(31.3)

Notes: Each estimate represents a separate regression. All models include the full set of covariates. Robust standard errors clustered at school level are shown in brackets. + significant at 10%; * significant at 5%; ** significant at 1%

Table 15: Effect of Competitive Food Availability on Children's Test Scores and Social-Behavioral Outcomes in Fifth Grade

	Dependent Variable				
	Grade 5 Externalizing BP Score	Grade 5 Internalizing BP Score	Grade 5 Self-Control/Interpersonal Skills Score	Grade 5 Reading Score	Grade 5 Math Score
	OLS3 (1)	OLS3 (2)	OLS3 (3)	OLS3 (4)	OLS3 (5)
A. Competitive Food Availability Measure					
Junk food available (school admin)	0.017	-0.001	0.012	0.825	0.264
	[0.018]	[0.017]	[0.021]	[0.515]	[0.452]
Junk food available (child)	-0.006	0.004	0.003	2.161**	0.931*
	[0.016]	[0.016]	[0.017]	[0.474]	[0.434]
Competitive food outlet	-0.007	-0.009	0.004	0.622	0.041
	[0.017]	[0.017]	[0.019]	[0.493]	[0.442]
B. Reduced Form Regression					
Attends a combined school	0.060*	0.043	-0.043	0.34	0.511
	[0.025]	[0.029]	[0.026]	[0.681]	[0.571]
Observations	8146	7962	7688	8609	8609
Mean(std dev) of dept var	1.63(0.57)	1.63(0.54)	3.16(0.58)	140(22.7)	114(20.8)

Notes: Each estimate represents a separate regression. All models include the full set of covariates. Robust standard errors clustered at school level are shown in brackets. For reading, math, and self control/interpersonal skills, higher scores indicate better outcomes. For externalizing and internalizing behavior problems, higher scores indicate worse outcomes. + significant at 10%; * significant at 5%; ** significant at 1%

APPENDIX 1: Effect of Competitive Food Availability on Obesity Status

	Obese in 5th Grade						
	OLS1	OLS2	OLS3	2SLS1	2SLS2	BVP1	BVP2
(1) Junk food available (school admin)	0.019*	0.009	-0.001	0.004	0.022	-0.031	-0.002
	[0.009]	[0.010]	[0.007]	[0.046]	[0.037]	[0.045]	[0.034]
First-stage F-Stat for instruments				22.7	21.56		
p-value				0.000	0.000		
Overidentification test statistic					0.015		
p-value					0.902		
(2) Junk food available (child)	0.008	-0.003	-0.001	0.003	0.027	-0.003	-0.003
	[0.009]	[0.010]	[0.008]	[0.041]	[0.043]	[0.041]	[0.039]
First-stage F-Stat for instruments				65.96	38.76		
p-value				0.000	0.000		
Overidentification test statistic					0.002		
p-value					0.969		
(3) Competitive food outlet	0.025**	0.015	0.008	0.003	0.021	-0.012	0.000
	[0.009]	[0.009]	[0.007]	[0.039]	[0.034]	[0.051]	[0.043]
First-stage F-Stat for instruments				28.3	25.79		
p-value				0.000	0.000		
Overidentification test statistic					0.016		
p-value					0.899		
Covariates							
Child, family & school characteristics	Y	Y	Y	Y	Y	Y	Y
State & urbanicity dummies	N	Y	Y	Y	Y	Y	Y
Baseline BMI	N	N	Y	Y	Y	Y	Y
Observations	9378	9378	9378	9378	9378	9378	9378

Notes: All coefficient estimates are marginal effects. Figures in brackets are robust standard errors clustered at the school level. 2SLS1 and BVP1 models use only one instrument (indicator for whether 5th grader is in elementary or combined/middle school) whereas 2SLS2 and BVP2 models use two instruments (highest and lowest grade level in the school).

APPENDIX 2: Effect of Competitive Food Availability on Quantiles of BMI

	Without IV	With IV
Junk food available (Sch Admin)		
10th	0.001 [0.004]	0.011 [0.023]
25th	0.002 [0.004]	0.013 [0.025]
50th	-0.001 [0.004]	0.021 [0.028]
75th	0.001 [0.006]	0.036 [0.034]
90th	0.005 [0.007]	0.038 [0.045]
Junk food available (Kid)		
10th	0.000 [0.004]	0.005 [0.025]
25th	0.003 [0.003]	0.006 [0.028]
50th	0.000 [0.004]	0.01 [0.033]
75th	-0.002 [0.005]	0.01 [0.036]
90th	0.003 [0.007]	0.017 [0.039]
Competitive food outlet		
10th	-0.001 [0.004]	-0.003 [0.021]
25th	0.002 [0.003]	-0.002 [0.024]
50th	0.003 [0.004]	-0.001 [0.030]
75th	0.010 [0.005]	0.007 [0.038]
90th	0.013 [0.007]	0.009 [0.038]
Observations	9,378	9,378

Notes: Differences in coefficient estimates across quantiles are statistically insignificant in all cases. Figures in brackets are standard errors. Standard errors in quantile regressions without instruments are obtained by bootstrapping and are adjusted for clustering at school level. Standard errors in quantile regressions with instruments are not adjusted for clustering. The estimates and standard errors from IV models are obtained using the Abadie, Angrist, and Imbens (2002) Quantile Treatment Effects (IV-QTE) estimator that is coded in Stata by Froelich and Melly (2008). The IV-QTE regressions include only region fixed effects (versus state fixed effects included in the OLS, 2SLS, and quantile regressions) due to program limitations in Froelich and Melly's program. However, an alternative IV quantile regression approach using the estimator proposed in Chernozhukov and Hansen (2005) (written in Stata by Le Wang) was also estimated that allowed us to include state fixed effects, and the results were similar. . * significant at 5%; ** significant at 1%.

APPENDIX 3: Junk Food Availability Questions in the ECLS-K Fifth Grade Wave

(A). School Administrator Questionnaire:

26. At this school, can students purchase food or beverages from: -

a. One or more vending machines at the school? .... Yes No

b. A school store, canteen, or snack bar? .... Yes No

27. Does this school offer a la carte lunch or breakfast items to students, that is, items not sold as part of the NSLP School Lunch or the School Breakfast Program?

YES.. 1

NO 2

28. Can students purchase, either from vending machines, school store, canteen, snack bar or a la carte items from the cafeteria during school hours?

a. Chocolate candy?

b. Other kinds of candy?

c. Cookies, crackers, cakes, pastries, or other baked goods that are not low in fat?

d. Salty snacks that are not low in fat, such as regular potato chips?

e. Ice cream or frozen yogurt that is not low in fat?

f. 2% or whole milk?

g. Fruits or vegetables, not juice?

h. Low-fat cookies, crackers, cakes, pastries, or other low-fat baked goods?

i. Salty snacks that are low in fat, such as pretzels, baked chips, or other low-fat chips?

j. Bread sticks, rolls, bagels, pita bread, or other bread products?

k. Low-fat or fat-free ice cream, frozen yogurt, or sherbet?

l. Low-fat or non-fat yogurt?

m. 1% or skim milk?

n. Bottled water?

o. 100% fruit juice?

p. 100% vegetable juice?

q. Soda pop, sports drinks, or fruit drinks that are not 100% juice?

(B). Child Food Consumption Questionnaire:

These questions are about buying food and drinks at your school. Please only think about buying things at school; do not think about eating at school.

1. In your school, can kids buy {FOOD} in the school?

2. If yes, during the last week that you were in school, how many times did you buy {FOOD} at school?

a. I did not buy any at school during the last week.

b. 1 or 2 times during the last week in school

c. 3 or 4 times during the last week in school

d. 1 time per day

e. 2 times per day

f. 3 times per day

g. 4 or more times per day

The above set of questions was asked separately for 3 food/beverage groups:

(i) Candy, ice cream, cookies, cakes, brownies or other sweets

(ii) Potato chips, corn chips (Fritos, Doritos), Cheetos, pretzels, popcorn, crackers or other salty snack foods

(iii) Soda pop (EXAMPLES Coke, Pepsi, Mountain Dew), sports drinks (EXAMPLE Gatorade), or fruit drinks that are not 100% fruit juice (EXAMPLES Kool-Aid, Hi-C, Fruitopia, Fruitworks)

The next questions ask about food you ate or drank during the past 7 days. Think about all the meals and snacks you had from the time you got up until you went to bed. Be sure to include food you ate at home, at school, at restaurants, or anywhere else.

1. During the past 7 days, how many times did you eat/drink {FOOD}?

   a. I did not eat/drink {FOOD} during the past 7 days

   b. 1 to 3 times during the past 7 days

   c. 4 to 6 times during the past 7 days

   d. 1 time per day

   e. 2 times per day

   f. 3 times per day

   g. 4 or more times per day

The above question was asked separately for 7 food groups:

1. Milk – Milk question was asked in terms of glasses of milk consumed in last 7 days. This included all types of milk, including cow's milk, soy milk or any other kind of milk; includes the milk {CHILD} drank in a glass or cup, from a carton, or with cereal. The half pint of milk served at school was counted as one glass.
2. Green salad
3. Potatoes (not counting French fries, fried potato, or potato chips)
4. Carrots
5. Other vegetables
6. Fruits (not counting juice)

7. Fast food – meal or snack from a fast food restaurant such as McDonald's, Pizza Hut, Burger King, KFC (Kentucky Fried Chicken), Taco Bell, Wendy's etc.

APPENDIX 4: Description of School Outcome Variables

Test Scores: Children surveyed in the ECLS-K were given individually administered math and reading assessments at each data collection point. In each subject area, assessments consisted of a two-stage assessment. In the first stage, children received a 12 to 20 item routing test. Performance on the routing items guided the selection of one of the several alternative second-stage tests. The second stage test contained items of appropriate difficulty for the level of ability indicated by the routing test. Since not all children took the exact same test, Item Response Theory (IRT) scale scores were computed for all children. Reading (math) IRT scores represent estimates of the number of items students would have answered correctly if they had taken all of the questions in the first and second stage reading (math) forms. These scores are comparable across students within a wave and also across waves enabling comparison of children's performance over time. The reliability of test scores was very high—0.93 for reading and 0.92 for math. Touranganeau et al (2006) provides more detailed information about the tests administered.

Social-behavioral outcomes: Measures of children's social and behavioral outcomes in school are based on the teacher-reported Social Rating Scale (SRS) administered in each wave of the ECLS-K. The SRS scale is adapted from the Social Skills Rating System (SSRS) Instrument developed by Gresham and Elliot (1990), which is a well-established and useful tool in assessing and targeting social skills deficits and competing problem behaviors. The teacher SRS is a self-administered questionnaire consisting of two scales externalizing and internalizing behavior problems. The externalizing scale includes information on acting out behaviors of children and is based on 5 items that rate the frequency with which a child argues, fights, gets angry, acts impulsively and disturbs ongoing activities. The internalizing behavior problem scale consists of 4 items that ask about the apparent presence of anxiety, loneliness, low self-esteem, and sadness in the child. The teacher SRS also includes two scales on positive behaviors such as self-control and interpersonal skills. The self-control scale includes four items that capture the child's ability to control behavior by respecting the property rights of others, controlling temper, accepting peer ideas for group activities, and responding appropriately to pressure from peers. Finally, the interpersonal skills scale includes five items that rate the child's skills in forming and maintaining friendships, getting along with people who are different, comforting or helping other children, expressing feelings, ideas and opinions in positive ways, and showing sensitivity to the feelings of others. Teachers use a response scale to report how often the child demonstrated the behavior described— 1 (never), 2 (occasionally or sometimes), 3 (regularly but not all the time), and 4 (most of the time). The scores on both scales are the mean rating on the items included in the scale. Higher scores on the externalizing and internalizing scales indicate worse outcomes, whereas higher scores on the self control and interpersonal skills scales indicate better outcomes.