Impact of Schooling on Childhood Obesity

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Abstract

This study examines whether children's exposure to formal schooling has an effect on their weight-related health outcomes, using data from the Early Childhood Longitudinal Study-Kindergarten Class of 1998-1999 (ECLS-K). Intrigued by the fact that children at similar ages can have one more/less year of schooling on the basis of their birthdates and school districts' cut-off dates for children's kindergarten enrollment, this study created a treatment group (children whose birth dates are within three months before the cut-off date) and a comparison group (children whose birth dates are within three months after the cut-off date) in a natural experimental setting.

This study finds that schooling significantly reduces the probability of being obese (or overweight) for children who were obese (or overweight) at the beginning of Kindergarten and that it does not bring about excessive weight problem for non-obese or normal weight children at the beginning of Kindergarten. However, the beneficial effect of schooling in reducing recurrent excessive weight problem is concentrated on male, Whites, children of middle class family. Schooling adversely affect weight problem for Blacks and Hispanics. This study also finds that children who attend school in which physical education is required and located in affluent neighborhood benefit from schooling, children who attend school in a relatively poor neighborhood do not exert beneficial effect of schooling.

School policies to reduce the prevalence of excessive weight problem should be targeted to more susceptible children.

Introduction

The prevalence of school-aged (6 – 11) children's obesity has been increasingly cited as a major health concern in the U.S. in recent decades. A recent statistic shows that more than one third of children were obese (i.e., at or above the 95^{th} percentile of Body Mass Index (BMI; in kg/m^2)) (Ogden et al., 2012). Well-established previous research reports that pediatric obesity is associated not only with an increased risk for immediate physiological and psychological problems (Daniels, 2006), but also with increased risk of weight problem and morbidity in adulthood (Singh et al., 2008). The increased potential risks of comorbidities due to childhood obesity result in significant increases in health care utilization and expenditure (Trasande & Chatterjee, 2009), as well as in indirect costs such as lost school days and poor academic performance (Datar et al., 2004). Despite clear evidence about the adverse effects of childhood obesity, the cause of the rapid rise in obesity among school-aged children is still a subject of long-lasting debate.

Certainly, weight gain is attributable to an imbalance between energy intake and energy expense and a variety of environmental factors – a so called, 'obesogenic' environment – upset the energy balance directly and/or indirectly. Intrigued by the fact that the majority of children aged 6 – 11 are enrolled in schools which provide contexts for healthy eating and intense physical activity, previous studies have prioritized investigations on the impact of the specific school-related risk factor on children's energy imbalance and consequent weight gain (Cawley et al, 2012; Chriqui et al., 2013; Kim, 2012; Li & Hooker, 2010; Story et al., 2009). However, knowledge is lacking about the impact of children's schooling itself on developing or recurring obesity, using a more comprehensive viewpoint that considers multiple school-related risk factors. This study examines whether children's exposure to formal schooling has an effect on their weight-related health outcomes, considering children's demographic characteristics, their initial weight when they enter school, family socio-economic status, and school characteristics. To address our research question, we use a natural experiment created by schools' cut-off dates for children's admission to kindergarten, using data from the Early Childhood Longitudinal Study-Kindergarten Class of 1998-1999 (ECLS-K). Children are one-grade apart because they are couple months older or younger than the schools' cut-off dates, which generate a random assignment of additional year of formal schooling.

Previous Studies

Considering that most children aged 6 – 11 are enrolled in schools, numerous previous studies investigated the impact of the diverse obesogenic components inside school walls, such as a calorie-dense school nutrition program and school food policy allowing competitive foods, low levels of physical activity due to insufficient Physical Education (PE) classes, skipping breakfast and/or insufficient sleep duration, and the influence of peer (Cawley et al, 2012; Chriqui et al., 2013; Christakis & Fowler, 2007; Deshmukh-Taskar et al., 2010; Li & Hooker, 2010; Rampersaud et al., 2005; Schanzenbach, 2009).

In previous studies, school nutrition programs were reported to increase children's obesity or overweight risk. According to Li & Hooker (2010), children participating in the National School Lunch Program (NSLP) and School Breakfast Program (SBP) had a higher BMI and probability of being overweight than non-participants due to unhealthy food choices in the program. Schanzenbach (2009) found that children who eat school lunches consumed an additional 40 calories per day than children who brown bag their lunch and were more likely to be obese. Millimet et al. (2010) also found that NSLP had a detrimental effect on participating children's weight gain, while SBP reduced children's excessive weight. A review of Story et al.

(2009) and the findings of Robinson-O'Brien et al. (2010) suggested that school food policy allowing higher-fat, salty, a la carte items sold outside the formal meal program was positively associated with low-nutrition, energy-dense food consumption and the consequent higher intake of calories and daily total fat and lower intake of fruits and vegetables.

Previous research studies offer evidence that many children did not engage in recommend levels of physical activity (at least 60 minutes per day, according to the US HHS physical guideline (2008)) and that participation in physical activities has decreased significantly over the past few decades. For example, Troiano et al. (2008) reported that only 42% of children obtained the recommended amount of physical activity. Many researchers also claimed that lower physical activity can be attributed to the dramatic decrease in Physical Education in the era of academic accountability (Cawley et al., 2013; Cradock et al., 2013; Lee et al., 2007; Story et al., 2006). In fact, children spent around 1 hour per week in PE class (Datar & Sturm, 2004) and only 3.8% of elementary schools provided nationally required daily PE for students (Lee et al., 2006). Recently, Cawley et al. (2013) reported that a reduction in PE instruction time was associated with the increased probability of being obese.

Studies also identified several channels through which schooling affects children's weight. First, during the transition to formal schooling, many children may experience psychological difficulty since they are faced with a new school environment surrounded by a large group of peers and new adult authority figure and with increased academic demands (Coplan & Arbeau, 2008; Wildenger et al., 2008). Psychological difficulty and stress are more likely to be associated with children's loss of control over eating or eating disorder (Marcus & Kalachian, 2003; Morgan et al., 2002). Second, rigorous school life may bring about behavioral changes in everyday routines such as bedtime and mealtime (Wildenger et al., 2008). Evidence showed that 8% ~ 20% of school-aged children skipped breakfast (Deshmukh-Taskar et al., 2010; Siega-Riz et al., 1998) and more than one quarter of them slept fewer hours than the recommended numbers of hours (National Sleep Foundation, 2004). It has been suggested that breakfast skipping and short sleep duration has adverse impacts on children's weight through different pathways. Breakfast skippers tend to eat more energy-dense low-nutritious food at subsequent meals and to engage in lower levels of physical activity (Deshmukh-Taskar et al., 2010; Rampersaud et al., 2005). Children with short sleep duration are more likely to be exposed to metabolic alteration and circadian rhythm disruption which lead to reduced energy consumption (Mitchell, 2013; Seegers et al., 2011). Third, children may be influenced by the appearance and behaviors of friends and teachers around them. According to Christakis & Fowler (2007), children tend to choose like friends and to share attributes or jointly experience events that influence their weight. They observed that when one's friends become obese, his or her probability of being obese increases by 57%. Williams (2012) also found that obese children experience more bullying by peers and that bullied children have lower body esteem.

While prior studies have made important contributions in our understanding of the diverse risk factors of the development of obesity in children, there are several issues to be addressed. First, previous studies revealed the impact of a specific risk factor at school on children's health outcomes (Ask et al., 2006; Carrel et al., 2005; Coleman et al., 2005; Dzewaltowski et al., 2010; James et al., 2004; Sallis et al., 1997; Spiegel & Foulk, 2006; Williamson et al., 2007; Yin et al., 2005), but there has been a paucity of knowledge regarding the impact of children's schooling itself on developing obesity, from a more comprehensive viewpoint considering multiple school-related risk factors. Exceptional work of Von Hippel et al. (2007) using one-group pretest-posttest design reported that BMI growth is faster during summer vacation than during the academic year, partly due to the unstructured nature of non-school days. Our study extends their findings, using a natural experiment created by schools' cut-off dates. Second, few studies explicitly investigate whether the effect of schooling on children's weight-related outcomes, if any, is moderated by the children's gender, ethnic groups, socio-economic status as well as whether students enroll in schools with physical education requirements or schools with economically poor peers. Our study extensively examines such moderate factors in the effect of schooling on children's weight-related outcomes. Third, in order to examine weight-related outcomes thoroughly, our study uses three different weight-related outcomes; an obesity indicator, an overweight indicator and a BMI z score that are based on an age-and gender-specific BMI distribution reported by the CDC. Fourth, since obese or overweight children respond to formal schooling differently, it is important to incorporate the initial weight status in the regression model. Thus, we construct the regression model controlling for children's initial weight status and its interaction term with the treatment variable.

Data

Overview

Data for this study is gathered from the Early Childhood Longitudinal Study-Kindergarten Class of 1998-1999 (ECLS-K). Administered by the National Center for Education Statistics, ECLS-K selected nationally representative 21,260 children from 1,277 schools who were in kindergarten in the fall of 1998 using a multi-stage cluster sampling and followed them through the eighth grade (total eight waves). Direct child self-assessments as well as in-depth interviews with parents, teachers, and school administrators provide us with rich information suitable to our study.

Sample

For our natural experiment, we paid attention to three waves[1], i.e., near the beginning of Kindergarten (the fall of Kindergarten; wave 1), near the end of Kindergarten (the spring of Kindergarten; wave 2), and near the end of first grade (the spring of first grade; wave 4). We selected 1,994 children from wave 1 who met our criteria: 1) they enrolled public Kindergarten for the first time; 2) their information regarding weight-related health outcome, demography, family characteristics, and school in each wave were available; 3) each school's cut-off dates for children's kindergarten enrollment (i.e. a turn-five cut-off date based on the child's birthdate) were between Jul 30th, 1998 and Oct 16th, 1998; 4) children's birthdate was within three months before/after cut-off date[2]. Readers should be cautious that our sample is not representative of the original sample of the ECLS-K of 1998-1999. Samples included in our study were less likely to be Hispanic and earned less income at baseline than children from the original sample.

Empirical Strategy

Natural Experiment Design

In order to explore the causal inference of children's formal schooling on their weights, random assignment experimental design should be the method of first resort (Shadish et al., 2002). However, as Nathan (2002) and Von Hippel et al. (2007) point out, random assignment of children to treatment or control groups is hardly implemented due to ethical and practical issues. On the other hand, a purely cross-sectional observational study may have difficulty in finding an ideal comparison group. Even if researchers find a comparison group such as home-schooling children, they are not free from endogeneity bias in their estimates since children's exposure to formal schooling may be a parental choice along with the children's developmental growth.

[1] We do not include the fall of first grade (wave 3) and later waves (wave 5 ~ 8) since ECLS-K surveyed only 30% of baseline sample in wave 3 and at two-year intervals in later waves.
[2] We also excluded children who entered Kindergarten early or late.

In this regard, this study takes advantage of a natural experiment created by school districts' cut-off dates for children's kindergarten enrollment (i.e. a turn-five cut-off date based on the child's birthdate) where children with similar age and individual characteristics are in different grades because their birth dates are before or after school cut-off dates. Thus, the effect of the schooling can be assessed by comparing the weights of children whose birthdays are close but before the cut-off date (i.e., treatment group that has one more year of schooling) to those whose birthdays are close but after the cut-off date (i.e., comparison group that has one less year of schooling). The critical question is 'how close is close enough' to assure that samples are randomly assigned into treatment group and comparison group without sacrificing efficiency. We deliberately choose three months as a criterion of 'close' since the characteristics (other than treatment) of treatment group and comparison group are not significantly different without efficiency loss.

Panel A of Figure 1 illustrate specifics of our idea of a natural experiment. Cut-off dates reported by schools in the data are used to define the treatment group where children's birth dates are within three months before the cut-off date and the comparison group where children's birth dates are within three months after the cut-off date. As a result, children in the treatment group are among the youngest in their grade and those in the comparison group are among the oldest in their grade. In other words, children in the treatment and comparison groups are similar at age, but those in the treatment group are in a year higher grade than those in the comparison group.

[Figure 1 here]

Panel B of Figure 1 shows how such a natural experiment can apply to our data. In our analysis sample, the treatment group is defined as a group of children who were three months older than the school's cut-off dates in 1998. On the other hand, the comparison group is defined as a group of children who were three months younger than the school's cut-off dates in 1997. Thus, children in the treatment and comparison groups started Kindergarten in the same year (fall of 1998) but children in the comparison group were about one year older than those in the treatment group. As a result, children's age in the treatment group at the spring semester of 1st grade is similar to the comparison group at the spring semester of Kindergarten; children in the treatment group were among the youngest (aged 79.37 to 85 months) in the first grade while those in the comparison group were among the oldest (aged 76.07 to 82.33 months) in kindergartens. Thus, we use two different survey periods to create the analysis sample. In our analysis sample, the impact of one more year of schooling on obesity is at children's age about 81 months (6 years and 9 months) which is defined as "age on evaluation" by us. Unfortunately, we could not compare children in the treatment and comparison groups in higher grades because children were surveyed in every two years after the first grade and there is no higher grade when children in the treatment and comparison groups were aligned in similar age but different grades.

Regression Model

[Table 1 here]

In Table 1, we examine individual characteristics of children in the treatment and comparison groups and find that none of variables except for age (in month) are statistically different. Thus, as we expected, children in the treatment and comparison groups created by the school cut-off dates are virtually the same. In order to estimate the impact of one more year of formal schooling on children's obesity status, we may simply compare the obesity status of children in the treatment group with the obesity status of children in the comparison group. However, simply comparing the obesity outcome of the treatment and comparison groups may mask what happens to children who were initially obese and non-obese.

To address our question whether one more year of schooling may differently affect children's weight-related health outcome depending upon whether they were obese and non-obese at the baseline (in the fall of 1998), we construct the following regression model.

$$obese_i = \delta_1 D_i + \delta_2 obese_{ib} + \delta_3 D_i obese_{ib} + \mathbf{X_{ib}} \boldsymbol{\beta} + u_i$$

where *i* indexes the child and *b* indexes the baseline (fall of 1998). The dependent variable, $obese_i$, is equal to 1 at age on evaluation (about 81 months) if the child's body mass index (BMI) is above the 95th percentile of the age- and gender-specific BMI distribution reported by the CDC. It is 0 otherwise. $obese_{ib}$ is the obesity status at the baseline. X_{ib} is a vector of individual characteristics at the baseline presented in Table 1. D_i is equal to 1 if a child belongs in the treatment group and to 0 otherwise. Thus, δ_1 indicates the impact of one more year of schooling on the risk of obesity among the non-obese children at the baseline while δ_3 indicates the impact of one more year of schooling on the risk of obesity among the obese children at the baseline. δ_2 indicates what fraction of obese children at the baseline survey leads to being obese at age on evaluation (around 81 months).

Instead of an obesity indicator that is useful to see the extensive margin of risk of obesity, we also use two other weight-related variables. First, in order to see the different extensive margin of children's weight-related health outcomes, we use an overweight indicator, $overweight_i$, as a dependent variable that is equal to 1 at age on evaluation (about 81 months) if the child's body mass index (BMI) is above the 85 percentile of the age- and gender-specific BMI distribution reported by the CDC. It is 0 otherwise. Also, instead of $obese_{ib}$, we control for $overweight_{ib}$ as children's overweight status at the baseline survey and interact it with the treatment group indicator, D_i, in the regression model. Thus, δ_1, δ_2, and δ_3 are interpreted in the same fashion for overweight and non-overweight children as in the original regression model for obese and non-obese children.

Second, in order to examine whether the impact of one more year of schooling increases the intensive margin of children's weight-related health outcomes, we use the BMI z score instead of an obesity indicator. Thus, an age-and gender-specific BMI z score of child *i* at age on evaluation (about 81 months), $BMIzscore_i$, is used as a dependent variable. Also, $BMIzscore_{ib}$ is controlled for children's BMI z score at the baseline survey and is interacted with the treatment group indicator, D_i. Because $BMIzscore_i$ and $BMIzscore_{ib}$ are continuous variables, δ_1, δ_2, and δ_3 should be interpreted differently. δ_1 captures the impact of one more year of schooling on their BMI z score at age on evaluation (about 81 months) among the children whose BMI z score was 0 (in the middle of the BMI distribution) at the baseline. On the other hand, δ_3 indicates the impact of one more year of schooling on the BMI z score among the children whose baseline BMI z score is one standard deviation greater than other children. δ_2 indicates what change in children's BMI z score at age on evaluation (around 81 months) are explained by one standard deviation of children's BMI z score at the baseline survey.

Empirical Result

We present the estimated regression coefficients of the schooling, initial weight related health outcome, and their interaction term in Tables 2 to 4. The first column in Table 2 shows schooling effect on children's weight related health outcome among all children after controlling for individual characteristics, family socioeconomic and behavioral factors, and school location. For all children who were not obese or overweight at the beginning of Kindergarten (baseline), schooling has no noticeable impact on the probability of being obese, the probability of being overweight, and BMI z score. However, for children who were obese or overweight at baseline, schooling decreases the probability of being obese or overweight by 10.7 percentage point (i.e., 0.031 -0.138, $p<0.05$) and 2.4 percentage point (i.e., 0.034 – 0.068, $p<0.1$), respectively. For children whose BMI z score were 1 standard deviation (SD) greater than 0 at baseline, children with one more year of schooling reported 0.03 SD decrease (i.e., 0.053-0.086, $p<0.1$) in BMI z score at the end of 1st grade.

[Table 2 here]

Subgroup analysis reveals that the beneficial effect of schooling on children's weight is concentrated on male and white obese children, while the adverse effect of schooling is concentrated on black and Hispanic non-obese children. As shown in the second column of Table 2, for male children who were not obese at baseline, schooling increases the probability of being obese by 4.4 percentage point, but this difference is not statistically significant. However, for male children who were obese at baseline, schooling reduces the probability of being obese by 22.4 percentage point (i.e., 0.044 – 0.268, $p<0.01$). Similarly, for male children who were overweight at baseline, schooling reduces the probability of being overweight by 3.6 percentage point (i.e., 0.084-0.120, $p<0.05$). Compared to male children in the comparison group, male children in treatment group report 0.05 SD (i.e., 0.099-0.152, $p<0.01$) less of BMI z score when they were 1 SD greater than 0 at baseline. The third column of Table 2 demonstrates that weights of female children are not affected by schooling, regardless of their initial weight.

As depicted in the fourth and the fifth column in Table 2, White obese or overweight children at baseline have lower probability of being obese or overweight by 21.6 percentage point (i.e., 0.01-0.226, $p<0.01$) and 8.6 percentage point (i.e., 0.021-0.107, $p<0.05$), respectively, when they were exposed to one more year of schooling. For White non-obese or normal weight children at baseline, schooling does not have an adverse effect on their weight. On the contrary, for Black and Hispanic who were not obese at baseline, schooling significantly increases the probability of being obese by 8.2 percentage point ($p<0.01$). For Black and Hispanic obese or overweight children at baseline, no noticeable impact of schooling is detected.

Table 3 demonstrates that the impact of schooling on children's weight is concentrated on families whose socioeconomic status is in third quintile. Among these families, the probability of being overweight of normal weight children at baseline increases by 11.9 percentage point ($p<0.05$) when they were exposed to one more year of schooling. Interestingly, the probability of being obese of non-obese children at baseline is not significantly increased. To the contrary, the probability of being obese of obese children at baseline decreased by 34.6 percentage point (i.e., 0.07-0.416, $p<0.01$) and the probability of being overweight of overweight children at baseline decreased by 12.7 percentage point (i.e., 0.119-0.246, $p<0.01$), when they experienced one more year of schooling. When we change our dependent variable from weight-related binary variables to BMI z-score, we find that schooling equally increases BMI z score of children in these families, regardless children's initial BMI z score. For example, for children whose BMI z score was 0 at baseline, their average BMI z score is increased by 0.26 SD ($p<0.05$) after schooling. For children whose BMI z score was 1 SD greater than 0 at baseline, their average BMI z score after schooling is 0.17 SD (i.e., 0.257-0.086, $p<0.05$) greater than the average BMI z score of those who have one less year of schooling.

[Table 3 here]

In Table 4, we find that obese or overweight children enjoy beneficial effect of schooling when they attend schools in states which adopt physical education requirement policy and/ or schools with affluent neighborhood. On the other hand, non-obese or normal weight children are adversely affected by schooling when they attend schools within a neighborhood in need. As shown in the first and the second column of Table 4, when obese children at baseline attend school in states which adopt physical education requirement policy, their probability of being obese is significantly reduced by 16.7 percentage point (i.e., 0.013-0.180, $p<0.05$). Similarly, the probability of being overweight decreases by 12.4 percentage point (i.e., 0.044-0.168, $p<0.01$). However, we do not find any noticeable effect of schooling on children's weight among non-obese or normal children who attend schools with physical education requirement policy and among all children who attend schools without physical education requirement policy. Interestingly, for children whose BMI z score is 1 SD greater than 0 at baseline, average BMI z score of children with one more year in schools with physical education requirement policy is 0.05 SD (i.e., 0.129-0.074, $p<0.1$) greater than the average BMI z score in the comparison group.

[Table 4 here]

The third to fifth columns of Table 4 demonstrates that obese or overweight children are less likely to be obese or overweight when they attend school with affluent neighborhood. For obese children at the baseline who attend schools in which the percentage of students participating in free or reduced price school lunch program is less than 5 percent, the probability of being obese decreases by 37.4 percentage point (i.e., 0.019-0.393, $p<0.01$). For overweight children at the baseline who attend schools in which free or reduced price school lunch program participation rate is less than 50 percent, the probability of being overweight is reduced by 17.2 percentage point (i.e, -0.005-0.167, $p<0.01$). Similarly, for children whose BMI z score were 1 SD greater than 0 at the baseline, average BMI z score in the treatment group is 0.036 SD (i.e., 0.101-0.147) less than average BMI z score in the comparison group. We do not find any beneficial or adverse effect of schooling for non-obese or normal weight children when they attend schools with affluent neighborhood.

On the other hand, the adverse effect of schooling is concentrated on non-obese or normal weight children who attend school in impoverished neighborhood, as shown in the fifth column in Table 4. For non-obese children at the baseline, children who spend one more year in schools in which the percentage of students participating in free or reduced price school lunch program is greater than 50 percent (i.e., treatment group) are 7.9 percentage point ($p<0.05$) more likely to be obese than children who spend one less year in schools (i.e., comparison group). For normal weight children at baseline, children in the treatment group are 12.7 percentage point ($p<0.01$) more likely to be overweight, compared to children in the comparison group. On average, BMI z score of the treatment group is 0.244 SD ($p<0.05$) greater than BMI z score of the comparison group. However, for obese or overweight children at baseline who attend school in impoverished neighborhood, there was no statistical significant effect of schooling on the probability of being obese or overweight.

In sum, schooling seems to reduce the probability of being obese or overweight among obese or overweight children at baseline and to decrease (increase) BMI z score of children above (below) the mean, while it may bring about weight gain problem for Black and Hispanic children who attend school in which physical education is not required and located in impoverished neighborhood.

Discussion and Conclusion

Intrigued by the fact that the majority of children aged 6 – 11 are enrolled in schools, health professionals and policymakers have identified schools as a key setting for diverse anti-obesity strategy to reverse current prevalence of childhood obesity (IOM, 2005; HHS, 2001;

Story et al., 2009). Though numerous previous studies evaluated the impact of specific school-based intervention on children's weight in experimental setting (Ask et al., 2006; Carrel et al., 2005; Coleman et al., 2005; Dzewaltowski et al., 2010; James et al., 2004; Sallis et al., 1997; Spiegel & Foulk, 2006; Williamson et al., 2007; Yin et al., 2005), few studies examined the impact of overall schooling on children's weight in such randomly assigned experimental setting due to practical and ethical issue.

To fill the void, this study takes advantage of a natural experiment where children at similar ages can have one more/less year of schooling on the basis of their birthdates and school districts' cut-off dates for children's kindergarten enrollment, creating a treatment group and a comparison group. This study finds that schooling significantly reduces the probability of being obese (or overweight) for children who were obese (or overweight) at the beginning of Kindergarten (baseline) and that it does not bring about excessive weight problem for non-obese or normal weight children at baseline. This finding is compatible with the work of Von Hippel et al. (2007), that BMI growth is slower during the school year than during summer vacation for initially overweight children. Adding to their study, our subgroup analysis reveals that not all children benefit from schooling. That is, while schooling is beneficial in preventing recurrent excessive weight problem for male and White children of middle class family when they attend school in which physical education is required and located in affluent neighborhood, it elevates risk of being obesity or overweight for Black and Hispanic children who attend school in a relatively poor neighborhood.

We are cautious about plausible channels of how schooling affects children' weight and why schooling impact is moderated by children's individual demography, family socioeconomic status, and school characteristics in our study. From our subsample analyses and previous studies, we suggest that children may benefit from well-regulated life to be on time for school, such as keeping a sleep routine and having regular meals at a same time, as well as from structured exercise and limited access to unhealthy food in school.

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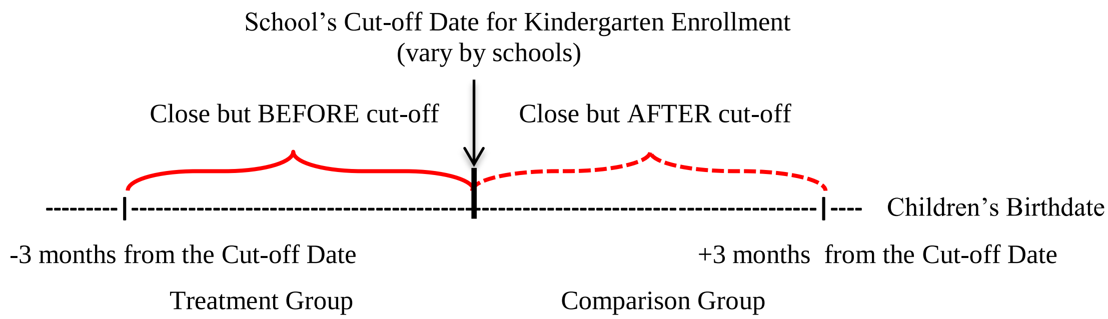
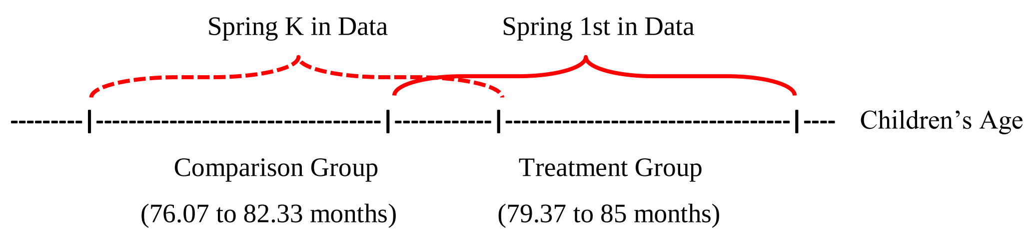
Figure 1. Treatment Group vs. Comparison Group

Panel A. Natural Experiment Idea



Panel B. Application to the Data



	Treatment Group	Comparison Group
Average Age (in month)	82.31 (1.12)	79.32 (1.19)
Grade	1st grade	Kindergarten
Obesity prevalence (%)	10.03 (30.06)	10.68 (30.90)
Overweight prevalence (%)	25.35 (43.53)	24.09 (42.78)
Average BMI z score	0.36 (1.03)	0.35 (1.03)
Average BMI percentile	60.49 (28.46)	60.33 (27.90)
# of observation	927	1067

Note: Standard deviations are in parenthesis.

Table 1. Sample Description at the Baseline Survey

	Treatment group	Comparison group	Statistical Significance At 5%
Obesity prevalence (%)	9.39 (29.18)	10.59 (30.79)	No
Overweight prevalence (%)	26.32 (44.06)	26.15 (43.96)	No
BMI z score	0.36 (1.04)	0.39 (1.02)	No
BMI percentile	60.98 (28.51)	61.17 (28.06)	No
Age (in month)	64.05 (1.21)	73.14 (1.21)	Yes
Male	48.65 (50.01)	51.92 (49.99)	No
Race/Ethnicity (%)			
White	64.40 (47.91)	67.57 (46.83)	No
Black	13.70 (34.70)	13.68 (34.38)	No
Hispanic	13.16 (33.82)	11.53 (31.95)	No
Asian	3.68 (18.81)	2.81 (16.54)	No
Other Race	5.07 (21.95)	4.40 (20.53)	No
Birth Weight (BW) Indicators (%)			
Low BW (≤ 2500g)	6.47 (24.61)	8.03 (27.19)	No
Normal BW	81.03 (39.23)	79.64 (40.29)	No
High BW (> 4000g)	12.50 (33.09)	12.33 (32.90)	No
Living with Older Adults (age ≥ 65) (%)	3.02 (17.12)	3.19 (17.57)	No
Number of Siblings			
age < 3 years	0.30 (0.52)	0.28 (0.52)	No
3 years ≤ age < 7 years	0.29 (0.50)	0.34 (0.54)	No
7 years ≤ age < 13 years	0.62 (0.75)	0.71 (0.80)	No
age ≤ 18 years	0.21 (0.59)	0.24 (0.60)	No
Participation in Pre-Kindergarten (%)	44.12 (49.68)	43.30 (49.57)	No
Family Income (in dollar)	49,130 (46,105)	47,313 (37,664)	No
Mother's Education (%)			
< High School	11.22 (31.58)	11.34 (31.72)	No
= High School	31.82 (46.60)	33.55 (47.23)	No
> High School	56.96 (49.54)	55.11 (49.76)	No
Mother's Marital Status (%)			
Single	26.32 (44.06)	26.34 (44.07)	No
Married	73.68 (44.06)	73.66 (43.07)	No
Mother's Work Experience before Kindergarten (%)	85.44 (35.29)	84.91 (35.81)	No
Mother's Average Work Hours per Week (in hours)	25.22 (19.47)	25.10 (19.56)	No
HOME Environment z score	-0.01 (1.01)	0.01 (0.97)	No
Number of Observations	927	1067	

Notes: Standard deviations are in parenthesis. Statistical difference is tested by running a regression of a treatment indicator on all control variables.

Table 2. Schooling Impact on Weight-related Health Outcome by Gender and Race/Ethnicity

	All	Male	Female	White	Black & Hispanic
Regression Analysis 1: Probability of Being Obese					
Schooling	0.031*	0.044	0.011	0.010	0.082**
	(0.017)	(0.028)	(0.023)	(0.020)	(0.037)
Obese at baseline	0.782***	0.807***	0.758***	0.823***	0.774***
	(0.038)	(0.051)	(0.054)	(0.042)	(0.079)
Schooling × Obese	-0.138**	-0.268***	0.021	-0.226***	-0.077
at baseline	(0.062)	(0.088)	(0.083)	(0.079)	(0.112)
# of Observation	1,994	1,005	989	1,318	518
R^2	0.540	0.530	0.598	0.588	0.565
Adjusted R^2	0.524	0.497	0.570	0.567	0.504
Regression Analysis 2: Probability of Being Overweight					
Schooling	0.034	0.084*	-0.011	0.021	0.046
	(0.026)	(0.039)	(0.043)	(0.037)	(0.062)
Overweight at baseline	0.801***	0.807***	0.779***	0.839***	0.761***
	(0.022)	(0.025)	(0.037)	(0.023)	(0.062)
Schooling × Overweight	-0.068*	-0.120**	-0.002	-0.107**	-0.033
at baseline	(0.038)	(0.053)	(0.056)	(0.051)	(0.082)
# of Observation	1,994	1,005	989	1,318	518
R^2	0.325	0.350	0.334	0.359	0.321
Adjusted R^2	0.301	0.304	0.287	0.327	0.225
Regression Analysis 3: BMI z score					
Schooling	0.053	0.099*	0.010	0.041	0.101
	(0.052)	(0.079)	(0.071)	(0.042)	(0.071)
BMI z-score at baseline	0.829***	0.838***	0.822***	0.811***	0.859***
	(0.024)	(0.038)	(0.029)	(0.031)	(0.042)
Schooling × BMI z score	-0.086*	-0.152***	-0.030	-0.092**	-0.019
at baseline	(0.035)	(0.054)	(0.044)	(0.044)	(0.056)
# of Observation	1,994	1,005	989	1,318	518
R^2	0.642	0.632	0.679	0.641	0.676
Adjusted R^2	0.632	0.610	0.660	0.625	0.636

Note: *** p<0.01, ** p<0.05, * p<0.1.
Note: Robust Standard Errors are used. Standard deviations are in parenthesis.
Note: Covariates include child's age (in month), gender dummy (male), race/ethnicity dummies(Black/Hispanic/Asian/Others), dummy for whether a child participated in pre-Kindergarten, child's birth weight dummies (low/high), family income (in dollars), mother's education (HS/more than HS), marital status dummy (married), dummy for whether mothers worked before Kindergarten, mother's average work hour per week, dummy for whether living with other adults (age ≥ 65), number of siblings aged 0~3, 3~7, 7~13, and under 18, dummies for each state, and dummies for HOME environment and activities (read books, tell stories, sing songs, do arts, do chores, play games, teach science, build toys, do sports, visit libraries, watch sesame street, etc.).

Table 3. Schooling Impact on Weight-related Health Outcome by SES

	Socio-Economic Status Index				
	First Quintile	Second Quintile	Third Quintile	Fourth Quintile	Fifth Quintile
Regression Analysis 1: Probability of Being Obese					
Schooling	0.008	-0.010	0.070	0.016	-0.005
	(0.045)	(0.039)	(0.043)	(0.044)	(0.032)
Obese at baseline	0.739***	0.776***	0.930***	0.823***	0.628***
	(0.105)	(0.067)	(0.040)	(0.081)	(0.122)
Schooling × Obese	0.072	-0.169	-0.416***	-0.092	-0.042
at baseline	0.008	-0.010	0.070	0.016	-0.005
# of Observation	302	451	449	424	368
R^2	0.713	0.632	0.589	0.585	0.534
Adjusted R^2	0.637	0.568	0.516	0.508	0.436
Regression Analysis 2: Probability of Being Overweight					
Schooling	-0.015	-0.023	0.119**	0.029	0.078
	(0.084)	(0.056)	(0.057)	(0.071)	(0.065)
Overweight at baseline	0.611***	0.726***	0.779***	0.684***	0.684***
	(0.081)	(0.054)	(0.055)	(0.060)	(0.087)
Schooling × Overweight	0.026	-0.096	-0.246***	-0.097	-0.119
at baseline	(0.112)	(0.092)	(0.081)	(0.090)	(0.119)
# of Observation	302	451	449	424	368
R^2	0.511	0.533	0.569	0.542	0.515
Adjusted R^2	0.381	0.451	0.493	0.458	0.412
Regression Analysis 3: BMI z score					
Schooling	0.099	0.028	0.257**	0.120	0.119
	(0.154)	(0.106)	(0.127)	(0.117)	(0.109)
BMI z-score at baseline	0.763***	0.847***	0.798***	0.898***	0.824***
	(0.059)	(0.048)	(0.054)	(0.046)	(0.049)
Schooling × BMI z score	-0.074	-0.134*	-0.086	-0.079	-0.055
at baseline	(0.084)	(0.073)	(0.076)	(0.068)	(0.080)
# of Observation	302	451	449	424	368
R^2	0.682	0.720	0.641	0.738	0.719
Adjusted R^2	0.598	0.672	0.578	0.690	0.660

Note: *** p<0.01, ** p<0.05, * p<0.1.

Note: Robust Standard Errors are used. Standard deviations are in parenthesis.

Note: Covariates include child's age (in month), gender dummy (male), race/ethnicity dummies(Black/Hispanic/Asian/Others), dummy for whether a child participated in pre-Kindergarten, child's birth weight dummies (low/high), marital status dummy (married), dummy for whether mothers worked before Kindergarten, mother's average work hour per week, dummy for whether living with other adults (age ≥ 65), number of siblings aged 0~3, 3~7, 7~13, and under 18, dummies for each state, and dummies for HOME environment and activities (read books, tell stories, sing songs, do arts, do chores, play games, teach science, build toys, do sports, visit libraries, watch sesame street, etc.).

Table 4. Schooling Impact on Weight-related Health Outcome by School Location

	Schools located in states with PE requirement		Free/Reduced meal percentage		
	Yes	No	FR meal < 5%	5 % ≤ FR meal < 50 %	FR meal ≥ 50%
Regression Analysis 1: Probability of Being Obese					
Schooling	0.013	0.041	0.019	-0.008	0.079**
	(0.018)	(0.026)	(0.029)	(0.025)	(0.037)
Obese at baseline	0.813***	0.739***	0.865***	0.718***	0.806***
	(0.044)	(0.065)	(0.065)	(0.061)	(0.067)
Schooling × Obese	-0.180**	-0.060	-0.393***	-0.080	-0.060
at baseline	(0.079)	(0.102)	(0.133)	(0.093)	(0.096)
# of Observation	1,237	751	468	928	598
R^2	0.550	0.526	0.614	0.531	0.608
Adjusted R^2	0.536	0.502	0.561	0.496	0.565
Regression Analysis 2: Probability of Being Overweight					
Schooling	0.044	0.027	0.004	-0.005	0.127**
	(0.030)	(0.039)	(0.045)	(0.040)	(0.061)
Overweight at baseline	0.731***	0.683***	0.779***	0.719***	0.655***
	(0.035)	(0.044)	(0.056)	(0.040)	(0.051)
Schooling × Overweight	-0.168***	-0.044	-0.146	-0.167***	-0.010
at baseline	(0.053)	(0.067)	(0.094)	(0.061)	(0.073)
# of Observation	1,237	751	468	928	598
R^2	0.462	0.493	0.570	0.491	0.471
Adjusted R^2	0.446	0.467	0.511	0.453	0.412
Regression Analysis 3: BMI z score					
Schooling	0.129**	0.130	0.101	0.101	0.244**
	(0.061)	(0.080)	(0.084)	(0.079)	(0.114)
BMI z-score at baseline	0.801***	0.871***	0.782***	0.849***	0.844***
	(0.030)	(0.045)	(0.045)	(0.036)	(0.040)
Schooling × BMI z score	-0.074*	-0.113*	-0.066	-0.147***	-0.029
at baseline	(0.043)	(0.062)	(0.069)	(0.057)	(0.054)
# of Observation	1,237	751	468	928	598
R^2	0.625	0.665	0.698	0.633	0.686
Adjusted R^2	0.613	0.648	0.656	0.605	0.651

Note: *** p<0.01, ** p<0.05, * p<0.1.

Note: Robust Standard Errors are used. Standard deviations are in parenthesis.

Note: Covariates include child's age (in month) gender dummy (male), race/ethnicity dummies(Black/Hispanic/Asian/Others), dummy for whether a child participated in pre-Kindergarten, child's birth weight dummies (low/high), marital status dummy (married), dummy for whether mothers worked before Kindergarten, mother's average work hour per week, dummy for whether living with other adults (age ≥ 65), number of siblings aged 0~3, 3~7, 7~13, and under 18, dummies for each state, and dummies for HOME environment and activities (read books, tell stories, sing songs, do arts, do chores, play games, teach science, build toys, do sports, visit libraries, watch sesame street, etc.).