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Trends in the School Lunch Program: Changes in Selection, Nutrition & Health

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Abstract

There has been significant media attention on the issue of childhood obesity, leading policymakers to reform the National School Lunch Program (NSLP) to include stricter nutritional requirements. The researchers use data on school lunch menus to document improvements in the nutritional quality of school meals between 1991 and 2010. They then evaluate how this change in nutritional content maps into obesity outcomes, using panel data on a nationally representative cohort of children, tracking them from kindergarten entry in fall 2010 through the end of fifth grade in spring 2016. They find little evidence that participation in the school lunch program leads to weight gain, as measured by changes in obesity, overweight, and BMI. These results suggest that improvements in the nutritional content of school lunches have been largely successful in reversing the previously negative relationship between school lunches and childhood obesity. Unrelated to school lunch participation, the authors find a strong relationship between mother's obesity status and both the level and growth of children's obesity, especially for girls and among high-SES families.

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I. Introduction

The first decade of the 2000s saw significant policy and media attention directed toward the problem of childhood obesity, a condition that roughly 1 in 6 children and adolescents experience (Ogden et al., 2014; CDC, 2015).[1] Dubbed an "epidemic" by members of the research and policy communities alike, initiatives aimed at stemming or reversing rising rates of overweight and obesity among children rose in prominence at local, state, and federal levels.

While many aspects of the increase in obesity are likely difficult to address with policy, schools are often seen as potentially important sites of intervention for policies and programs aimed at improving health and reducing obesity among children. The National School Lunch Program (NSLP) serves meals to over half of the nation's school-aged population each school day, so improvements to the nutritional quality of school meals could have important impacts on obesity—particularly in light of research that found participating in school lunch increased children's caloric intake and body weight (Schanzenbach, 2009; Millimet et al., 2010). The Healthy Hunger-Free Kids Act (HHFKA) was passed in 2010, making dramatic reforms to nutrition standards in the National School Lunch Program (NSLP) and School Breakfast Program (SBP) and enhancing requirements for local school wellness policies governing nutrition and physical activity environments.

In this paper, we assess the relationship between school lunch participation and obesity status for the cohort of children in the Early Childhood Longitudinal Study who entered kindergarten in 2010-11 (ECLS-K:2010-11). Although HHFKA was not fully implemented until the 2012-13 school year (when the cohort studied is in second grade), we show evidence that

[1] Underweight, overweight, and obese classifications are determined based a child's BMI percentile given his/her age in months and gender. Children who are at or above the 85^{th} percentile on CDC 2000 growth charts are considered overweight and children at or above the 95^{th} percentile are considered obese.

some schools began making changes to improve the nutritional quality of their school meals prior to the full implementation of the law, potentially spurred by national attention to the issues of childhood obesity or in anticipation of the implementation of the new school meals standards. We also investigate the change in the relationship between school lunch participation and obesity over time, by comparing the ECLS-K cohort that entered kindergarten in 2010-11 with the cohort that entered in 1998-99.

We address two key questions of interest in this paper. First, using data from two waves of surveys on school lunch menus, we measure changes in the nutrient content of school meals during the 2000s—both overall and across socio-economic status of schools. The timing of these surveys roughly match the years covered by the two ECLS-K cohorts, which allows us to relate changes in lunch menus between these two surveys to observed changes in obesity and overweight. We show that over time school lunches become healthier across the board.

Second, we estimate the relationship between school lunch participation and the rate of weight gain from the beginning of kindergarten through 5th grade. We compare these findings to earlier work using a previous wave of ECLS-K data that followed a cohort of children entering kindergarten in 1998-99. Our results suggest that in recent years there is limited relationship between eating school lunches and weight gain, contrasting with prior studies. We generally find small and not statistically significant effects of school lunch participation on weight gain. This suggests that changes in the nutritional content of school meals during the 2000s improved obesity outcomes for children who eat them relative to those who bring lunches from home.

II. Background and literature review

a. Overview of the NSLP and HHFKA

The National School Lunch Program was originally created in 1946 out of concern that malnourishment was affecting national security and welfare. Today, the program (together with the National School Breakfast Program) plays an important dual role of being the front line of defense against childhood hunger and a vehicle through which policy can encourage healthy eating.[2] Nearly all public schools participate in the school lunch program and the NSLP provides lunch to more than half of all students in the U.S. each school day.[3] Participating schools receive cash reimbursements for meals served subject to two conditions. First, all meals provided are to meet federal nutritional requirements. Second, meals must be available at a free or discounted rate for students who come from families with incomes at or below 185 percent of the federal poverty level.[4] In 2014, the NSLP cost $11.3 billion, an amount almost double its 1990 level, after adjusting for inflation (Hoynes and Schanzenbach, 2016).

Prior to the implementation of the HHFKA, school lunches were required to meet a minimum number of calories (633 for grades K-3, 785 for grades 4-12, and an optional minimum of 825 for grades 7-12), to ensure that no more than 10 percent of the meal's calories came from saturated fats, and to meet minimum levels of daily fruits and vegetables, meats, grains, and milk. The HHFKA modified these standards by reducing the minimum calorie requirements,

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[2] The NSLP also helps keep farming market prices steady because it uses USDA federal surplus commodities as part of the foods sold to schools.

[3] The NSLP serves roughly 30 million children across 95,000 schools each year. This includes students eligible for free/reduced price meals, as well as students who are ineligible but buy lunch at school. In 2010, there were a total of 98,817 public elementary and secondary schools in the U.S. serving 49.5 million children, implying a child-level participation rate of 61% and near-universal school participation. See https://crsreports.congress.gov/product/pdf/R/R46234 and https://nces.ed.gov/pubs2017/2017094.pdf

[4] Students from families with incomes at or below 130 percent of the poverty line are eligible for free lunch and students from families with incomes between 130 and 185 percent of the poverty line are eligible for reduced price meals, see http://www.fns.usda.gov/sites/default/files/NSLPFactSheet.pdf

adding requirements for the *maximum* number of calories provided in an average meal (650 for students in grades K-5, 700 for students in grades 6-8, and 850 for students in grades 9-12), and increasing nutritional requirements. These nutritional requirements include specific weekly requirements for a variety of vegetables (such as dark green, red/orange, legumes, and starchy), a shift to sources of lean protein, restrictions on the fat content of milk (must be low-fat or fat-free), a phased-in requirement to use only whole grain rich grains, and a phased-in limit on the amount of sodium in the average meal.[5] Schools meeting these enhanced nutrition requirements received an additional 6-cent reimbursement payment per meal.

Perhaps unsurprisingly, phasing in these requirements was not without challenges. Some school districts struggled to meet the new standards and many schools noted increased plate waste and declining participation rates (Murphy 2015). Some students took to social media to protest the new meal standards, posting pictures of their smaller, unappetizing lunches along with the hashtag #ThanksMichelleObama.[6] However, this may in large part reflect typical implementation challenges associated with any significant change in practice—and, indeed, there is evidence that plate waste has decreased over time (Cohen et al., 2014; Schwartz et al., 2015).

b. Literature review

Evaluating the school meal program overall is difficult because it is challenging to identify a credible research design. Since almost all schools offer the NSLP and nutrition standards are generally set at the federal level, there is relatively little plausibly exogenous program variation of the type that researchers can use to isolate its impact. Further, students who select into school meals are likely different than those who do not participate across both

[5] http://www.fns.usda.gov/sites/default/files/dietaryspecs.pdf
[6] Michelle Obama championed the HHFKA legislation, see https://letsmove.obamawhitehouse.archives.gov/first-lady-column-healthy-hunger-free-kids-act.

observable and unobservable dimensions. For example, low-income children are more likely to participate in the program, in part because they are eligible to receive the meal free-of-cost or at a reduced price. Because low-income children are more likely to participate in the NSLP *and* because their outcomes are systematically different even in the absence of the program (e.g., they are more likely to be overweight/obese at kindergarten entry, have lower performance on academic tests, etc.), a regression that does not adequately address potential omitted variables would yield a biased estimate of the relationship between NSLP participation and outcomes. Even among higher-income children, selection into NSLP is unlikely to be random—it may be predicted by parents' preferences for preparing meals at home, the child's food preferences, etc.—and participation rates may be correlated with the food environment a child faces outside of school, similarly biasing the estimate of the relationship between participation in the NSLP and outcomes such as overweight and obesity.

Previous research, therefore, has typically employed quasi-experimental techniques to identify the causal effect of participation in the NSLP on a variety of student outcomes. Schanzenbach (2009) employs a difference-in-difference design to identify the effect of participation in school meals on obesity and other outcomes using the earlier 1998-99 ECLS-K cohort of kindergarten students. When comparing non-poor students who participate in the school lunch program to their schoolmates who do not participate, she finds that both groups enter kindergarten with similar body weights, test scores, and other characteristics. Subsequently, NSLP participants became comparatively more likely to be obese—by approximately 2 percentage points per year—compared to their peers who brought their lunch from home. Using the same ECLS-K data and employing a selection model approach, Millimet, Tchernis, and Husain (2010) also find evidence that participation in school lunch increases body weight and the likelihood a child is obese among the full range of lunch participants (including free, reduced-price, and paid participants). In contrast, Gundersen, Kreider, and Pepper (2012) using NHANES data and a nonparametric bounding approach, find that NSLP participation across the entire student population *reduced* the incidence of poor child health and obesity. Findings on the effect of participation in the NSLP from the period prior to HHFKA are arguably somewhat mixed, though this may in part reflect heterogeneous treatment effects across the income distribution.[7]

In addition to obesity and health impacts, researchers have also investigated how NSLP affects other aspects of participants' lives, such as academic achievement and food insecurity. Comparing differences in dietary intake between summer months and the school year using a difference-in-difference approach, Nord and Romig (2006) find that NSLP availability significantly decreases food insecurity rates.

Considering academic outcomes, Schwartz and Rothbart (2020) find that providing school meals free of charge to all students in New York City middle schools substantially increases participation in school lunch for both lower-income and higher-income students and improves math and reading performance in both groups. Ruffini (2022) uses within- and across-state variation in the availability of the Community Eligibility Provision (CEP), which provides financial incentives for schools and districts to offer universally free school meals. Consistent with the New York City work, she finds sizeable increases in meal participation and some evidence of improved performance in mathematics. In related work, Gordon and Ruffini (2021)

[7] Several recent papers have examined changes in participation and student outcomes such as attendance and academic achievement when school meals—typically breakfast—are offered at no cost to all students. For example, Leos-Urbel et al. (2013) finds an increase in breakfast participation for all eligibility groups when NYC public schools shifted to universal free breakfast, with modest improvements in attendance among some subgroups.

find that universal free meals through CEP reduce suspensions in elementary schools.[8] Hinrichs (2010) uses NSLP funding changes during the initial program rollout in the 1960s to isolate long-term program impacts. He finds that increasing NSLP exposure by 10 percentage points increases completed education by one-third of a year for women and nearly 1 year for males. Similarly, though not focused on the NSLP specifically, Anderson, Gallagher, and Ramirez Ritchie (2018) show that test scores improve when schools in California contract with healthier meal providers.[9] Therefore, though the NSLP may in recent years increased overweight and obesity, there is substantial evidence documenting positive outcomes along other important dimensions.

The majority of recent NSLP research within economics uses data pre-HHFKA implementation. Some post-HHFKA literature focuses on plate waste levels and student preferences and acceptance of the new meals. For example, Cohen et al. (2014) find that plate waste levels declined, and selection of healthful foods increased, after the HHFKA mandates. Schwartz et al. (2015) find that fruit and vegetable waste decreased and fruit consumption increased post-HHFKA. Smith, Mojduszka and Chen (2021) and Valizadeh and Ng (2020) use NHANES data from 2009-2016 to assess changes in school-age children's dietary quality as measured by the Healthy Eating Index 2010 and calories. Both studies find that students' consumption of school-prepared meals becomes relatively healthier compared with home-prepared meals after HHFKA. Other research investigates changes in obesity from 2003-2018 using an interrupted time series design and finds that obesity declined among children in poverty (who are more likely to eat school meals) after HHFKA (Kenney, et al., 2020).

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[8] Marcus and Yewell (2022) find that CEP reduces households' grocery spending and improves the dietary quality of foods purchased.

[9] Belot and James (2011) also show evidence that academic outcomes improve and school absences fall in response to healthier school meals in the United Kingdom.

III. Data and methods

a. Sources of data

This paper uses data from the Early Childhood Longitudinal Study (ECLS-K) conducted by the National Center for Education Statistics (NCES), as well as the School Nutrition Dietary Assessment (SNDA) conducted by the USDA Food and Nutrition Service (FNS). In this section, we provide a brief overview of each in turn.

The ECLS-K is a panel dataset that collects information on a nationally representative sample of students in the fall of the child's kindergarten year and in the spring of kindergarten and subsequent grades. Students are administered standardized tests in math and reading. Parents, teachers, and school administrators are surveyed about a wide variety of student characteristics, including their home and school environments, providing rich data on children's early life and school experiences, contexts, and outcomes. Students are weighed and measured by the survey collectors, and we convert these measures to body mass index and calculate whether a student is obese, overweight, or underweight according to standard practices using Centers for Disease Control guidelines based on the child's gender and age in months.[10]

To date, the ECLS-K has been collected for two cohorts of students: first for the kindergarten class of 1998-99 (on which Schanzenbach 2009 and Millimet et al. 2010 were based) and more recently for the kindergarten class of 2010-11.[11] This paper primarily uses the more recent wave of ECLS-K data, covering students who entered kindergarten in the fall of 2010, with data available to follow them through the end of fifth grade. Among this cohort,

[10] A child is considered obese if their BMI falls at or above the 95th percentile for their age and gender group. Over- and underweight are similarly defined by the 85th and 5th percentiles respectively.
[11] The next ECLS-K cohort will survey the kindergarten class of 2023-24.

HHFKA was implemented during second grade, so we have some data available both before and after the school lunch policy change.

To supplement the analysis, we use data from the School Nutrition Dietary Assessment Study (SNDA), a U.S. Department of Agriculture survey of schools and school food authorities on school food environments. These data provide school-level information on demographics (such as enrollment and the share of students eligible for free lunches), the school meal program (including meal prices, participation rates by eligibility group, and the method by which menus are planned), the school food environment (including information on competitive foods, and policies and practices regarding meal times, nutrition promotion, school wellness policies, and requirements around physical activity and fitness), and the quantity and quality of the nutrient content of school meals and snacks. We use two waves of SNDA data: wave II, collected in the 1998-99 school year (coinciding with the older ECLS-K's kindergarten year), and wave IV collected in the 2009-10 school year (one year before the newer ECLS-K cohort entered kindergarten). We compare calorie contents and other nutrient metrics of meals across the two time periods in a difference-in-differences framework.

b. Analytic approach

To examine the relationship between participation in the school lunch program and childhood obesity, we estimate models of the form:

$$(1) \qquad Y_{is} = \beta_0 + \beta_1 schoollunch_{is} + \beta_2 Y\_KG\_entry_{is} + X_{is}\beta_3 + \delta_s + \varepsilon_{is}$$

where i indexes students and s indexes first grade schools.[12] Y is the child's health outcome of interest—typically a binary variable that equals one if the child is obese for their age and gender,

[12] We limit our sample to students attending public schools where the school administrator reports that the school participates in the school lunch program.

but in some cases the dependent variable is a binary variable for overweight or the student's (continuous) body mass index (BMI). The independent variable of interest, *schoollunch*, is an indicator taking a value of 1 if the parent reports his/her student usually participates in the school lunch program in 1st grade.[13] While it may be the case that some students change their school lunch participation over time, we hold participation fixed in first grade.[14] We use first grade rather than kindergarten lunch participation, as many students attend half-day kindergarten and therefore kindergarten lunch status will be less predictive of future school lunch participation. X is a vector of student and home characteristics measured at kindergarten entry including age, race, gender, mother's education, mother's employment, presence of a father in the home, language spoken at home, number of children's books in the home, birthweight, whether the child was born premature, indicators for whether the family participated in any income support programs, an indicator for participation in non-parental care prior to school entry, and controls for household income; δ are first-grade school fixed effects, and ε is the usual error term. The ECLS-K also collects biological mother's obesity status, Following Schanzenbach (2009), our primary analysis is conducted on students who are not eligible for free or reduced-price meals. This ensures that we are comparing students with similar incentives for participating in the school lunch program. Standard errors are clustered at the school level and all analyses use the appropriate survey weights.

In some models, we also include the same body weight measure used as the dependent variable (obesity, BMI, etc.) measured at kindergarten entry as a control variable. The resulting estimates are growth models, testing whether a student's increase in obesity varies by school

[13] Parents are asked: "Does {child} usually receive a complete lunch offered at school?"
[14] Unfortunately, we cannot test the sensitivity of our results to this decision, because information on student participation in the school lunch program is not collected after first grade.

lunch participation. As we will show in Table 2 below, students who participate in the school lunch program come into kindergarten with higher obesity rates than their schoolmates who do not participate in school lunch. Controlling for baseline obesity rates, as well as other characteristics of a student and her home environment, helps isolate the impact of school lunch. If, however, students who were on a more rapid obesity growth trajectory were more likely to choose to participate in the school lunch program, the resulting omitted variables bias would bias upward the coefficient on the participation variable. In addition, we compare estimates of the school lunch impact before and after HHFKA.

IV. Results

a. Changes in nutritional content

Before examining the effects of school lunch on obesity, we first provide evidence that the HHFKA and the momentum surrounding it had a meaningful impact on the nutritional content of school lunches. To do so, we analyze school menu data from two waves of the School Nutrition Dietary Assessment (SNDA), nationally representative samples of school meals conducted in years that roughly correspond to the ECLS-K cohort studied in this paper as well as the cohort studied in Schanzenbach (2009) and Millimet et al. (2010).

Table 1 presents regression results, separately by school level, of the number of calories served at lunch in the two SNDA surveys. Columns (1) through (3) stack the data across waves (1998-99 and 2009-10) and include an indicator variable for being in the later wave of data. Note that the average number of calories served at lunch in the earlier wave, represented by the constant, increases across school levels, ranging from 695 calories in elementary schools to 735 in high schools. In elementary schools, the average number of calories served in the newer wave declined by 37 calories per day compared with the older wave—a decline equal to 5 percent of the mean. Calories served also declined in middle schools, by an average of 22 calories or 3 percent of the mean. Calories served in high schools were unchanged across waves as shown in column (3). Columns (4) through (6) test for a gradient in calories by the share of students eligible for free meals, and whether that gradient changed over time. The results are only significant among high schools, where in the base year schools with a higher share eligible for free lunch served more caloric lunches. This relationship was eliminated by wave IV.

Digging further into the elementary schools that are the focus of the obesity results from the ECLS-K presented below, Figure 1 plots the relationship between the share of students eligible for free or reduced-price lunch in a school and the average calories served in their school lunch among elementary schools, using kernel-weighted local polynomial regressions. Each line represents a different wave of SNDA allowing us to explore nonparametrically how calories vary across school socio-economic status as well as how this relationship has changed over time. The red line that is generally on top corresponds to calories served in the 1998-99 school year and shows that students were served around 700 calories on average. While low-poverty schools on average served more calories at lunch than high-poverty schools, the difference between the lowest- and highest-poverty schools was around 15 calories per day. The blue solid line shows calories served in the 2009-10 school year (one year prior to kindergarten entry of the ECLS-K cohort, three years prior to the implementation of HHFKA, and the most recent data available). Gray shaded areas represent 95% confidence intervals.

Two patterns are apparent. First, in schools across the distribution of socio-economic status, the number of calories served is generally lower in the later wave of data. Among both the lowest-poverty schools and the highest-poverty schools, the average number of calories served declined by approximately 60 calories. This indicates that there were substantial changes in content of school lunches over time, perhaps due to HHFKA and/or the momentum leading up to it. Thus, there is reason to believe that the relationship between school lunch participation and obesity may have also changed. Appendix Table 1 presents summary statistics and additional measures of the nutritional content of school lunches in elementary schools, by quintile of the school's share of free lunch eligibility. These data further suggest nutritional improvements over time, such as reduction in fat and saturated fat content of lunches, while showing little change in lunch participation rates except among the lowest-poverty schools where the participation rate increased by 4 percentage points.

b. Selection into school lunch

We now turn to data from the ECLS-K to analyze the relationship between school lunch and weight gain. Participation in the school lunch program is voluntary, which poses an evaluation challenge. Of course, to the extent that students who opt to participate in school lunches are different—along observable or non-observable factors—than their peers who do not, the relationship between school lunch participation and obesity will not necessarily represent the causal impact of school lunch but will also reflect the other factors that are correlated with participation. Using the earlier panel of ECLS-K data, Schanzenbach (2009) found that, among students who were not eligible for free or reduced-price school lunch, at kindergarten entry those students who would go on to participate in the school lunch program were observationally similar to their peers who would go on to brown bag their lunches. As we show below, the same pattern does not hold in the 2010-11 panel of the ECLS-K.

Appendix Table 2 presents summary statistics for students who are not eligible for free or reduced-price lunch, separately for the 60 percent of students who typically ate school lunch in first grade (column 1) and the remainder who typically brought lunch from home (column 2). Non-poor students who eat school lunch are observably different from their brown-bagging peers across a variety of dimensions. They are more likely to be obese at kindergarten entry and at the end of every year through fifth grade and are less likely to be clinically underweight at kindergarten entry. School lunch participants are also less likely to be white and are more likely to be Black or Hispanic. Within school, there is no difference in age, gender, or health at birth as measured by birthweight or an indicator for being born premature. School lunch participants have lower test scores at kindergarten entry and continue to have lower math scores at the end of first grade. Although the sample includes only those who are not eligible for free or reduced-price meals, even among this sample, lunch participants are economically disadvantaged relative to non-participants: they have lower socio-economic status, are more likely to have been born to a teenage mother, have mothers with lower education levels, are less likely to have a father in the house, and have fewer children's books in the home. With a few exceptions, these differences are generally statistically significant, both when testing for differences between participants and non-participants overall (column 3), and when testing for within-school differences (column 4).[15]

Table 2 tests for differences in obesity rates at kindergarten entry between school lunch participants and those who do not participate, to assess selection into school lunch participation. Column 1 runs the simplest specification, regressing an indicator for obesity at kindergarten

[15] Note that one characteristic that is not significantly different is student age. This can be particularly important in studies of children's body weight because weight and height are closely related to age in months, and because children experience an "adiposity rebound"—that is, a rise in body mass index—at some point between ages 3 and 7 years. If school lunch participants were, say, systematically older, then we could potentially get a spurious relationship between lunch and obesity. While there is no systematic difference in age, we take care to not only adjust BMI by age in months (and gender), but also to control directly for age.

entry on the school lunch indicator, conditional on school fixed effects. We find that the coefficient on the school lunch indicator is positive and significant, indicating that students who eat school lunch in first grade are already 3.9 percentage points more likely to be obese when they enter kindergarten than those who bring their lunch.[16] This stands in contrast to the findings of Schanzenbach (2009) from the earlier ECLS-K wave, which found no difference in obesity by school lunch status at kindergarten entry. Column 2 additionally includes a vector of covariates including the child's age, race and gender, mother's education and employment status, presence of a father in the home, language spoken at home, number of children's books in the home, birthweight, whether the child was born premature, indicators for whether the family participated in any income support programs, an indicator for participation in non-parental care prior to school entry, and controls for household income. The addition of these covariates weakens the relationship between pre-kindergarten obesity and school lunch participation only modestly, with school lunch participants 2.4 percentage points more likely to be obese at kindergarten entry than their brown-bagging schoolmates. Column (3) adds an indicator for whether the child's biological mother is obese. While the coefficient on this covariate is large, positive and statistically significant—indicating that a child with an obese mother is 15 percentage points more likely to be obese at kindergarten entry—its inclusion has a negligible impact on the coefficient on school lunch. Finally, column (4) adds an expanded set of control variables that proxy for physical activity, including participation in school athletics and the teacher's report of the student's physical activity level, to test the sensitivity of the school lunch coefficient. The relationship between school lunch and obesity at kindergarten entry is unchanged by the addition of the expanded controls. Taken together, the results presented in Table 2 indicate that non-poor

[16] Without school fixed effects, the coefficient is 0.067 and statistically significant.

students who select into the school lunch program differ in their initial obesity levels when compared to their schoolmates who do not participate.

c. Participation in school lunch and obesity growth

In Table 3 we examine how participation in the school lunch program influences the evolution of obesity over time. Columns (1) and (2) present the same specifications as the first two columns in Table 2, but here the dependent variable is an indicator for obesity at the end of grade 1. Results are largely the same as those for obesity at kindergarten entry, with school lunch eaters about 4 percentage points more likely to be obese than their schoolmates who do not eat school lunch (column 1), and 3 points more likely after covariates are controlled (column 2). However, once we control for students' initial obesity status in columns (3)-(5), the estimates change dramatically and become small and statistically insignificant. With this addition, we now interpret the coefficient on the school lunch indicator as a growth rate, describing the change in obesity rates by the end of first grade relative to the beginning of kindergarten. Column (3), controlling for standard covariates, obesity at kindergarten entry, and school fixed effects, shows an insignificant 0.008 coefficient on school lunch participation. Column (4) adds mother's obesity status, which does not impact the coefficient on school lunch participation but itself predicts a 4 percentage-point increase in obesity conditional on fall kindergarten status. The addition of the expanded controls in column (5) has no meaningful impact on the coefficient of interest.

Table 4 presents the specifications from columns (2) and (4) for grades 2 through 5. Odd columns present results with first grade school fixed effects and the vector of covariates, while even columns add obesity status at kindergarten entry and mother's obesity status (our preferred model). With the exception of second grade, there is no significant relationship between school lunch participation and obesity status, after controlling for students' obesity status before entering school. Since the HHFKA policy change took effect when this cohort was in second grade, it is somewhat surprising to find a sharp, temporary increase in obesity at that time. As will be shown in Table 5, though, this aberrant result is not evident in second grade's overweight or BMI measures. Overall, we find that the positive relationship between school lunch participation and obesity that is found in the odd columns is driven by the fact that children who participate in school lunch were more likely to be obese at kindergarten entry. After controlling for this initial selection, the relationship between school lunch participation and obesity diminishes sharply and is generally not statistically significantly different from zero. For example, by 5th grade, the coefficient on school lunch (shown in column 8) represents a statistically insignificant 0.3 percentage point decline in obesity. Note that the coefficient on mother's obesity status increases across grade levels.[17]

Obesity is only one weight outcome of interest and reflects the share of students above one particular cut point (since obesity is defined as a BMI above the 95th percentile of a baseline distribution). We next investigate the relationship between school meal participation and two other measures of body weight: log BMI and the incidence of overweight (i.e., BMI above the 85th percentile of a baseline distribution).[18] All regression models present our preferred specification, which includes student-level covariates, school fixed effects, mother's obesity status, and measures of the outcome variable at kindergarten entry. Columns (1) through (5) of Table 5 investigate overweight. After controlling for the baseline rate of overweight, students

[17] As was the case in Table 3, coefficients on school lunch and kindergarten obesity are little changed by the inclusion of mother's obesity status. (Results available upon request).
[18] We also report estimates of BMI levels in Appendix Table 3. Results mirror those of log BMI.

who eat school lunch are statistically no more likely to be overweight at the end of any subsequent grades, and the estimated coefficients are modest. Columns (6) through (10) investigate log BMI, finding a similar pattern, with the exception of grade 1 where the estimate is statistically significant but small in magnitude.

d. Heterogeneous Treatment Effects

While school lunch participation does not generally predict weight gain in the overall sample, selection and treatment may differ in important ways across subgroups. In Table 6, we present results separately by gender and socioeconomic status.[19] Panel A presents results separately by gender. As shown in the row marked “control group mean,” boys in the control group are more likely to be obese than girls starting in second grade—by fifth grade 15.9 percent of brown bagging boys are obese compared to 9.1% percent of girls. There is also greater selection into eating school lunch for boys, with boys who eat school lunch in grade 1 entering kindergarten 3.5 percentage points more likely to be obese than boys who bring lunch from home. For girls, there is no significant difference in obesity at kindergarten entry.

Overall, we find that the eating school lunch significantly increases obesity rates in second grade for both boys and girls, consistent with the aggregate results shown in Table 4. Treatment effects appear to be similar by gender in early years but diverge as children age. (Recall that school lunch status is measured only in first grade, so this does not represent differential selection into school lunch by grade.) Though the difference in treatment effects for boys and girls is only significant in grade 5, we start to see the pattern that boys are more

[19]Ideally, we would also provide estimates showing heterogeneity by race. Unfortunately, after filtering our sample to students above 185% of the poverty line and accounting for school fixed effects (limiting our sample to schools with more than one student of a given subgroup in the survey), we do not have a large enough sample of Black or Hispanic students to provide precise estimates.

negatively affected by school lunch participation than girls are as early as third grade. This difference does not seem to be explained by differences in levels of physical activity—in unreported results we find no significant differences across lunch status-gender pairs in terms of teacher-reported activity levels, and the coefficient on school lunch is little changed by including a broader set of controls that proxy for physical activity levels. Further, girls who eat school lunch (the group with the lowest growth in obesity as of grade 5) are the least likely group to participate in school sports in all years. Note that mother's obesity status is more predictive of daughters' obesity than of sons'.

We next turn to heterogeneity by socioeconomic status in panel B. To measure socioeconomic status, we use the index provided by the ECLS-K, which is an average of standardized values of parental education, occupational prestige score, and household income. This index is reported on a scale of -3 to 3, and we bin the full sample of ECLS-K students (before filtering to our >185% poverty line sample) into SES quintiles based on this index. After filtering to our analysis sample, 36.9% of students in our sample come from the top SES quintile. Unsurprisingly, given that we limit our sample to students whose families earn enough income to make them ineligible for reduced price lunch, just 10% of our students come from the bottom 40% of the SES distribution.[20]

Panel B shows results separately for students from the top SES quintile and those in quintiles 1-4. Here we find striking differences in the impact of lunch participation by SES. High SES students who participate in school lunch are significantly more likely to become obese than their high SES schoolmates who do not participate in grades 1 through 4, with large and positive coefficients across all grades. In contrast, the relationship between school lunch participation and

[20] SES quintile 3 makes up 21% of the analysis sample, and quintiles 4 and 5 make up 32% and 37%, respectively.

obesity growth is small, not statistically significant, and often even negative students from SES quintiles 1-4 across all grades. Note that the relative relationship between mother's obesity and child's obesity changes across grades, with mother's obesity more predictive for lower SES groups in grades K-2, and less predictive in grades 3-5.

To further understand what may be driving differences across SES in the school lunch effect, we investigate differences in selection and treatment by SES. First, we note that lower-SES students are over twice as likely to be obese at kindergarten entry than top SES students (14.1 percent vs. 6.5 percent in the full sample; 9.5 percent vs. 5.3 percent in the control groups). In addition, the quality of lunch served may systematically differ across schools that are more likely to be attended by students from different parts of the SES distribution. For example, as shown in Appendix Table 1, schools that have a low share of students eligible for free lunches tend to serve more-caloric lunches, with higher amounts of fat and sodium, than schools with a higher share of students eligible for free lunches. This may reflect the need for low-poverty schools, for whom a smaller share of students receive lunch for free, to compete more aggressively to offer lunches that are more appealing to children than their outside option of brown bagging lunch.[21] One way to investigate whether the difference in the impact of school lunch is driven by cross-school treatment differences is to test whether there are differences in the impact of school lunch on obesity growth by SES within schools. Appendix Table 4 shows results of this exercise, which is estimated on the set of schools in which at least one top SES student and one student from SES groups 1-4 were sampled. In these regressions, we add an interaction term between top-SES and the school lunch indicator to our regression specification

[21] The difference between school lunch and brown bag lunch across school income level may be even larger if parents in low-poverty schools pack healthier lunches than those in higher-poverty schools. We do not have data to directly test this, however.

from Equation 1. If socioeconomic differences in the effect of school lunch on obesity are driven by differences in the types of lunches served across schools, we would expect no significant differences in treatment effects by SES. Indeed, this is what we find. As before, we find that obesity is only significantly affected by school lunch participation in second grade, and participation does not differentially impact students by SES (though the estimates are imprecise). These results suggest that the cross-SES differences are driven by different school-level treatment effects. School lunches are associated with gains in obesity rates more strongly in schools that are more likely to be attended by high SES students.

To summarize our results so far, we find minimal effects of school lunch participation on childhood obesity in aggregate, though this is not the case for all subgroups. We find suggestive evidence that boys who eat school lunch are more likely to become obese than those who bring lunch from home, but no such relationship for girls. We also found that the effect of school lunches on obesity is larger for students in the top SES quintile, a difference that is appears to be primarily due to differences in the nutritional content of lunches across schools rather than differences in the effects of lunches by SES within schools.

e. Changes Across Cohorts

In the final set of results, we relate our findings from the ECLS-K: 2010-2011 to those from the ECLS-K: 1998-1999 to asses how impacts of school lunch participation have changed over time. Across samples, only grades 1, 3, and 5 are available in both data sets.[22] For each grade, we estimate the following regression model:

[22] We also drop biological mother's weight from the set of controls as this is not available in the 1998-1999 cohort and impute income as the midpoint of categorical income ranges as the continuous income variable is only available in the more recent survey. Additionally, in the 1998-1999 survey, school administrators do not report NSLP

$$Y_{is} = \beta_0 + \beta_1 schoollunch_{is} + \beta_2 Y\_KG\_entry_{is} + X_{is}\beta_3 + \beta_4 ECLSK{:}2010 \times schoollunch_{is} + \delta_s + \varepsilon_{is}$$

1

Our coefficient of interest is β_4, which captures the difference in treatment effects between the 1998-1999 cohort and the 2010-2011 cohort. A negative coefficient implies that the effect of school lunch participation on weight gain has decreased over time, while a positive coefficient would mean the causal effect has grown stronger.

Table 7 reports results from Equation 2. First, note that in the 1998 cohort, eating school lunch predicts a 2.7-3.8 percentage point increase in obesity rates across all three grade levels. Though the coefficients on the interaction between the 2010 cohort indicator and the school lunch indicator are not significant, they are negative and relatively large in magnitude (between 1.9 and 3.5 percentage points) in all three grades, and the joint test of eat school lunch and the interaction term is not statistically significantly different from zero. This suggests there has been a significant decrease in the relationship between school lunches and obesity across cohorts.

f. Additional Robustness Checks

We conclude our analysis by exploring the robustness of our results to various sample and specification choices. First, we repeat our primary analysis on a balanced sample. For the analysis up to this point, we have only required children to be present in our data in kindergarten and first grade, otherwise allowing children to drop out of the sample between years. This results in a fifth-grade sample that is 69% of the size of the initial cohort of kindergarteners. To evaluate

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participation status. However, parents are asked whether their school offers the program, so we follow the previous literature by defining school-level NSLP participation based on the modal parent response to this question. We then filter the analysis sample to the subset of schools that meet this screen (i.e., schools where at least half of the parents who responded reported that their school offers NSLP).

whether selection in this attrition affects our estimates, Appendix Table 5 replicates Table 4 but uses only those students who are present in the data in all six years, yielding a sample of 2,490 students.[23] Results are nearly identical to those in Tables 3 and 4; with the exception of second grade, there is no significant difference in changes in obesity status for school lunch participants and brownbaggers.

Next, we again replicate Table 4, but dropping any students who report receiving free or reduced-price lunch. Based on individual eligibility standards, students whose household income is above 185% of the poverty line are not eligible for free or reduced-price lunches. For the primary analysis, we limit our sample to students whose family incomes are above this threshold to compare children whose financial incentives for school lunch participation are the same.[24] However, in schools or districts with high shares of students receiving free or reduced-price lunch, sometimes all students receive subsidized meals, regardless of their individual income status. In Appendix Table 6, we present results where we additionally drop school lunch participants above the income cutoff who report receiving lunches for free or at reduced-price. Despite the bias that this asymmetric filter induces, our results remain largely unchanged, assuaging concerns that our results are driven by the small handful of non-poor children receiving free or reduced-price meals.

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[23] This sample is slightly smaller than the sample of fifth graders studied in Columns 7 and 8 of Table 4. The reason for this is that some students may drop out of the sample in certain years but return in future ones. This could happen, for example, if a student is absent from school on the days of the height and weight measurements.

[24] Up to this point, we have kept students whose families have incomes above 185% of the poverty line but who nonetheless receive subsidized lunches in our analysis sample, because parents are only asked about the price they pay for school lunches if they first report that their child eats school lunch. As a result, any filtering we do on access to free or reduced-price meals (on top of the income requirement) will only drop eligible students who take up the offer of subsidized lunch, not those who have the option available but who bring lunch from home instead. Since this could introduce selection bias to our estimates, in our primary analysis we choose to filter only on the income criterion, which we can apply to all students, regardless of lunch participation status.

Appendix Tables 7 and 8 break down the alternate dependent variables (overweight and log BMI) by SES and gender. When using log BMI and overweight as outcomes, results are largely insignificant across gender, with the exception of grade 5, when boys who buy school lunch have 1.9% higher BMI's than boys who bring lunch from home. Looking instead at SES, again the pattern mirrors that of our headline obesity results. The effect of school lunch participation on both overweight and log BMI is small, insignificant, and often negative in sign across all grades for SES quintile 1-4 students. In contrast, top SES students who eat school lunch experience significantly larger growth in overweight rates and BMI than their top SES peers who bring lunch from home. Across grade levels, estimates range from 0.8-5.8 percentage point increases in overweight and 0.9-2.2 percent increases in BMI.

We also report heterogeneity estimates for the cross-ECLS cohort analysis. Appendix Table 9 reports estimates of the regression specification in Equation 2 estimated separately by gender and SES. We again find decreases in the effects of school lunch participation on obesity, though our results are not precise enough to rule out small increases. Notably, when looking at SES in Panel B, we see that in the 1998 ECLS-K cohort, there is a smaller gradient in the effect of school lunch participation on obesity than there is in the 2010 cohort. This further supports our hypothesis that the difference in treatment effects between top and lower SES students that we observe in the 2010 sample is a product of differential enforcement of HHFKA-era reforms across schools serving different populations of students, rather than a disparity that has been persistent across time.

Finally, we explore how obesity evolves during kindergarten by half-day status. Our growth rate model will capture any changes in obesity status that occur between kindergarten entry and the school year in question. One concern with this model could be that students who attend kindergarten full day (and therefore eat lunch at school) receive an extra year of "treatment" relative to students who attend half-day kindergarten, who likely eat lunch away from school. If half-day kindergarten status is correlated with future school lunch participation, this difference in exposure to school lunches could bias our estimates.

To address this, we evaluate growth in obesity rates over the course of kindergarten. Because students are weighed and measured in both the fall and the spring of their kindergarten year, we can measure the change in obesity rates during the course of that year and evaluate whether they differ by half-day status and/or school lunch participation in grade 1 (our proxy for school lunch participation in all years). Appendix Table 10 presents these results. Column 1 pools all kindergarteners together and shows the average change in obesity for all students using our preferred specification. Here we see there is no significant evidence that future school lunch participation predicts weight gain during kindergarten in aggregate. Columns 2 and 3 repeat this exercise on the samples of half-day and full-day kindergarten students respectively. Again, there is no evidence of weight gain due to future school lunch status during kindergarten. Finally, in Column 4 we pool full-day and half-day students and include an interaction term between half-day status and school lunch participation in first grade. This allows us to directly test whether students who attend kindergarten full day and eat school lunch in the future (i.e., those who may receive an extra year of treatment) gain more weight throughout kindergarten than other students. Again, we see no significant differences, either by half-day status or by future school lunch participation.

V. Summary and Conclusions

Given the importance of childhood obesity to public health, and the potentially important role that the school lunch program has in addressing it, the results of this analysis should be interpreted—with caution—as good news. We find that among students who are ineligible for free or reduced-price school lunches there is generally no large or statistically significant relationship between school lunch participation and growth in obesity rates across grades K through 5. This stands in contrast to similar work on an earlier cohort of data that found a substantial, positive impact of school lunch participation on obesity in the early grades.

In recent years, the growth in obesity rate among 6 to 11 year-olds has leveled off, after climbing rapidly between 1980 and 2000 (Anderson, Butcher, and Schanzenbach, 2019). It is possible that changes in the school lunch program have contributed to this flattening. While our data do not allow us to speak directly to the HHFKA reforms and their role in changing the quality of school meals, we find some direct evidence that school meals became healthier over our study time period, as measured by calories and other dietary metrics, prior to the implementation of HHFKA.

Without question, further research is needed. When additional data are available, more direct analysis of the impact of HHFKA—including its effects on nutritional quality of school meals as well as participation in the program—will be of great interest. Further, this paper is limited to the role of school lunches on obesity growth among elementary school age students, while the reforms may have had different impacts on students in middle and high school. Nonetheless, this evaluation of recent impacts of the school lunch program suggests that recent changes to the program have reversed the earlier, troublesome relationship between school lunch participation and obesity.

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Table 1: Calories Served by School Level

	Dependent variable:					
	Calories served					
	Elementary	Middle	High	Elementary	Middle	High
	(1)	(2)	(3)	(4)	(5)	(6)
SNDA-IV	-36.9***	-21.7**	-2.8	-25.6*	-36.5**	19.6
	(7.4)	(8.5)	(9.7)	(14.5)	(16.2)	(16.9)
Share free lunch eligible				-9.2	-39.7	63.7*
				(22.5)	(30.4)	(37.6)
SNDA-IV * Share free				-22.1	48.6	-66.2
				(29.7)	(38.0)	(45.7)
Constant	695.3***	711.9***	735.3***	696.2***	725.0***	721.8***
	(5.2)	(6.1)	(7.2)	(9.7)	(11.1)	(11.7)
Observations	693	606	602	646	567	564
R^2	0.03	0.01	0.00	0.04	0.01	0.01

Notes: Data from USDA's School Nutrition Dietary Assessment study, waves II (1998-99 school year) and IV (2009-10 school year). A school is classified as an elementary school if either the lowest grade is between pre-kindergarten and grade 3 OR the lowest grade is 4 or 5 and the highest grade is less than 8. Note that this means K-8 and K-12 schools are classified as elementary schools. Middle schools are schools where either the lowest grade is 4 or 5 and the highest grade is 8 or higher OR the lowest grade is between 6 and 9 and the highest grade is less than 10. High schools are schools where the lowest grade is between 6 and 9 and the highest grade is 10 or higher OR the lowest grade is 10 or higher. *** p<0.01, ** p<0.05, * p<0.1.

Table 2: Obesity at Kindergarten Entry

	(1)	(2)	(3)	(4)
Eat school lunch (1st grade)	0.039^{***}	0.028^{**}	0.024^{*}	0.027^{**}
	(0.014)	(0.013)	(0.013)	(0.013)
Mother is obese			0.154^{***}	0.149^{***}
			(0.023)	(0.023)
School FEs	Y	Y	Y	Y
Include standard covariates	N	Y	Y	Y
Include expanded covariates	N	N	N	Y
Observations	4,090	4,090	4,090	4,090
Adjusted R^2	0.101	0.121	0.146	0.167

Source: Authors' calculations from U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Studies Program Kindergarten Class of 2010-11 (ECLS-K:2011). Due to disclosure requirements, observations numbers are rounded to the nearest 10. Following standard practice, child obesity is an indicator variable for whether the child's BMI falls at or above the 95^{th} percentile on CDC 2000 growth charts for their age in months and gender. Standard covariates include age, race, gender, mother's education, mother's employment, presence of a father in the home, language spoken at home, number of children's books in the home, birthweight, whether the child was born premature, indicators for whether the family participated in any income support programs, an indicator for participation in non-parental care prior to school entry, and controls for household income. Biological mother's obesity status is measured only once in spring of the children's kindergarten year. All other covariates are measured in spring of grade 1. Expanded covariates include participation in school sports and teacher's assessment of child's physical activity level. *** p<0.01, ** p<0.05, * p<0.1.

Table 3: Obesity in First Grade Spring

	(1)	(2)	(3)	(4)	(5)
Eat school lunch (1st grade)	0.037***	0.029**	0.008	0.007	0.009
	(0.014)	(0.015)	(0.010)	(0.010)	(0.010)
Obese at KG entry			0.729***	0.719***	0.713***
			(0.024)	(0.025)	(0.025)
Mother is obese				0.040***	0.039**
				(0.016)	(0.015)
School FEs	Y	Y	Y	Y	Y
Include standard covariates	N	Y	Y	Y	Y
Include expanded covariates	N	N	N	N	Y
Observations	4,090	4,090	4,090	4,090	4,090
Adjusted R^2	0.113	0.125	0.601	0.601	0.604

Source: Authors' calculations from U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Studies Program Kindergarten Class of 2010-11 (ECLS-K:2011). Due to disclosure requirements, observations numbers are rounded to the nearest 10. Following standard practice, child obesity is an indicator variable for whether the child's BMI falls at or above the 95th percentile on CDC 2000 growth charts for their age in months and gender. Standard covariates include age, race, gender, mother's education, mother's employment, presence of a father in the home, language spoken at home, number of children's books in the home, birthweight, whether the child was born premature, indicators for whether the family participated in any income support programs, an indicator for participation in non-parental care prior to school entry, and controls for household income. Biological mother's obesity status is measured only once in spring of the children's kindergarten year. All other covariates are measured in spring of grade 1. Expanded covariates include participation in school sports and teacher's assessment of child's physical activity level. *** p<0.01, ** p<0.05, * p<0.1

Table 4: Obesity in Spring Grades 2-5

	Obese in 2nd Grade		Obese in 3rd Grade		Obese in 4th Grade		Obese in 5th Grade	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Eat school lunch (1st grade)	0.061***	0.030***	0.042**	0.019	0.036*	0.011	0.025	-0.003
	(0.015)	(0.011)	(0.017)	(0.014)	(0.019)	(0.016)	(0.022)	(0.019)
Obese at KG entry		0.698***		0.662***		0.583***		0.587***
		(0.028)		(0.031)		(0.033)		(0.034)
Mother is obese		0.051***		0.062***		0.084***		0.098***
		(0.017)		(0.018)		(0.024)		(0.026)
Control group mean	0.078	0.078	0.095	0.095	0.116	0.116	0.125	0.125
School FEs	Y	Y	Y	Y	Y	Y	Y	Y
Include covariates	Y	Y	Y	Y	Y	Y	Y	Y
Observations	3270	3270	3310	3310	3050	3050	2820	2820
Adjusted R^2	0.152	0.537	0.142	0.460	0.198	0.431	0.189	0.409

Source: Authors' calculations from U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Studies Program Kindergarten Class of 2010-11 (ECLS-K:2011). Due to disclosure requirements, observations numbers are rounded to the nearest 10. Following standard practice, child obesity is an indicator variable for whether the child's BMI falls at or above the 95^{th} percentile on CDC 2000 growth charts for their age in months and gender. Covariates include age, race, gender, mother's education, mother's employment, presence of a father in the home, language spoken at home, number of children's books in the home, birthweight, whether the child was born premature, indicators for whether the family participated in any income support programs, an indicator for participation in non-parental care prior to school entry, and controls for household income. Biological mother's obesity status is measured only once in spring of the children's kindergarten year. All other covariates are measured in spring of grade 1. *** p<0.01, ** p<0.05, * p<0.1

Table 5: Overweight and Log BMI in Grades 1-5

	Dependent variable:									
	Overweight					Log BMI				
	1st Grade	2nd Grade	3rd Grade	4th Grade	5th Grade	1st Grade	2nd Grade	3rd Grade	4th Grade	5th Grade
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Eat school lunch (1st grade)	0.014	0.007	0.019	-0.001	0.001	0.007**	0.007	0.005	0.006	0.004
	(0.014)	(0.016)	(0.018)	(0.019)	(0.022)	(0.003)	(0.004)	(0.006)	(0.007)	(0.008)
Dep var at KG entry	0.659***	0.605***	0.611***	0.599***	0.526***	1.001***	1.102***	1.205***	1.245***	1.234***
	(0.020)	(0.024)	(0.021)	(0.025)	(0.026)	(0.018)	(0.022)	(0.026)	(0.034)	(0.035)
Mother is obese	0.034*	0.102***	0.104***	0.115***	0.117***	0.013***	0.029***	0.031***	0.042***	0.055***
	(0.020)	(0.024)	(0.024)	(0.027)	(0.028)	(0.005)	(0.006)	(0.007)	(0.010)	(0.010)
Control group mean	0.194	0.214	0.243	0.273	0.276	2.777	2.809	2.843	2.884	2.928
School FEs	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Include covariates	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	4,090	3,270	3,310	3,050	2,820	4,090	3,270	3,310	3,050	2,820
Adjusted R^2	0.528	0.459	0.464	0.439	0.394	0.792	0.74	0.688	0.626	0.627

Source: Authors' calculations from U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Studies Program Kindergarten Class of 2010-11 (ECLS-K:2011). Due to disclosure requirements, observations numbers are rounded to the nearest 10. Following standard practice, BMI is calculated as the child's weight in kilograms divided by the square of height in meters, and child overweight is an indicator variable for whether the child's BMI falls at or above the 85th percentile on CDC 2000 growth charts for their age in months and gender. Covariates include age, race, gender, mother's education, mother's employment, presence of a father in the home, language spoken at home, number of children's books in the home, birthweight, whether the child was born premature, indicators for whether the family participated in any income support programs, an indicator for participation in non-parental care prior to school entry, and controls for household income. Biological mother's obesity status is measured only once in spring of the children's kindergarten year. All other covariates are measured in spring of grade 1. *** p<0.01, ** p<0.05, * p<0.1

Table 6: Obesity by Gender and Socioeconomic Status

Panel A: Gender

	Male						Female					
	K	1st	2nd	3rd	4th	5th	K	1st	2nd	3rd	4th	5th
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Eat school lunch (1st grade)	0.035**	0.012	0.032*	0.030	0.042*	0.048	0.011	0.016	0.030*	0.026	0.013	-0.011
	(0.017)	(0.013)	(0.016)	(0.021)	(0.025)	(0.029)	(0.020)	(0.015)	(0.018)	(0.021)	(0.020)	(0.023)
Obese at KG entry		0.750***	0.715***	0.698***	0.615***	0.651***		0.702***	0.694***	0.658***	0.547***	0.566***
		(0.034)	(0.040)	(0.042)	(0.048)	(0.050)		(0.038)	(0.042)	(0.044)	(0.047)	(0.048)
Mother is obese	0.131***	0.023	0.052**	0.057**	0.078**	0.085**	0.193***	0.050**	0.072***	0.100***	0.099***	0.121***
	(0.028)	(0.019)	(0.021)	(0.027)	(0.034)	(0.037)	(0.038)	(0.021)	(0.027)	(0.030)	(0.037)	(0.040)
Control group mean	0.070	0.067	0.087	0.105	0.132	0.159	0.084	0.073	0.069	0.085	0.100	0.091
Observations	2,100	2,100	1,680	1,700	1,540	1,420	1,980	1,980	1,590	1,620	1,500	1,390
Adjusted R^2	0.187	0.65	0.598	0.47	0.455	0.463	0.159	0.588	0.544	0.496	0.429	0.419

Panel B: SES

	SES Quintiles 1-4						SES Quintile 5					
	K	1st	2nd	3rd	4th	5th	K	1st	2nd	3rd	4th	5th
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Eat school lunch (1st grade)	0.013	-0.013	0.017	0.003	-0.005	-0.019	0.031	0.035***	0.048**	0.043**	0.040*	0.032
	(0.018)	(0.015)	(0.016)	(0.019)	(0.024)	(0.028)	(0.021)	(0.012)	(0.020)	(0.021)	(0.023)	(0.024)
Obese at KG entry		0.739***	0.718***	0.711***	0.613***	0.612***		0.659***	0.591***	0.511***	0.439***	0.437***
		(0.028)	(0.032)	(0.035)	(0.039)	(0.039)		(0.055)	(0.067)	(0.069)	(0.065)	(0.075)
Mother is obese	0.165***	0.038**	0.059***	0.050**	0.060**	0.082**	0.102**	0.026	0.035	0.102***	0.179***	0.151**
	(0.029)	(0.019)	(0.022)	(0.023)	(0.029)	(0.033)	(0.040)	(0.020)	(0.030)	(0.038)	(0.050)	(0.059)
Control group mean	0.095	0.100	0.109	0.130	0.159	0.164	0.053	0.029	0.036	0.049	0.058	0.073
Observations	2,560	2,560	1,980	2,020	1,840	1,690	1,520	1,520	1,290	1,290	1,210	1,120
Adjusted R^2	0.148	0.614	0.567	0.486	0.454	0.439	0.126	0.544	0.373	0.273	0.269	0.221

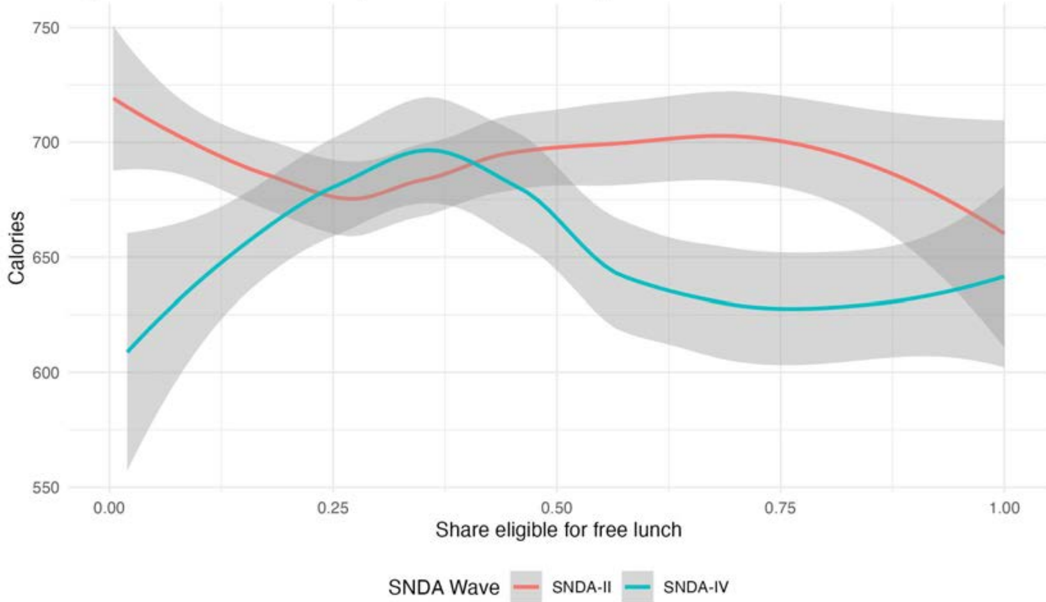
Source: Authors' calculations from U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Studies Program Kindergarten Class of 2010-11 (ECLS-K:2011). Due to disclosure requirements, observations numbers are rounded to the nearest 10. Following standard practice, child obesity is an indicator variable for whether the child's BMI falls at or above the 95^{th} percentile on CDC 2000 growth charts for their age in months and gender. Covariates include age, race, gender, mother's education, mother's employment, presence of a father in the home, language spoken at home, number of children's books in the home, birthweight, whether the child was born premature, indicators for whether the family participated in any income support programs, an indicator for participation in non-parental care prior to school entry, and controls for household income. Biological mother's obesity status is measured only once in spring of the children's kindergarten year. All other covariates are measured in spring of grade 1. *** p<0.01, ** p<0.05, * p<0.1

Table 7: Obesity Outcomes Across ECLS Cohorts

	Dependent variable:		
	Obesity in 1st grade	Obesity in 3rd grade	Obesity in 5th grade
	(1)	(2)	(3)
Eat school lunch (1st grade)	0.027**	0.038**	0.031
	(0.012)	(0.016)	(0.023)
Obese at KG entry	0.715***	0.694***	0.602***
	(0.018)	(0.020)	(0.026)
ECLS-K:2011 * Eat school lunch	-0.020	-0.019	-0.035
	(0.015)	(0.021)	(0.029)
School FEs	Y	Y	Y
Include covariates	Y	Y	Y
Observations	9,480	7,630	6,310
Adjusted R^2	0.558	0.442	0.411

Source: Authors' calculations from U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Studies Program Kindergarten Class of 2010-11 (ECLS-K:2011) and Early Childhood Longitudinal Studies Program Kindergarten Class of 1998-99 (ECLS-K:1999). Due to disclosure requirements, observations numbers are rounded to the nearest 10. Following standard practice, child obesity is an indicator variable for whether the child's BMI falls at or above the 95^{th} percentile on CDC 2000 growth charts for their age in months and gender. Covariates include age, race, gender, mother's education, mother's employment, presence of a father in the home, language spoken at home, number of children's books in the home, birthweight, whether the child was born premature, indicators for whether the family participated in any income support programs, an indicator for participation in non-parental care prior to school entry, and controls for household income. Covariates are measured in spring of grade 1. *** p<0.01, ** p<0.05, * p<0.1

Figure 1: Calories served by share of students eligible for free lunch



Notes: Data from USDA's School Nutrition Dietary Assessment study, waves II (1998-99 school year) and IV (2009-10 school year). A school is classified as an elementary school if either the lowest grade is between pre-kindergarten and grade 3 OR the lowest grade is 4 or 5 and the highest grade is less than 8. Note that this means K-8 and K-12 schools are classified as elementary schools. Lines reflect kernel-weighted local polynomial regressions with shaded areas representing 95% confidence intervals.

Appendix Table 1: Nutritional Content of Elementary School Meals

Quintile of share eligible for free lunch	*SNDA-II*					*SNDA-IV*				
	1	2	3	4	5	1	2	3	4	5
Calories served	705.6	681.1	690.4	697.0	690.3	643.0	688.8	669.3	645.8	632.4
Calories offered	770.6	731.5	725.5	730.0	716.8	737.6	755.7	719.7	719.7	680.8
Protein served (gm)	28.8	29.2	28.6	29.2	29.6	27.0	28.9	27.9	28.0	28.0
Carbohydrates served (gm)	91.4	87.2	89.8	89.5	86.2	84.7	93.0	89.1	87.1	84.4
Total fat served (gm)	26.0	24.9	25.2	25.9	26.2	23.1	24.0	23.7	22.0	21.7
Saturated fat served (gm)	9.5	9.1	9.0	9.1	9.4	7.5	7.6	7.5	7.1	7.0
Sodium served (mg)	1259.5	1240.5	1258.8	1272.0	1227.0	1308.2	1434.2	1348.6	1255.6	1224.6
Cholesterol served (mg)	62.4	63.3	62.3	65.0	70.4	53.7	52.3	52.9	52.6	53.2
Fiber served (gm)	6.0	6.1	6.4	6.3	6.2	5.6	6.7	6.2	6.4	6.2
Vitamin A served (mcg RE)	534.4	400.8	414.5	444.6	370.7	337.0	358.7	352.6	347.2	340.6
Vitamin C served (mg)	31.5	22.6	28.1	25.3	27.7	19.4	22.3	21.6	26.1	20.4
Calcium served (mg)	496.6	485.4	461.5	477.0	464.0	474.7	497.2	479.6	486.5	462.8
Iron served (mg)	4.4	4.3	4.4	4.4	4.4	3.9	4.3	4.3	4.1	4.1
Share eligible for free lunch	0.07	0.21	0.35	0.50	0.78	0.13	0.30	0.45	0.64	0.91
Avg. total stud part rate-lunch	0.49	0.65	0.70	0.75	0.84	0.53	0.65	0.71	0.77	0.84
Avg. total stud part rate-brk	0.07	0.16	0.24	0.31	0.47	0.14	0.21	0.32	0.40	0.52
Enrollment	582.5	480.6	454.3	503.2	455.3	497.5	364.0	444.3	477.2	445.4
# of schools	79	79	78	78	78	56	56	56	55	55

Notes: Data from USDA's School Nutrition Dietary Assessment study, waves II (1998-99 school year) and IV (2009-10 school year). A school is classified as an elementary school if either the lowest grade is between pre-kindergarten and grade 3 OR the lowest grade is 4 or 5 and the highest grade is less than 8. Note that this means K-8 and K-12 schools are classified as elementary schools. *** p<0.01, ** p<0.05, * p<0.1.

Appendix Table 2: ECLS-K Summary Statistics

	School lunch	Bag lunch	p-value of difference	p-value conditional on school FE
	(1)	(2)	(3)	(4)
Obese (Fall K)	0.143	0.077	0.000	0.006
Obese (Spring grade 1)	0.144	0.070	0.000	0.008
Obese (Spring grade 2)	0.168	0.076	0.000	0.000
Obese (Spring grade 3)	0.182	0.096	0.000	0.004
Obese (Spring grade 4)	0.196	0.109	0.000	0.005
Obese (Spring grade 5)	0.213	0.122	0.000	0.016
Underweight (Fall K)	0.021	0.045	0.001	0.009
Underweight (Spring grade 1)	0.023	0.037	0.031	0.456
White	0.665	0.742	0.000	0.001
Black	0.085	0.039	0.000	0.063
Hispanic	0.157	0.108	0.001	0.152
Female	0.477	0.482	0.760	0.300
Age at Fall K (months)	67.9	67.4	0.010	0.918
Birthweight (ounces)	117.3	118.1	0.375	0.442
Child born premature	0.093	0.088	0.585	0.899
Math score (Fall K)	0.188	0.431	0.000	0.001
Math score (Spring grade 1)	0.193	0.408	0.000	0.000
Teen mom at first birth	0.152	0.068	0.000	0.005
Mom 30+ at first birth	0.229	0.354	0.000	0.152
Mom less than HS	0.029	0.011	0.002	0.483
Mom HS exactly	0.162	0.101	0.000	0.132
Mom some college	0.411	0.289	0.000	0.004
Mom college degree or more	0.399	0.602	0.000	0.000
Mom worked	0.788	0.708	0.000	0.000
Biological mom obese	0.225	0.145	0.000	0.030
Father figure in home	0.885	0.925	0.000	0.000
Dad HS exactly	0.276	0.166	0.000	0.005
Dad college degree or more	0.345	0.548	0.000	0.000
Currently in any non-parental care	0.517	0.394	0.000	0.000
Hours per week in non-parental care	8.45	6.2	0.000	0.000
Number of siblings	1.36	1.41	0.117	0.008
Only child	0.155	0.130	0.047	0.047
SES (quintiles)	3.63	4.14	0.000	0.000
Number of children's books in house	102.9	134.0	0.000	0.000
N	2450	1640		

Source: Authors' calculations from U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Studies Program Kindergarten Class of 2010-11 (ECLS-K:2011). Due to disclosure requirements, observations numbers are rounded to the nearest 10. Following standard practice, child obesity is an indicator variable for whether the child's BMI falls at or above the 95^{th} percentile on CDC 2000 growth charts for their age in months and gender. Biological mother's obesity status is measured only once in spring of the children's kindergarten year. All variables unless otherwise noted are measured in spring of grade 1. "Mom worked" is an indicator equal to one if a maternal figure (biological, adoptive, step-, or foster) reported working (for any number of hours) in the week prior to the parent survey being administered. "Father figure in home" measures whether a male figure was listed in a parental role (including biological, adoptive, step-, or foster) in the parent survey.

Appendix Table 3: BMI Level Outcomes in Grades 1-5

	Dependent variable:				
	1st Grade Spring	2nd Grade Spring	3rd Grade Spring	4th Grade Spring	5th Grade Spring
	(1)	(2)	(3)	(4)	(5)
Eat school lunch (1st grade)	0.116**	0.13	0.103	0.123	0.084
	(0.054)	(0.081)	(0.103)	(0.135)	(0.159)
BMI at Kindergarten entry	1.053***	1.209***	1.375***	1.467***	1.527***
	(0.021)	(0.030)	(0.028)	(0.042)	(0.046)
Control group mean	16.194	16.752	17.396	18.195	19.029
School FEs	Y	Y	Y	Y	Y
Include covariates	Y	Y	Y	Y	Y
Observations	4,090	3,270	3,310	3,050	2,820
Adjusted R^2	0.809	0.752	0.719	0.661	0.638

Source: Authors' calculations from U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Studies Program Kindergarten Class of 2010-11 (ECLS-K:2011). Due to disclosure requirements, observations numbers are rounded to the nearest 10. Following standard practice, BMI is calculated as the child's weight in kilograms divided by the square of height in meters. Covariates include age, race, gender, mother's education, mother's employment, presence of a father in the home, language spoken at home, number of children's books in the home, birthweight, whether the child was born premature, indicators for whether the family participated in any income support programs, an indicator for participation in non-parental care prior to school entry, and controls for household income. Biological mother's obesity status is measured only once in spring of the children's kindergarten year. All other covariates are measured in spring of grade 1. *** p<0.01, ** p<0.05, * p<0.1

Appendix Table 5: Obesity Outcomes in Grades 1-5 (Constant Sample)

	Dependent variable:									
	Obese at 1st Grade Spring		Obese at 2nd Grade Spring		Obese at 3rd Grade Spring		Obese at 4th Grade Spring		Obese at 5th Grade Spring	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Eat school lunch (1st grade)	0.041***	0.015	0.051***	0.023*	0.047**	0.022	0.031	0.011	0.013	-0.006
	(0.015)	(0.012)	(0.016)	(0.013)	(0.018)	(0.015)	(0.019)	(0.017)	(0.021)	(0.019)
Obese at Kindergarten entry		0.706***		0.694***		0.664***		0.573***		0.574***
		(0.032)		(0.034)		(0.036)		(0.037)		(0.037)
Control group mean	0.068	0.068	0.082	0.082	0.093	0.093	0.111	0.111	0.120	0.120
School FEs	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Include covariates	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	2,490	2,490	2,490	2,490	2,490	2,490	2,490	2,490	2,490	2,490
Adjusted R^2	0.183	0.600	0.195	0.533	0.168	0.454	0.221	0.422	0.221	0.406

Source: Authors' calculations from U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Studies Program Kindergarten Class of 2010-11 (ECLS-K:2011). Due to disclosure requirements, observations numbers are rounded to the nearest 10. Following standard practice, child obesity is an indicator variable for whether the child's BMI falls at or above the 95th percentile on CDC 2000 growth charts for their age in months and gender. Covariates include age, race, gender, mother's education, mother's employment, presence of a father in the home, language spoken at home, number of children's books in the home, birthweight, whether the child was born premature, indicators for whether the family participated in any income support programs, an indicator for participation in non-parental care prior to school entry, and controls for household income. Biological mother's obesity status is measured only once in spring of the children's kindergarten year. All other covariates are measured in spring of grade 1. *** p<0.01, ** p<0.05, * p<0.1

Appendix Table 6: Obesity Outcomes in Grades 1-5 (Reports not receiving free or reduced-price lunch)

	Dependent variable:									
	Obese at 1st Grade Spring		Obese at 2nd Grade Spring		Obese at 3rd Grade Spring		Obese at 4th Grade Spring		Obese at 5th Grade Spring	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Eat school lunch (1st grade)	0.030**	0.011	0.052***	0.027**	0.037**	0.016	0.030*	0.008	0.012	-0.010
	(0.013)	(0.010)	(0.014)	(0.011)	(0.016)	(0.014)	(0.018)	(0.016)	(0.020)	(0.018)
Obese at Kindergarten entry		0.690***		0.676***		0.649***		0.576***		0.586***
		(0.029)		(0.032)		(0.036)		(0.037)		(0.039)
Control group mean	0.070	0.070	0.078	0.078	0.095	0.095	0.116	0.116	0.125	0.125
School FEs	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Include covariates	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	3,540	3,540	2,910	2,910	2,930	2,930	2,700	2,700	2,510	2,510
Adjusted R^2	0.132	0.562	0.170	0.513	0.154	0.433	0.201	0.402	0.197	0.388

Source: Authors' calculations from U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Studies Program Kindergarten Class of 2010-11 (ECLS-K:2011). Due to disclosure requirements, observations numbers are rounded to the nearest 10. Following standard practice, child obesity is an indicator variable for whether the child's BMI falls at or above the 95^{th} percentile on CDC 2000 growth charts for their age in months and gender. Covariates include age, race, gender, mother's education, mother's employment, presence of a father in the home, language spoken at home, number of children's books in the home, birthweight, whether the child was born premature, indicators for whether the family participated in any income support programs, an indicator for participation in non-parental care prior to school entry, and controls for household income. Biological mother's obesity status is measured only once in spring of the children's kindergarten year. All other covariates are measured in spring of grade 1. *** p<0.01, ** p<0.05, * p<0.1

Appendix Table 7: Overweight Outcomes by Gender and Socioeconomic Status

Panel A: Gender

	Male						Female					
	K	1st	2nd	3rd	4th	5th	K	1st	2nd	3rd	4th	5th
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Eat school lunch	0.018	0.014	0.023	0.031	0.016	0.03	0.034	0.022	0.03	0.023	0.012	0.016
(1st grade)	(0.028)	(0.019)	(0.027)	(0.025)	(0.027)	(0.035)	(0.027)	(0.020)	(0.025)	(0.027)	(0.028)	(0.032)
Overweight at		0.621***	0.579***	0.612***	0.586***	0.522***		0.696***	0.649***	0.623***	0.650***	0.560***
KG entry		(0.030)	(0.037)	(0.030)	(0.034)	(0.039)		(0.027)	(0.033)	(0.034)	(0.036)	(0.043)
Control group mean	0.228	0.193	0.228	0.276	0.306	0.314	0.221	0.194	0.200	0.210	0.240	0.238
Observations	2,100	2,100	1,680	1,700	1,540	1,420	1,980	1,980	1,590	1,620	1,500	1,390
Adjusted R^2	0.158	0.542	0.436	0.476	0.469	0.428	0.141	0.556	0.524	0.483	0.464	0.391

Panel B: SES

	SES Quintiles 1-4						Top SES Quintile					
	K	1st	2nd	3rd	4th	5th	K	1st	2nd	3rd	4th	5th
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Eat school lunch	0.007	0.006	-0.017	0.018	-0.019	-0.016	0.065**	0.008	0.058*	0.009	0.045	0.054*
(1st grade)	(0.024)	(0.017)	(0.021)	(0.025)	(0.025)	(0.031)	(0.028)	(0.024)	(0.031)	(0.029)	(0.034)	(0.033)
Overweight at		0.663***	0.633***	0.636***	0.624***	0.535***		0.579***	0.476***	0.477***	0.456***	0.433***
KG entry		(0.025)	(0.030)	(0.027)	(0.032)	(0.034)		(0.036)	(0.045)	(0.038)	(0.043)	(0.043)
Control group mean	0.268	0.230	0.262	0.299	0.340	0.350	0.167	0.144	0.150	0.168	0.181	0.178
Observations	2,560	2,560	1,980	2,020	1,840	1,690	1,520	1,520	1,290	1,290	1,210	1,120
Adjusted R^2	0.121	0.537	0.504	0.497	0.485	0.428	0.118	0.457	0.334	0.335	0.294	0.288

Source: Authors' calculations from U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Studies Program Kindergarten Class of 2010-11 (ECLS-K:2011). Due to disclosure requirements, observations numbers are rounded to the nearest 10. Following standard practice, child obesity is an indicator variable for whether the child's BMI falls at or above the 95th percentile on CDC 2000 growth charts for their age in months and gender. Covariates include age, race, gender, mother's education, mother's employment, presence of a father in the home, language spoken at home, number of children's books in the home, birthweight, whether the child was born premature, indicators for whether the family participated in any income support programs, an indicator for participation in non-parental care prior to school entry, and controls for household income. Biological mother's obesity status is measured only once in spring of the children's kindergarten year. All other covariates are measured in spring of grade 1. *** p<0.01, ** p<0.05, * p<0.1

Appendix Table 8: Log BMI Outcomes by Gender and Socioeconomic Status

Panel A: Gender

	Male						Female					
	K	1st	2nd	3rd	4th	5th	K	1st	2nd	3rd	4th	5th
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Eat school lunch	0.018**	0.005	0.006	0.004	0.001	0.019*	0.015*	0.007	0.010	0.005	0.006	0.003
(1st grade)	(0.007)	(0.004)	(0.006)	(0.009)	(0.010)	(0.011)	(0.008)	(0.004)	(0.007)	(0.008)	(0.009)	(0.010)
Log BMI at KG		1.011***	1.117***	1.240***	1.313***	1.238***		0.991***	1.081***	1.200***	1.218***	1.262***
entry		(0.026)	(0.032)	(0.044)	(0.047)	(0.064)		(0.025)	(0.034)	(0.039)	(0.051)	(0.052)
Control group mean	2.769	2.778	2.813	2.845	2.889	2.932	2.759	2.777	2.804	2.840	2.879	2.924
Observations	2,100	2,100	1,680	1,700	1,540	1,420	1,980	1,980	1,590	1,620	1,500	1,390
Adjusted R^2	0.2	0.804	0.753	0.656	0.646	0.642	0.211	0.798	0.743	0.725	0.627	0.642

Panel B: SES

	Lower SES						Top SES					
	K	1st	2nd	3rd	4th	5th	K	1st	2nd	3rd	4th	5th
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Eat school lunch	0.008	0.004	0.0002	-0.002	0.002	0.002	0.026***	0.009*	0.022**	0.016	0.022**	0.014
	(0.006)	(0.004)	(0.005)	(0.008)	(0.010)	(0.011)	(0.009)	(0.005)	(0.009)	(0.011)	(0.011)	(0.011)
Log BMI at KG		1.022***	1.131***	1.259***	1.284***	1.239***		0.908***	0.968***	1.017***	1.085***	1.132***
entry		(0.023)	(0.027)	(0.027)	(0.044)	(0.042)		(0.033)	(0.045)	(0.063)	(0.074)	(0.068)
Control group mean	2.774	2.790	2.826	2.861	2.911	2.955	2.751	2.761	2.786	2.818	2.848	2.892
Observations	2,560	2,560	1,980	2,020	1,840	1,690	1,520	1,520	1,290	1,290	1,210	1,120
Adjusted R^2	0.212	0.804	0.794	0.731	0.647	0.659	0.168	0.728	0.586	0.527	0.527	0.513

Source: Authors' calculations from U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Studies Program Kindergarten Class of 2010-11 (ECLS-K:2011). Due to disclosure requirements, observations numbers are rounded to the nearest 10. Following standard practice, child obesity is an indicator variable for whether the child's BMI falls at or above the 95th percentile on CDC 2000 growth charts for their age in months and gender. Covariates include age, race, gender, mother's education, mother's employment, presence of a father in the home, language spoken at home, number of children's books in the home, birthweight, whether the child was born premature, indicators for whether the family participated in any income support programs, an indicator for participation in non-parental care prior to school entry, and controls for household income. Biological mother's obesity status is measured only once in spring of the children's kindergarten year. All other covariates are measured in spring of grade 1. *** p<0.01, ** p<0.05, * p<0.1

Appendix Table 9: Heterogeneity in Obesity Outcomes Across ECLS Cohorts

Panel A: Gender						
	Male			Female		
	1st	3rd	5th	1st	3rd	5th
	(1)	(2)	(3)	(4)	(5)	(6)
Eat school lunch (1st	0.019	0.042**	-0.005	0.027*	0.037	0.034
	(0.017)	(0.020)	(0.029)	(0.016)	(0.024)	(0.023)
Obese at KG Entry	0.710***	0.677***	0.641***	0.720***	0.737***	0.607***
	(0.026)	(0.029)	(0.035)	(0.026)	(0.029)	(0.035)
ECLS-K:2011 * Eat school	-0.007	-0.011	0.054	-0.012	-0.009	-0.04
	(0.022)	(0.029)	(0.040)	(0.022)	(0.032)	(0.034)
Observations	4,900	3,940	3,230	4,580	3,690	3,080
Adjusted R^2	0.577	0.451	0.451	0.557	0.472	0.461
Panel B: SES						
	Middle SES			Top SES		
	1st	3rd	5th	1st	3rd	5th
	(1)	(2)	(3)	(4)	(5)	(6)
Eat school lunch (1st	0.027*	0.034	0.033	0.038**	0.045*	0.045*
	(0.015)	(0.023)	(0.036)	(0.017)	(0.024)	(0.025)
Obese at KG Entry	0.734***	0.725***	0.642***	0.641***	0.620***	0.486***
	(0.022)	(0.024)	(0.031)	(0.037)	(0.043)	(0.050)
ECLS-K:2011 * Eat school	-0.041*	-0.029	-0.055	-0.005	-0.006	-0.006
	(0.022)	(0.030)	(0.046)	(0.021)	(0.031)	(0.035)
Observations	6,080	4,760	3,890	3,400	2,860	2,420
Adjusted R^2	0.579	0.457	0.441	0.496	0.362	0.333

Source: Authors' calculations from U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Studies Program Kindergarten Class of 2010-11 (ECLS-K:2011) and Early Childhood Longitudinal Studies Program Kindergarten Class of 1998-99 (ECLS-K:1999). Due to disclosure requirements, observations numbers are rounded to the nearest 10. Following standard practice, child obesity is an indicator variable for whether the child's BMI falls at or above the 95^{th} percentile on CDC 2000 growth charts for their age in months and gender. Covariates include age, race, gender, mother's education, mother's employment, presence of a father in the home, language spoken at home, number of children's books in the home, birthweight, whether the child was born premature, indicators for whether the family participated in any income support programs, an indicator for participation in non-parental care prior to school entry, and controls for household income. Covariates are measured in spring of grade 1. *** p<0.01, ** p<0.05, * p<0.1

Appendix Table 10: Obesity in Kindergarten Spring by Half-Day Status

	Dependent variable:			
	Pooled	Half-day	Full-day	Pooled
	(1)	(2)	(3)	(4)
Eat school lunch (1st grade)	-0.004	0.007	-0.003	-0.005
	(0.009)	(0.016)	(0.009)	(0.010)
Obese at KG entry	0.736***	0.664***	0.745***	0.734***
	(0.024)	(0.050)	(0.026)	(0.024)
Attends half-day				0.014
				(0.017)
Half-day * Eat school lunch				0.014
				(0.019)
Control group mean	0.073	0.063	0.074	0.073
School FEs	Y	Y	Y	Y
Include covariates	Y	Y	Y	Y
Observations	4,080	1,020	2,990	4,000
Adjusted R^2	0.643	0.599	0.662	0.648

Source: Authors' calculations from U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Studies Program Kindergarten Class of 2010-11 (ECLS-K:2011). Due to disclosure requirements, observations numbers are rounded to the nearest 10. Following standard practice, child obesity is an indicator variable for whether the child's BMI falls at or above the 95^{th} percentile on CDC 2000 growth charts for their age in months and gender. Covariates include age, race, gender, mother's education, mother's employment, presence of a father in the home, language spoken at home, number of children's books in the home, birthweight, whether the child was born premature, indicators for whether the family participated in any income support programs, an indicator for participation in non-parental care prior to school entry, and controls for household income. Biological mother's obesity status is measured only once in spring of the children's kindergarten year. All other covariates are measured in spring of grade 1. *** p<0.01, ** p<0.05, * p<0.1