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Junk Food in Schools and Childhood Obesity

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Abstract

Despite limited empirical evidence, there is growing concern that junk food availability in schools has contributed to the childhood obesity epidemic. In this paper, we estimate the effects of junk food availability on BMI, obesity, and related outcomes among a national sample of fifth-graders. Unlike previous studies, we address the endogeneity of the school food environment by controlling for children's BMI at school entry and estimating instrumental variables regressions that leverage variation in the school's grade span. Our main finding is that junk food availability does not significantly increase BMI or obesity among this fifth grade cohort despite the increased likelihood of in-school junk food purchases. The results are robust to alternate measures of junk food availability including school administrator reports of sales during school hours, school administrator reports of competitive food outlets, and children's reports of junk food availability. Moreover, the absence of any effects on overall food consumption and physical activity further support the null findings for BMI and obesity.

Keywords

Junk food; Competitive foods; Obesity

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", defined as foods and beverages available or sold in schools outside of the school lunch and breakfast programs, has been a much debated issue. On the one hand, opponents question the nutritional value of competitive foods and consider them the primary source of "junk foods" in schools. Indeed, the available evidence suggests that these 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 (Gordon et al 2007a).

The debate draws from largely cross-sectional research that rarely addresses the potential endogeneity of the school food environment. Our paper advances the literature by

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attempting to isolate the causal effect of junk food availability on children's food consumption and BMI. We use longitudinal data on BMI for a national sample of fifth graders from the Early Childhood Longitudinal Study – Kindergarten Class (ECLS-K) and an instrumental variables (IV) approach that leverages the well-documented fact that junk foods are significantly more prevalent in middle and high schools relative to elementary schools (Finkelstein, Hill and Whitaker 2008). Plausibly exogenous variation in junk food availability across a cohort of fifth graders is identified using the grade structure in their schools. 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 junk foods compared to a fifth grader in an elementary school (e.g. K-5, K-6), but that the school's grade span has no direct effect on a child's weight. First-stage regressions confirm that combined school attendance is a strong predictor of junk food availability. Further tests for instrument validity including an examination of sorting and peer effects support our use of the instrument.

We find that junk food availability has small positive associations with BMI and obesity in basic OLS models that only control for a limited set of covariates, but those associations become insignificant when controls for BMI at school entry and state fixed effects are added. Our IV models, which address potential bias in the OLS models, generate somewhat larger, albeit less precise, point estimates that are also not statistically significant. Even if the IV point estimates were statistically significant, they would still represent only minor increases in BMI and obesity, generally one-third of one percent. Moreover, reduced form estimates, which are more precisely estimated than IV estimates, provide further support because combined school attendance has no significant effects on 5th graders' BMI and obesity. These results are robust to alternative measures of junk food availability and sample restrictions. The models also produce the expected findings on various falsification tests.

While we acknowledge their limitations, ancillary analyses of children's in-school junk food purchases, total consumption of healthy and unhealthy foods, and physical activity are consistent with our null findings for BMI and obesity. Our estimates suggest that the caloric contributions of in-school junk food purchases are likely to be small. Moreover, we find evidence consistent with substitution between in- and out-of-school consumption. Specifically, the *total* amount of soda and fast food consumed in- and out-of-school, is not significantly higher among those children with greater exposure to junk food in school (i.e. attending a combined school). And, finally, we find little support for the notion that children substitute calories from healthy foods or increase their physical activity to compensate for increased junk food intake.

The remainder of this paper is organized as follows. We first discuss junk food availability in schools and the findings from the existing literature in Section 2. Section 3 describes our data and relevant analysis variables. In Section 4, we describe our empirical strategy, which leverages longitudinal information on BMI and implements an instrumental variables approach to identify the causal impact of junk food availability. In Section 5, we first discuss our main results for children's BMI and obesity and then support these findings with robustness checks and falsification tests. We also present supporting evidence from models of in-school purchases of junk food, total consumption of various healthy and unhealthy items, and physical activity. Finally, Section 6 concludes with the policy implications of our findings.

2. Background and Literature

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, are not subject to federal nutritional standards. As a result, competitive foods account for much of the variation in the food environment across schools. Competitive foods are available in a large share of schools, although the availability of these foods varies significantly across elementary, middle, and high schools. For example, as many as 97% of high schools and 82% of middle schools have vending machines compared to only 17% of elementary schools (Gordon et al 2007a). However, a la carte lines, which are the predominant source of competitive food sales, operate not only in most high (93%) and middle (92%) schools, but also in a large proportion of elementary schools (71%) (Gordon et al 2007b).

Sales of competitive foods have the potential to generate significant revenues for schools. During 2005–2006, middle and high schools earned an average of $10,850 and $15,233, respectively, from a la carte sales alone (Gordon et al 2007a). In addition, nearly a third of high schools and middle schools earned between $1,000–$9,999 during that same year from vending machines, another ten percent earned between $10,000–$50,000, and a small number earned in excess of $50,000 per year. These revenues may in turn be supplemented by on-site school stores and pouring contracts with beverage companies. While availability and revenues were less common in elementary schools, nearly half of elementary schools had pouring rights contracts, and competitive food sales from fundraising activities were also common.

The U.S. Department of Agriculture's regulations on competitive foods in schools 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 (Institute of Medicine 2007). In recent years, several states, districts, and schools have enacted competitive food policies that are more restrictive than federal regulations. And, 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). At the local level, 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.

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 is associated with a decline in nutritional quality of meals consumed at school (Cullen et al 2000, Cullen & Zakeri 2004; Templeton, Marlette & Panemangalore 2005).[1] However, less is known about the effects on overall diet quality (consumed both in and out of school) and children's weight. The literature does provide some evidence of substitution of caloric intake across meals and locations among adults (Anderson and Matsa 2011), but the evidence is less clear regarding children for whom parental oversight can also play a role. Only Kubik and colleagues have examined 24 hour dietary recall (2003) and BMI (2005) among children, however these studies are based on small cross-sectional samples and do not address the potential endogeneity of the school food environment.[2,3]

[1]Other studies have examined the effects of price reductions, 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 found positive effects.

The only effort to address endogeneity is in Anderson and Butcher (2006), who use national data on adolescents aged 14–20 years to examine whether various school food policies influence BMI (based on self-reported height and weight data). In the absence of a single data source containing information on school food policies and BMI among adolescents, the authors use a two-sample IV approach that employs county, state, and regional characteristics as instruments to 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. But this effect is primarily driven by adolescents with an overweight parent, which the authors interpret as a measure of family susceptibility.[4] Their 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 existing literature in its sample, methodology and scope. First, to our knowledge, ours is the only study that addresses the endogeneity of the school food environment among younger children. The focus on fifth graders is useful because junk food regulations are increasingly targeting elementary and middle schools.[5] And our national sample of children provides a larger and more representative sample with significant variation in school environments. Second, our data contain actual measurements of children's height and weight, unlike the self-reports from other national datasets that have been used to examine this question previously. Third, our approach improves on the common cross-sectional designs by controlling for children's BMI at school entry and state fixed-effects, and leveraging variation in schools' grade spans to estimate IV models. Finally, unlike previous studies, we also provide evidence on the underlying mechanisms by examining effects on food consumption and physical activity.

3. Data

The ECLS-K is a panel dataset on a nationally representative cohort of kindergarteners in the U.S. who entered school in fall 1998. In the fall and spring of kindergarten and the spring of the first, third, and fifth grades, the study collected information from the children and their parents, teachers, and schools on children′s cognitive, social, emotional, physical development (including BMI), and their home, classroom, and school environments. One limitation is that the information on the school food environment and children's food consumption was collected only in the fifth grade. Our analysis sample includes the approximately 9,380 children attending the fifth grade in public and private schools in the 2003–04 school year.[6] In this section, we describe the key variables for our analyses.

3.1. Dependent Variables Measuring BMI, Food Consumption and Physical Activity

Body Mass Index (BMI)—A distinct advantage of the ECLS-K is that it collected height and weight measurements from children at kindergarten (school) entry and in the spring of kindergarten and first, third, and fifth grades. Measurements are superior to self- or parent-reported height and weight data that may introduce non-random measurement error. These measurements are used to compute BMI, defined as weight in kilograms divided by height

[2]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 Minneapolis-St Paul schools. Using the same data, Kubik et al (2005) show that using competitive foods as rewards and incentives is positively associated with BMI.

[3]Also, using the ECLS-K, Fernandes (2008) found small positive associations between soda availability in schools and both in-school and overall soda consumption of fifth graders.

[4]Their results for the other school policies, pouring rights contracts, and food and beverage advertisements are smaller and less precise.

[5]For example, California's first nutrition policy (SB 677) implemented beverage standards for elementary and middle schools, not high schools.

[6]All sample sizes have been rounded to the nearest 10 per the ECLS-K's restricted-use data agreement.

in meters squared. The average BMI in our sample during the fifth grade is 20.4 (Table 1). Approximately 20% of the ECLS-K sample is categorized as obese – this is nearly identical to prevalence rates among 6–11 years olds from the 2007–8 National Health and Nutrition Examination Survey (Ogden et al 2010).[7]

Junk Food Purchase in School—The food consumption questionnaire collected information on in-school junk food purchase during the fifth grade. These questions asked children about their purchases of sweets, salty snack foods, and sweetened beverages (hereafter, referred to as "soda") during the previous week.[8] A substantial majority of the children did not purchase junk food in school during the reference week: 77% for sweets, 84% for salty snacks, and 88% for soda (see Appendix Table A1). But a large share of these children did not have junk food available in their schools (see Section 3.2). Conditional on availability, about half the sample purchased any of these unhealthy foods at least once a week in school. Among those who did purchase, the modal response was 1 to 2 purchases per week: 68 percent for sweets, 72 percent for salty snacks, and 70 percent for soda.[9]

Total Consumption of Selected Foods and Beverages—The child food consumption questionnaire asked about the frequency of overall consumption of specific food items during the past week. Children were asked to include foods they ate at home, at school, at restaurants, or anywhere else. We examine the consumption of two unhealthy items - soda and fast food, and six healthy food items – milk, green salad, potatoes[10], carrots, other vegetables, and fruits. The percentage of children not consuming any soda or fast food during the previous week was 16 and 29 percent, respectively, with modal responses at 1 to 3 times per week (see Appendix Table A1). Among the healthy foods, green salad, carrots and potatoes were consumed most infrequently with nearly half of children reporting no consumption during the past week. The modal responses for the other healthy foods were 1 to 3 times during the past week.

3.2. Junk Food Availability

Detailed information on junk food availability in schools was collected from the school administrators and from children in the fifth grade. School administrators were asked whether students could purchase 17 individual food and beverage items, either from vending machines, school store, canteen, snack bar or a la carte items from the cafeteria during school hours. From these responses, we constructed an indicator variable of junk food availability in school that equals 1 if the administrator reports that students can purchase food and beverage items containing high sodium and/or sugar, including candy, chocolate, baked foods (e.g. cookies), salty snacks (e.g. potato chips), ice cream or frozen yogurt, or sweetened beverages during school hours, and zero otherwise.[11] Based on these school administrator reports, approximately 61 percent of the children had junk food availability in school. For robustness checks, we also considered two alternative measures of availability.

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[7]Obesity is defined as BMI greater than the 95th percentile for age and gender on the Center for Disease Control growth charts.

[8]Sweets include candy, ice cream, cookies, brownies or other sweets; salty snack foods include potato chips, corn chips, Cheetos, pretzels, popcorn, crackers or other salty snacks, and sweetened beverages include soda pop, sports drinks or fruit drinks that are not 100 percent juice.

[9]To validate the ECLS-K estimates, we examined the Third School Nutrition and Dietary Assessment Study (SNDA-III), which collected 24-hour dietary recall from 2,300 children attending a nationally representative sample of public schools in 2005. Similar to the ECLS-K, eighty percent of elementary school children reported no competitive food purchases. Among children who made a purchase, the median daily caloric intake from these foods was 185 calories. The SNDA estimate is higher than our ECLS-K estimates (62 calories reported in Section 5) because it includes healthy foods purchased from competitive food venues: for example, milk was by far the most popular item purchased from competitive food venues and yogurt also ranked highly.

[10]The "potatoes" category excluded French fries, fried potatoes, and potato chips.

[11]The questionnaire separately asked about availability of high- and low-fat options for baked foods, salty snacks, and ice cream/frozen yogurt/sherbert. We include both the low- and high-fat options in our measure, however, in sensitivity analyses, we used only the high-fat versions to construct our school-administrator based measure of junk food availability and found results to be similar.

The first is based on whether the modal child at each school reports that foods containing sugar, salty snacks, or sweetened beverages can be purchased at school. Based on this measure, about 75 percent of the children had junk foods available. And the second is based on whether the administrator reports any of the following competitive food outlets operate in the school: vending machines, school stores, canteens, snack bars, and a la carte lines. About 60 percent of the sample had at least one competitive food outlet.[12]

4. Empirical Approach

4.1. Econometric Model

The relationship between junk food availability and children's BMI in fifth grade can be estimated cross-sectionally using the following linear regression model.

$$BMI_{iks}=\beta_1\, JF_k+\beta_2\, X_i+\beta_3\, S_k+\beta_4\, BBMI_i+\theta_s+\varepsilon_{iks} \quad (1)$$

where, BMI_{iks}, denotes fifth grade BMI for child i attending school k located in state s, JF_k captures junk food availability in the child's school, X_i and S_k are the vectors of individual/family (gender, age, age interacted with gender, race/ethnicity, mother's education, household income) and school characteristics (private/public, percent minority, enrollment, urbanicity, state/region), respectively, and ε_{iks} is the error term. The child's baseline BMI ($BBMI_i$) is included to address potential heterogeneity that can bias OLS estimates such as student demand for junk foods, genetic susceptibility, and sorting. Because junk food availability is collected only in fifth grade, we do not know the length of exposure during prior school years. Therefore, BMI at school entry is the preferred baseline because it is measured prior to any exposure to the school food environment. Finally, since states differ markedly in terms of obesity prevalence in their populations as well as the policy environment geared towards combating obesity, we include state fixed effects (θ_s) to control for state-specific time-invariant unobserved heterogeneity that may be correlated with school food environments and children's weight.

The parameter of interest in Equation (1) 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 junk 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 junk 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 or districts 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.

4.2. Addressing Endogeneity of Junk Food Availability in Schools

We address the potential endogeneity of junk food availability using instrumental variables. Specifically, we estimate the model in Equations (2.1) and (2.2) using Two-Stage Least Squares.

[12]We rely mainly on the first measure of junk food availability because it is the most specific with respect to the quality of foods and because school-level policies regarding junk food availability are frequently set by school principals and staff (Gordon et al 2007a). We prefer this measure over the simple dichotomy of having any (unregulated) competitive food outlets because the outlet-based measure does not differentiate the type of foods sold (e.g. milk vs. soda). We also prefer it over the child-report because children who do not consume junk foods are less likely to accurately report availability and because children reported only the availability of *any* sweets, salty snacks, or sweetened beverages, but did not differentiate specific items (e.g. low-fat vs. high-fat).

$$JF_{iks}=\alpha_1\,CS_k+\alpha_2\,X_i+\alpha_3\,S_k+\alpha_4\,BBMI_i+\theta_s+\nu_{iks} \quad (2.1)$$

$$BMI_{iks}=\beta_1\,\widehat{JF}_k+\beta_2\,X_i+\beta_3\,S_k+\beta_4\,BBMI_i+\theta_s+\varepsilon_{iks} \quad (2.2)$$

Equation 2.1 represents the first-stage regression where junk food availability (JF_k) is regressed on the combined school attendance instrument (CS_k), individual (X_i) and school (S_k) characteristics, baseline BMI ($BBMI_i$), and state fixed effects (θ_s). Equation 2.2 represents the second stage where children's BMI (or obesity) is regressed on the predicted availability of junk foods from the first stage ($\hat{J}F_k$) in addition to the common covariates.

We also report results from the reduced form, which regresses BMI or obesity directly on the instrument (Equation 3). These results have the advantage of being unbiased and providing evidence of whether a causal relationship exists in the regression of interest.[13]

$$BMI_{iks}=\beta_1\,CS_k+\beta_2\,X_i+\beta_3\,S_k+\beta_4\,BBMI_i+\theta_s+\varepsilon_{iks} \quad (3)$$

4.2.1. Instrument—Our sample consists of a single cohort of 5th graders attending schools with a variety of grade spans. Given that junk food availability is significantly higher in middle and high schools compared to elementary schools, a potentially useful instrument for junk food availability is whether the 5th grader attends a combined school (defined as the highest grade is seventh or higher) or whether the 5th grader is in an elementary school (defined as highest grade is 5th or 6th). Our instrument considers only this dichotomy of school type: elementary versus combined. Over 70 percent of our sample attends elementary schools while the remainder attends combined schools usually with grade spans of K-8, K-12 and 5–8 (see Appendix Table A2).

For combined school attendance to be a valid instrument, it must be the case that the school's grade span has no direct effect on children's weight except through the junk food environment. One potential concern is that there may be unobserved factors that are correlated with both the likelihood of combined school attendance as well as BMI. For example, it is well known that states differ markedly in the prevalence of childhood obesity. But, states are also likely to differ in terms of factors that contribute to school grade span such as: (1) the size of the school-age population, (2) its distribution within the state, (3) differences in the educational systems and policies, as well as (4) education budgets. Similarly, school grade span can vary across urban versus rural areas (even within states), with the latter more likely to have combined schools largely because of a smaller school-age population. The inclusion of state and urbanicity dummies in our regressions controls for unobserved differences across states and across rural/urban areas that may be correlated with combined school attendance (or grade span, more generally) and BMI.

Another potential concern with this identification strategy is that variation in grade span exposes children to older peers who may influence obesogenic behaviors. Peers, defined broadly, have been shown to influence a wide range of adolescent behaviors and outcomes.[14] However, of particular relevance to our identification strategy is the literature examining a specific type of peer effect, namely, the effect of exposure to older peers due to school grade span.

[13]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.

Several studies have examined peer effects on academic, social-behavioral and substance use outcomes by leveraging variation in school grade span (Clark and Folk 2007; Clark and Loheac 2007; Eisenberg 2004; Bedard and Do 2005; Cook et al 2008). Most studies compare students in the same grade who attend *middle versus combined schools* or *middle versus elementary schools*.[15] These studies generally find that 6th or 7th graders who attend middle school fare poorly compared to those who attend elementary or combined schools.[16] However, we are not aware of any studies that compare children in the same grade level who attend *elementary versus combined schools*. The exception is Rickles (2005), whose findings suggest inconsistent effects of *elementary versus combined schools* attendance on achievement.

Furthermore, there is very limited evidence on the influence of older peers on food choices. Cullen and Zakeri (2004) compared changes in food consumption of 4th graders who transitioned to middle school in 5th grade and gained access to school snack bars to changes in food consumption of 5th 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.

Overall, the literature suggests that *the presence of older peers* may adversely affect academic and social behavioral outcomes, but there is less evidence to support effects on their eating behaviors. Nevertheless, if such an effect exists, the potential bias in our IV estimates due to peer effects is likely to be upward. That is, 5th 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. In that case, an insignificant finding is unlikely to be undermined.

4.2.2. Checks for Instrument Validity—Identification in our IV models relies on the assumption that, conditional on state and urbanicity dummies, the school's grade span does not influence BMI except through differences in the availability of junk foods. Districts typically determine the grade span at the time of the schools' opening based on a number of factors including transportation costs, length of bus ride, desired number of transitions, population size, site availability, preferred school size, and likelihood of parental involvement (Paglin and Fager 1997) rather than children's health outcomes. Changes in grade span over time are possible, but infrequent and similarly-motivated. For example, in our ECLS-K sample, less than 4 percent of the children who remained in the same school between kindergarten and fifth grade experienced a grade-span change from combined to elementary school or vice-versa. While unlikely, it is nevertheless possible that schools may change grade span in response to children's physical size. Therefore, below we report results from several tests that support the validity of our instruments. These analyses are based on our preferred specification, which controls for the full set of covariates, including state and urbanicity dummies and baseline BMI.

[14]This literature examines peer effects on a wide range of outcomes including substance use (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), academic achievement (Hanushek et al 2003; Cook et al 2008), adolescent food choices (Perry, Kelder, Komro 1993; Cullen et al 2001; French et al 2004) and weight (Trogdon, Nonnemaker and Pais 2008).

[15]However, Clark and Loheac (2007) estimate how substance use behavior of students within the *same* school who are one year older influences adolescent substance use and find a positive relationship.

[16]One exception is Eisenberg (2004) who finds that 7th and 8th graders who attend schools with older peers are no more likely to use substances relative to those who attend schools with younger peers.

First, we report first-stage estimates of the effect of our instrument – combined school attendance – on junk food availability in school. The first-stage estimates show that combined school attendance significantly increases the likelihood of junk food availability with an F-statistic on the instrument that exceeds 22 (Table 2).

Second, since our instrument leverages across school variation we might be concerned that selection into different schools (or communities) might undermine the validity of our instrument. To test for differential selection into combined versus elementary schools, we regress BMI, obesity, test scores, social-behavioral outcomes, and parental involvement measured in kindergarten on combined school attendance in 5th grade (Table 3).[17] Because these outcomes are determined prior to exposure to school, these comparisons allow us to test for selection. The results suggest that, conditional on observed characteristics, combined school attendance is uncorrelated with pre-exposure BMI, obesity, test scores, social-behavioral outcomes and parental involvement.

Third, another concern is that combined school attendance might generate peer effects on BMI, obesity, food consumption and physical activity, independent of junk food availability. We test for the presence of peer effects by regressing these outcomes on combined school attendance using only the sample of schools that do not offer junk foods (Table 4). The results do not provide any support for peer effects on BMI, obesity, food consumption or physical activity.[18]

Overall, the instrument appears to be strongly predictive of junk food availability and there is no evidence that selection or peer effects threaten its validity.

5. Results

We now turn to our main results, which examine the effects of junk food availability on BMI and other outcomes. We first estimate basic OLS models of BMI and obesity, then augment with state fixed effects and baseline BMI to address omitted variable bias and selection, and finally estimate the IV and reduced form specifications (Section 5.1). In Section 5.2, we examine the sensitivity of our results to alternate measures of junk food availability and various sample restrictions. We also report findings from falsification tests. And finally, in Section 5.3, 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.

5.1. BMI and Obesity

Our main results focus on whether the availability of junk foods increases BMI and obesity among 5th graders (Table 5). Columns 1 and 4 in Panel A show the results of basic OLS regressions of log BMI and obesity, respectively, on junk food availability controlling for child, household, and school characteristics.[19] These regressions yield a statistically

[17]We also examined unadjusted differences in children's individual, family and school characteristics during the 5th grade (see Appendix Table A3). There were slight differences for some of the covariates. However, there was no overall pattern in the socioeconomic factors that would threaten the validity of the IV approach: that is, some differences imply better BMI outcomes for one group and others worse. For example, in our sample, elementary school students are more likely to be Hispanic and Asian while combined school students are more likely to be white. There are no differences in the share that are Black. Similarly, there is no consistent pattern in maternal education. Elementary school students are more likely to have poorly and highly educated mothers (less than high school, more than Bachelors).

[18]To check whether these null findings are merely due to lack of power instead of absence of peer effects, we estimated the same models using social-behavioral outcomes and test scores as dependent variables because the literature finds evidence of peer effects on these outcomes. We were able to identify statistically significant peer effects on social-behavioral outcomes (but not test scores), which suggests that lack of power is an unlikely explanation for the finding of null peer effects on BMI and related outcomes.

significant increase in both BMI and obesity when junk food is available, although the point estimates are small. The inclusion of state fixed effects and urbanicity dummies (Panel A, columns 2 and 5) and then baseline BMI measured in kindergarten (Panel A, columns 3 and 6) eliminates the significant coefficients. The fully-specified OLS models have very small, precisely estimated, and statistically insignificant point estimates.

However, the coefficients from these OLS models may be biased if junk 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 adopt more stringent nutritional policies that reduce the availability of junk foods in school. In such situations, OLS regressions may show no significant relationship or even a negative relationship between junk food availability and BMI. OLS estimates might also suffer from attenuation bias due to the presence of measurement error in the junk food availability measures.

To address these issues, we estimate instrumental variables (IV) and reduced form regressions using grade span as the instrument: whether the 5th grader attends a combined school with older peers.[20] The IV point estimates are relatively larger than the OLS estimates, but less precisely estimated rendering them statistically insignificant (Table 5, Panel B).[21], [22] IV estimates from models that do not control for state and urbanicity dummies and baseline BMI (columns 1 and 4) are much larger than those in our preferred specification (Columns 3 and 6), although they are not statistically significantly different from each other. Even if the IV point estimates in our preferred specification (columns 3 and 6) were significant, they would represent only small increases in BMI and obesity of less than one-third of one percent. Hausman tests that check for the endogeneity of junk food availability by comparing estimates from the fully-specified OLS regression with the IV cannot reject the null hypothesis that both estimates are consistent. Therefore, we also report the reduced form estimates of BMI and obesity regressed directly on our instrument (Table 5, Panel C). The coefficients on the instrument are close to zero and very precisely estimated, which further confirm the null findings. Given concerns about unobserved heterogeneity in the OLS specifications and the larger standard errors in the IV specifications, the reduced form estimates are preferred.

5.2. Sensitivity and Falsification Checks

We conducted a number of sensitivity analyses to test the robustness of our findings. In this section, we report results from a few key analyses and then turn to falsification tests.[23] These analyses control for the full set of covariates, including state and urbanicity dummies and baseline BMI.

For the sensitivity analyses, we first re-estimate our BMI and obesity regressions with the two alternate measures of junk food availability (Table 6). Both the child-reported measure of junk food availability and the school-administrator reported measure of competitive food outlet show no effect of junk food availability on BMI or obesity. Next, we re-estimate the models with the exclusion of three particular groups that might confound our instrument

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

[20]In alternate analyses, we used continuous measures of the highest and lowest grades in the school as instruments. In these over-identified models, both instruments had a strong positive association with junk food availability (i.e. increases in the highest and lowest grades available at the school were strongly predictive of junk food availability). This approach yielded qualitatively similar results as the exactly-identified models (available upon request).

[21]The IV regressions were also estimated without baseline BMI. The point estimates, first-stage F-statistics, and Hausman tests yield similar results (available upon request).

[22]A concern with our IV specification estimated via two-stage least-squares is that our first stage models do not account for the dichotomous nature of the treatment variable (Maddala 1983). Estimates from binary treatment effect IV models confirm that the effects of junk food availability on BMI are neither substantive nor significant (available upon request).

(Table 7). First, because combined schools are much more likely to be private, our instruments may simply capture variation across public versus private schools students, even though the regressions control for private school attendance. We re-estimate the models on a sample that excludes children who attend private schools (Table 7, Panel A) and find no effects on BMI and obesity.[24] Second, even though Section 4.2.2 suggests there are no peer effects on BMI and related behaviors, we test the sensitivity of our results to exclusion of the oldest peers (e.g., grade 9 or higher), but still find no evidence of an effect on BMI and obesity (Table 7, Panel B). Finally, children who switch schools for unobservable reasons potentially related to junk food availability may bias our estimates, but estimates from models that exclude children who changed schools between kindergarten and fifth grade confirm no effects (Table 7, Panel C). The point estimates from the OLS, IV and reduced form regressions for these sensitivity checks are essentially zero, though less precisely estimated in the IV models.[25]

As falsification tests, we examined whether junk food availability in the fifth grade influenced children's height in the fifth grade and their pre-exposure BMI. Height should clearly be unrelated. And indeed, the coefficients are essentially zero and insignificant (Table 8). Because BMI and obesity in kindergarten is measured prior to exposure to junk foods in school, any effects would suggest unobserved heterogeneity. The OLS, IV and reduced form point estimates are close to zero (though the IV estimates are less precise) and the reduced form specifications also show no relationship (Table 9, Panel A). Results for BMI and obesity measured in first and third grade likewise confirm insignificant effects of junk food availability during fifth grade (Table 9, Panels B and C). However, because our data do not contain information on junk food availability prior to 5th grade, these results are also consistent with the absence of junk foods in earlier grades.

5.3. Effects of Junk Food Availability on Food Consumption and Physical Activity

The consistent lack of significant findings for BMI and obesity raises questions regarding how the energy balance equation is affected by junk food availability. While we cannot measure children's energy intake and expenditure explicitly with these data, we can examine whether junk food availability influences general food consumption patterns and physical activity. Unlike BMI and obesity, the consumption and physical activity measures are based on parents' and children's *reports*. As a result, they are subject to measurement error and consequently produce noisier estimates particularly for the IV models. Nevertheless, they represent our best opportunity for understanding important mechanisms underlying our null finding. Therefore, for the in-school junk food purchases, total consumption, and physical activity analyses, we focus mainly on the reduced form results (though we provide OLS results for comparison).[26]

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[23] We also conducted additional sensitivity analyses not reported here. First, given that we do not know the exposure to junk food in previous grades and given concerns that genetic susceptibility may not have a constant proportional effect on BMI at every point in the life cycle, we controlled for 1st or 3rd grade BMI instead of BMI in Kindergarten and obtained similar results. Second, inclusion of controls for school meal participation did not change our findings. Third, we used BMI z-scores as the dependent variable to accurately control for age and gender influences on BMI and obtained qualitatively similar results. Fourth, we estimated quantile regressions to test whether the effects of junk food availability varied across the BMI distribution, but found no evidence for heterogeneous effects. Finally, we also re-estimated our BMI and obesity models separately for each gender. The results for junk food availability mirrored those for the full sample. The OLS, IV, and RF models show no significant effects of junk food availability for either boys or girls. Still we may be concerned about differential peer effects, for example, if girls are influenced by older peers' concerns about body image, which would bias our IV estimates downward. Restricting the sample to those boys and girls attending schools without junk food availability, the coefficients from the reduced form were nearly identical to those based on the full sample of boys and girls, which suggests that peer effects are not an issue even when regressions are gender-specific.

[24] Estimates based only on the sample of private schools yield small and statistically insignificant effects of competitive food availability on BMI in both OLS and IV specifications, although the F-statistics for the instrument in the first stage were smaller (Results available upon request).

[25] Hausman tests cannot reject the consistency of fully-specified OLS estimates in any of our sensitivity checks.

5.3.1 In-School Purchases and Overall Consumption—One potential explanation for our null findings for BMI and obesity may be that availability does not impact overall food consumption. This may happen for several different reasons. First, young children may not purchase significant amounts of junk food in school either due to limited access to such foods or fewer discretionary resources to purchase them. 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 between junk food consumed in-school and out-of-school.

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 purchases 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. While not definitive, we can use this information to gain some insight into underlying eating behaviors and lend support for our BMI and obesity findings.

Not surprisingly, our analysis of in-school consumption of junk foods does confirm that children purchase junk food when it is available.[27] The OLS estimates show a significant relationship for purchases of all types of junk food when junk foods are available in schools (Table 10, Panel A). And the reduced form estimates show that children in combined schools are between 5 and 9 percentage points more likely to purchase junk foods compared to those in elementary schools Table 10, Panel B).

To provide a sense of the caloric contribution of these purchases, we multiplied the increase in the probability of purchase from attending a combined school by the median number of times that food was purchased among children who purchased at least once, by the number of the calories per unit.[28] Summing across the three junk food groups yields 50 calories per week (7 calories per day) from in-school junk food purchases. The caloric contribution of in-school purchases is much higher (435 calories per week or 62 calories per day for the median child) among children who purchase these foods (as opposed to merely having them available). But even the 62 calories per day represents less than a quarter (23 percent) of the daily discretionary calorie allowance (267 calories) for a moderately active fifth grader.[29]

It is possible that children substitute in-school purchases for snacks brought from home or eaten at home either due to satiation or parental monitoring. With our simple dietary recall measures, we cannot explicitly test the nature of potential substitution. 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 and total consumption separately. Fast food, on the other hand, does not

[26]Although not shown, the IV (Wald) estimates are easily calculated by dividing the reduced form estimates in Table 10–Table 12 by 0.2 (first stage estimate from Table 2). The IV coefficients are never significant in part due to the larger standard errors in the regressions of reported eating behaviors and physical activity.

[27]We dichotomize the in-school purchase variables and estimate linear probability models since much of the variation in junk food purchases at school occurs on the extensive margin.

[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). We assume that salty snacks add 140 calories (typical calories from a bag of potato chips), sweets add 200 calories (typically calories from a candy bar), and soda adds 150 calories. Given the limitations of the consumption data in the ECLS-K, we caution the reader to treat these caloric intake calculations as approximations.

[29]Discretionary calories are the difference between an individual's total energy requirement and the energy necessary to meet nutrient requirements. According to Dietary Guidelines for Americans, the discretionary allowance for a 2000 calorie diet is 267 calories. See: http://www.health.gov/dietaryguidelines/dga2005/document/html/chapter2.htm#table3 accessed August 22, 2008.

correspond exactly to the in-school snack food consumption categories. We find that junk food availability is not associated with significant increases in children's total consumption of soda or fast foods (Table 11, Columns 1 and 2).[30] The OLS regressions show negative, though generally insignificant, estimates.[31] More importantly, the reduced form estimates confirm that there is no relationship between combined school attendance 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 provides support for the substitution hypothesis. This finding is also consistent with the literature, which indicates that only 27 percent of soda and sweetened drinks consumed in elementary schools are bought at school compared to 67 percent brought from home (Briefel et al 2009).

While BMI is a widely-used outcome 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 junk food availability. If children are consuming junk food in lieu of healthy foods, there may still be concerns about their nutrition. Columns 3 through 8 of Table 11 examine whether children with in-school availability of junk foods consume less milk, green salad, carrots, potatoes, other vegetables, and fruit. The OLS results show no significant associations with junk food availability. Moreover, reduced form regressions also show that combined school attendance does not significantly impact total consumption of the healthy foods.[32]

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 changes in the availability of and participation in physical activity. For example, revenues from junk food sales may be used to fund playgrounds or pay for physical education instructors. Or it may be that combined schools simply offer more opportunities for physical activity due to their scale and organization relative to elementary schools. Another possibility is that parents or children may increase children's physical activity to balance junk food intake. If physical activity is greater, then we may find no change in BMI or obesity despite an increase in caloric intake.

OLS and reduced form estimates for school- and parent-reported physical activity measures are reported in Table 12. OLS estimates show no relationship between junk food availability and minutes per week of physical education at school, minutes per week of recess at school, and parent-reported participation in physical activity (measured as the number of days per week that the child engaged in exercise that causes rapid heart beat for 20 continuous minutes or more). The reduced form regressions show no significant effects of combined school attendance on minutes per week of physical education instruction. Children attending combined school have fewer minutes of recess (Table 12, Column 2), but slightly higher days of parent-reported physical activity (Table 12, Column 3) though neither finding is statistically significant at.conventional levels. Overall, the regressions do not provide consistent evidence that increased energy expenditure explains the null finding for BMI and obesity.

6. Conclusion

Junk food availability is a prominent issue for middle and high schools in the U.S. However, there is also widespread legislation and regulation targeting junk foods even in elementary

[30]The total consumption variables are not dichotomized because there is sufficient variation on the intensive margin.
[31]Negative binomial models with a binary treatment variable to account for the count-data distribution of the total consumption variable and the binary nature of junk food availability produced qualitatively similar results. (Results available upon request).
[32]Given the limitations of the ECLS-K's consumption variables, we again examined the SNDA-III data and found no evidence that combined school attendance increases total caloric intake.

school (Trust for American's Health 2009). Young children's access to junk foods in school is an important concern due to the strong correlation between childhood overweight and obesity in adolescence and adulthood (Institute of Medicine 2005). In this paper, we examined whether junk food availability increased BMI and obesity among a national sample of 5th graders. Those 5th graders who attend a combined school are much more likely to have junk food availability relative to those in elementary school. While estimates from naïve models that only control for a limited set of covariates suggest a positive association between junk foods in school and BMI and obesity, fully-specified OLS models that control for BMI at school entry and state fixed-effects demonstrate no statistically or economically significant relationships among these young children. Likewise, the IV and reduced form models, which are not subject to the potential bias undermining OLS models, confirm the null findings for BMI and obesity. These results are not sensitive to various robustness checks including alternate measures of junk food availability and sample restrictions.

Finally, we provide further support for the null findings by examining in-school and overall food consumption patterns as well as physical activity. The null effects on BMI and obesity cannot be explained entirely by limited access or limited discretionary resources among young children because 5^{th} graders do purchase junk food when it is available in schools. However, our results suggest that the caloric contribution of in-school purchases is likely to be small. Moreover, we find no evidence of significant changes in the overall frequency of consumption of soda and fast food, which is consistent with children substituting in-school purchases of junk food for that taken from or eaten at home. Alternative explanations such as compensatory changes children's consumption of healthy foods and in their opportunities for and participation in physical activity do not appear to play a significant role in explaining our null findings for BMI and obesity.

Our findings may have implications in the current economic environment. Half of the states are projecting budget shortfalls that threaten staffing, compensation, extracurricular activities, and policy initiatives such as mandated limits on class size.[33] Many schools subsidize their funding with revenue from the sale of junk foods. In total, elementary schools earn approximately $442 million annually from junk food sales (Institute of Medicine 2007). In light of our findings, certain policy measures, such as outright bans on junk food sales (at least among elementary school children), might appear premature given that they remove a key source of discretionary funds.

While our results are robust, we caution that we could not consider the full range of consequences of junk food availability. Not only are the dietary intake measures in the ECLS-K limited, but we are also not able to examine whether related health outcomes such as diet quality or dental caries are influenced by junk food availability. Also, we are unable to examine the generalizability of our findings to older children who may have greater junk food access and intake both in and outside school. And finally, we could not consider whether exclusive contracts between schools and beverage/snack companies influence students' food choices in the longer run through product or brand recognition. Additional research is necessary to fully understand the potential consequences before costly legislation is implemented. Such research might also consider the consequences of junk 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.

[33]"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, 2009).

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Table 1

Descriptive Statistics in the Fifth Grade

Variable	Mean
BMI	20.4 (4.4)
Obese	0.20
Junk food availability in school	0.61
Combined school attendance (i.e. highest grade>=7)	0.29
Age in months	134.6 (4.4)
Male	0.51
White	0.60
Black	0.11
Hispanic	0.18
Asian	0.07
Private school	0.20
Mother’s education	
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=9,380. Means are unweighted. Standard deviation in parentheses.

Table 2

First Stage Regression Estimates of Junk Food Availability in Fifth Grade

	Junk Food Availability
Combined school attendance	0.195 **
	[0.041]
Partial R-square of excluded instruments	0.02
F-statistic on excluded instruments	22.7; p=0.000
Observations	9380

Notes: Figures in brackets are robust standard errors clustered at the school level. Other covariates in the model include male, age (months), male*age, 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 3

Effect of Attending a Combined School on Kindergarten Outcomes

	Log (BMI) (1)	Obese (2)	Reading Score (3)	Math Score (4)	Externalizing BP Score (5)	Internalizing BP Score (6)	Self Control Score (7)	Interpersonal Skills Score (8)	Parent Involvement (9)
Combined school attendance	0.002	−0.004	−0.401	−0.333	0.028	0.019	−0.005	0.001	0.151
	[0.003]	[0.010]	[0.376]	[0.310]	[0.023]	[0.021]	[0.027]	[0.026]	[0.364]
Observations	9380	9380	7910	8400	9050	9000	9020	9000	8250
Mean(std dev) of dept var	16.4(2.2)	0.12	30.1(10.0)	23.6(9.0)	1.6(0.6)	1.5(0.5)	3.2(0.6)	3.2(0.6)	34.4 (11.2)

Notes: Each estimate represents a separate regression. Other covariates in the models include age, male, age*male, race/ethnicity, kindergarten BMI (not in model in Columns 1 and 2), 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. Parent involvement is measured as the sum of the number of times/week that the parent engages in 9 activities with the child (e.g. reading books, talk about nature, do science projects, tell stories).

+ significant at 10%;

* significant at 5%;

** significant at 1%.

Table 4

Effect of Combined School Attendance on BMI, Obesity and Related Behaviors Without Junk Food Availability in Fifth Grade

			Total Consumption								Days per Week of Physical Activity
	Log BMI	**Obese**	**Soda**	**Fast food**	**Milk**	**Green salad**	**Carrots**	**Potatoes**	**Other vegetables**	**Fruit**	
Combined school attendance	−0.001	0.001	−0.166	0.156	−0.553	−0.341	−0.118	−0.081	−0.539	−0.27	−0.010
	[0.007]	[0.015]	[0.368]	[0.230]	[0.436]	[0.178]	[0.302]	[0.152]	[0.353]	[0.371]	[0.131]
Observations	3620	3620	3620	3620	3620	3620	3620	3620	3620	3620	3320

Notes: Each estimate represents a separate 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 5

Effects of Junk Food Availability on BMI and Obesity in Fifth Grade

	Log BMI			Obese		
	(1)	(2)	(3)	(4)	(5)	(6)
A. OLS Estimates						
Junk food availability	0.011*	0.007	0.001	0.019*	0.009	−0.001
	[0.005]	[0.005]	[0.003]	[0.009]	[0.010]	[0.007]
B. IV Estimates						
Junk food availability	0.083	0.010	0.003	0.104	0.014	0.003
	[0.064]	[0.029]	[0.020]	[0.114]	[0.060]	[0.046]
C. Reduced Form Estimates						
Combined school attendance	0.009	0.002	0.001	0.012	0.003	0.001
	[0.006]	[0.006]	[0.004]	[0.011]	[0.012]	[0.009]
Covariates						
Demographics	Y	Y	Y	Y	Y	Y
State & urbanicity dummies	N	Y	Y	N	Y	Y
Baseline BMI	N	N	Y	N	N	Y

Notes: N=9,380. Robust standard errors clustered at school level are shown in brackets. Other covariates in the model include male, age (months), male*age, 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. First stage results are shown in Table 2.

+ significant at 10%;

* significant at 5%;

** significant at 1%.

Table 6

Effects of Alternate Measures of Junk Food Availability on BMI and Obesity in Fifth Grade

	Log BMI			Obese		
	(1)	(2)	(3)	(4)	(5)	(6)
A. Junk food availability (modal child response)						
OLS Estimates	0.006	−0.002	0.004	0.007	−0.007	0.003
	[0.005]	[0.005]	[0.004]	[0.010]	[0.011]	[0.008]
IV Estimates	0.054	0.008	0.003	0.069	0.012	0.002
	[0.037]	[0.025]	[0.017]	[0.070]	[0.051]	[0.039]
B. Competitive food outlet[a] (school admin)						
OLS Estimates	0.014**	0.008+	0.005	0.025**	0.015+	0.009
	[0.005]	[0.005]	[0.003]	[0.009]	[0.009]	[0.007]
IV Estimates	0.042	0.009	0.003	0.053	0.012	0.003
	[0.027]	[0.025]	[0.018]	[0.053]	[]0.052	[0.040]
Covariates						
Demographics	Y	Y	Y	Y	Y	Y
State & urbanicity dummies	N	Y	Y	N	Y	Y
Baseline BMI	N	N	Y	N	N	Y

Notes: N=9,380

[a]Competitive Food Outlet measure captures whether school has vending machines, school stores, canteens, snack bars, or a la carte lines through which competitive foods are sold. Robust standard errors clustered at school level are shown in brackets. Other covariates in the model include male, age (months), male*age, 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 7

Effects of Junk Food Availability on BMI and Obesity in Fifth Grade with Alternate Sample Restrictions

	Log BMI	Obese
A. Sample Excluding Private School Students (N=7540)		
OLS Estimates		
Junk food availability	0.003	0.003
	[0.004]	[0.008]
IV Estimates		
Junk food availability	0.005	0.011
	[0.024]	[0.052]
Reduced Form Estimates		
Combined school attendance	0.001	0.002
	[0.005]	[0.010]
B. Sample Excluding Schools With Grades 9 or higher (N=9030)		
OLS Estimates		
Junk food availability	0.001	−0.002
	[0.003]	[0.007]
IV Estimates		
Junk food availability	0.006	−0.003
	[0.023]	[0.053]
Reduced Form Estimates		
Combined school attendance	0.001	0.000
	[0.004]	[0.009]
C. Sample Excluding Children Who Changed Schools Between Kindergarten and Fifth Grade (N=6980)		
OLS Estimates		
Junk food availability	0.001	−0.004
	[0.004]	[0.008]
IV Estimates		
Junk food availability	−0.007	0.019
	[0.029]	[0.070]
Reduced Form Estimates		
Combined school attendance	−0.001	0.003
	[0.005]	[0.012]

Notes: All models include the full set of covariates. Robust standard errors clustered at school level are shown in brackets. Hausman tests for consistency of OLS 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 8

Effect of Junk Food Availability in School on Height in Fifth Grade

	Log (5th Grade Height)		
	(1)	**(2)**	**(3)**
OLS Estimates			
Junk food availability	0.000	0.001	0.000
	[0.001]	[0.001]	[0.001]
IV Estimates			
Junk food availability	0.020	0.007	0.006
	[0.016]	[0.008]	[0.008]
Reduced Form Estimates			
Combined school attendance	0.002	0.001	0.001
	[0.001]	[0.002]	[0.001]
Covariates			
Demographics	Y	Y	Y
State & urbanicity dummies	N	Y	Y
Baseline BMI	N	N	Y

Note: N=9,380. Robust standard errors clustered at school level are shown in brackets.

+ significant at 10%;

* significant at 5%;

** significant at 1%

Table 9

Effects of Junk Food Availability on BMI and Obesity in Kindergarten, First, and Third Grade

	Log BMI	Obese
A. BMI/Obesity in Kindergarten (N=9380)		
OLS Estimates		
Junk food availability	0.005	0.007
	[0.003]	[0.008]
IV Estimates		
Junk food availability	0.005	−0.019
	[0.021]	[0.051]
Reduced Form Estimates		
Combined school attendance	0.002	−0.004
	[0.003]	[0.010]
B. BMI/Obesity in First Grade (N=8750)		
OLS Estimates		
Junk food availability	0.002	−0.003
	[0.004]	[0.008]
IV Estimates		
Junk food availability	−0.015	−0.000
	[0.026]	[0.056]
Reduced Form Estimates		
Combined school attendance	−0.004	−0.000
	[0.003]	[0.011]
C. BMI/Obesity in Third Grade (N=9040)		
OLS Estimates		
Junk food availability	0.002	0.008
	[0.005]	[0.009]
IV Estimates		
Junk food availability	−0.002	0.014
	[0.029]	[0.063]
Reduced Form Estimates		
Combined school attendance	−0.001	0.003
	[0.003]	[0.012]

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 10

Effect of Junk Food Availability on In-School Junk Food Purchases in Fifth Grade

	Purchased junk food in school		
	Bought any sweets	**Bought any salty snacks**	**Bought any soda**
Explanatory Variable	**(1)**	**(2)**	**(3)**
OLS Estimates			
Junk food availability	0.175 **	0.113 **	0.078 **
	[0.012]	[0.012]	[0.011]
Reduced Form Estimates			
Combined school attendance	0.051 **	0.066 **	0.092 **
	[0.017]	[0.017]	[0.018]

Notes: N=9380. Each estimate represents a separate regression. Dependent variables in columns (1)–(3) 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 11

Effect of Junk Food Availability on Total Consumption of Selected Unhealthy and Healthy Foods in Fifth Grade

	Dependent Variable							
	Unhealthy		Healthy Foods					
	Soda	**Fast Foods**	**Milk**	**Green salad**	**Carrots**	**Potatoes**	**Other vegetables**	**Fruits**
Explanatory Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
OLS Estimates								
Junk food availability	−0.075	−0.054	−0.263	0.074	−0.21	−0.133	−0.280 +	−0.317
	[0.189]	[0.120]	[0.220]	[0.105]	[0.133]	[0.084]	[0.156]	[0.202]
Reduced Form Estimates								
Combined school attendance	−0.193	−0.109	−0.256	0.15	−0.05	−0.072	−0.008	−0.086
	[0.268]	[0.147]	[0.305]	[0.126]	[0.157]	[0.105]	[0.203]	[0.239]
Median of dept var	2	2	7	2	2	2	2	5
Mean(std dev) of dept var	6.14(7.58)	2.9(4.7)	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: N=9380. 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 12

Effects of Junk Food Availability on Physical Education, Recess and Physical Activity in Fifth Grade

	Minutes/Week Physical Education Instruction in School (1)	Minutes/Week Recess in School (2)	Parent-Reported Days/Week of Physical Activity (3)
OLS Estimates			
Junk food availability	0.751	−0.562	0.002
	[1.761]	[3.220]	[0.050]
Reduced Form Estimates			
Combined school attendance	3.012	−10.004+	0.120+
	[2.753]	[5.193]	[0.072]
Observations	9010	8940	8650
Mean(std dev) of dept var	77.6 (31.3)	87.5 (57.3)	3.7 (1.9)

Notes: Each estimate represents a separate regression. All models include the full set of covariates as well as the baseline (kindergarten) measure of the dependent variable. Robust standard errors clustered at school level are shown in brackets.

+significant at 10%;

*significant at 5%;

**significant at 1%.

Table A1

In-School and Total Food Consumption in Fifth Grade

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	Pot atoes	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=9,380. Percentages are unweighted. Figures in the top panel are not conditional on availability in school.

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Table A2

Variation in Grade Span in Fifth Grade

	Lowest Grade-Level in School								
Highest Grade-Level in School	**Pre-K or Kindergarten**	**1**	**2**	**3**	**4**	**5**	**6**	**Total**	
4	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.8	
5	40.6	1.1	0.4	2.0	1.3	0.1	0.0	45.5	Elementary 70.6%
6	19.7	0.1	0.3	0.4	1.4	2.4	0.0	24.3	
7	0.2	0.0	0.0	0.0	0.0	0.2	0.0	0.3	
8	21.0	0.1	0.1	0.2	0.6	3.3	0.0	25.5	
9	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.3	
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Combined 29.4%
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
12	3.0	0.2	0.0	0.0	0.0	0.1	0.0	3.3	
Total	85.5	1.6	0.8	2.7	3.3	6.1	0.0	100.0	

Notes: N=9380. “Combined” schools are defined as schools with highest grade equal to 7 or higher.

Table A3

Means by Attendance in Elementary Versus Combined School and by Private/Public

5th Grade Covariates	Public School Sample		Private School Sample	
	Elementary	Combined	Elementary	Combined
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: N=9,380.

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

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Table A4

Effect of Grade-Span on Academic and Social-Behavioral Outcomes Among Schools Without Junk Food Availability in Fifth Grade

	Externalizing BP Score	Internalizing BP Score	Self-Control/ Interpersonal Skills Score	Reading Score	Math Score
Combined school attendance	0.154**	0.059	−0.115*	0.146	0.767
	[0.044]	[0.037]	[0.050]	[1.102]	[1.187]
Observations	2780	2730	2670	2910	3170