The Influence of School on Childhood Weight Gain

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I. Introduction

Childhood overweight, defined as having a body mass index (BMI) at or above the 95th percentile, is one of the most significant health issues facing American children today. The prevalence of overweight among young U.S. school children has more than tripled over the past three decades (CDC, 2010). The dramatic increase in weight problems among children has been described as an epidemic, with public officials at a loss to explain this rapid rise in overweight among American children. Results from the 2007-2008 National Health and Nutrition Examination Survey (NHANES) indicate that about 16.9% of children aged 2-19 years are obese. From the mid 1970s to 2008 obesity increased from 5.0% to 10.4% among children aged 2-5 years, from 6.5% to 19.6% among those aged 6-11 years, and during the same time period obesity increased from 5.0% to 18.1% among adolescents aged 12-19 years. Weight problems are especially prevalent among black and Hispanic school children, 20% of whom are overweight (CDC, 2010).

Childhood obesity carries with it both short term and long term consequences. Obesity affects children's health and psychosocial outcomes both today and in the future. Obese children are more likely to have risk factors associated with cardiovascular disease, such as high blood pressure, high cholesterol, and type II diabetes than are healthy-weight children (CDC, 2010). Obesity also affects children's psychosocial outcomes, such as low self-esteem and depression (Strauss, 2000). Obese children are often targets of social discrimination and the stress of social stigmatization can cause low self-esteem, which can inhibit academic and social growth, all of which may persist into adulthood. Datar, Sturm and Magnabosco (2004) find that overweight children have significantly lower math and reading tests scores when compared to non-overweight kindergartners, further promoting the negative effects of obesity on academics. Obese children are more likely to become obese adults; Whitaker (1997) and Freedman (2001) find that about 80% of children who are overweight at the age of 10-15 years are obese at age 25, and 25% of obese adults were overweight as children. Obesity in adulthood carries not only severe health problems but can also have detrimental economic effects. Obese adults are more likely to suffer disability during their working years (Anderson, et al. 2007); Averett and Korenman (1996) and Cawley (2000) find negative relationships between obesity and education and earnings. Furthermore, overweight and obesity has a significant impact on the U.S. economy. The total economic cost of overweight and obesity in the U.S. is estimated at $270 billion per year, as compared to the estimated cost of $30 billion per year in Canada. The $270 billion includes both the direct costs; preventative, diagnostic and treatment costs, as well as the indirect costs associated with overweight and obesity. Indirect costs include the loss of productivity due to higher rates of death, and the disability of active workers (Preidt, 2011).

It is important to consider what causes a child to be overweight. At the physiological level, the cause of overweight among children is simple; weight gain results from consuming more energy than one expends. In order to effectively address this policy concern, however, it is critical to examine the determinants of a child's caloric intake and expenditure. Children split their time between school and home environments. Schools are often criticized for contributing to the growing obesity epidemic through their offerings of unhealthy school lunches and fewer physical education classes. Yet, there is currently little research on the relative impacts of school and home environments on a child's weight. Several explanations have been put forth. Researchers have suggested that childhood overweight results from the overconsumption of fast food, from a lack of sidewalks or recreational areas, from excessive television viewing, and from a reduction in parental supervision as they become more involved in the work force (Anderson, 2003). However, others have faulted schools for children's weight problems, citing their fattening lunches, easy access to vending machines, and inadequate time for exercise. Anderson and Butcher (2006), for example, find that a 10 percentage point increase in the likelihood of being exposed to junk food in school results in a 1 percent increase in a student’s BMI. Aaron Levin, from Medical News Today, even goes as far to cite schools as “obesity zones” (Levin, 2004).

This paper aims to answer the question of whether childhood overweight arises primarily from school or nonschool influences. It is difficult to identify all of the school and nonschool influences on a child’s BMI. However, the structure of the school year allows for the observation of children under both school and nonschool conditions. If school influences are primarily to blame for childhood overweight, then BMI should have accelerated gains during the school year. However, if overweight arises primarily from nonschool influences then BMI should have accelerated gains during summer vacation.

Sociologists Von Hippel, et al. (2007) conducts a similar study comparing school and nonschool influences on children’s BMIs by estimating rates of weight gain while children are in school and then again while they are on summer vacation. They find that growth in BMI is faster and more variable during summer vacation and that the difference between school and summer growth rates is especially large for black children, Hispanic children, and children who were already overweight before kindergarten. In contrast, when comparing children who have had one versus two years of school exposure Anderson, et al. (2008) finds that there is no strong evidence to suggest that an additional year of schooling has either positive or negative effects on weight outcomes. Anderson (2003) finds that a child is more likely to be overweight if his/her mother works more hours per week. These results suggest that although schools may not provide ideal environments for healthy BMI growth, they are healthier than most children’s nonschool environments, indicating that the non-structured home environments allow for children to indulge in sedentary lifestyles and excessive eating.

While there are strong cases for both negative and positive relationships between school attendance and weight gain, I hypothesize that during the summer break children will experience an increased rate of growth in their BMI. Structured exercise, meal times, and constant supervision keeps kids active and reduces the intake of calories from the excessive eating which tends to stem from boredom and a lack of supervision. Data from the Early Childhood Longitudinal Study- Kindergarten Cohort 1998 is used to observe variation in BMI growth. Parents, teachers, and school officials were interviewed twice a year beginning in the fall of the child's kindergarten year and carrying through eighth grade (interviews were only conducted in kindergarten, first grade, third grade, fifth grade, and eighth grade). Questionnaires were given once in the fall and once in the spring, allowing for the observation of weight gain between the end of kindergarten and the beginning of first grade, which is necessary to observe the influence of summer vacation in comparison to the trend in BMI growth throughout the nine months in kindergarten and first grade. The decision to focus on the summer between kindergarten and first grade is simple. At this age children are at their lowest BMIs and have yet to begin any biological changes that would create a rapid change in BMI; therefore any change in BMI growth rate identified would more likely come from a change in energy intake or expenditure, rather than biological changes. Other factors that can influence BMI growth rates such as race, gender, family size, parental education and work status, and location are also included.

The rest of the paper is organized as follows. Section II provides a review of past economic literature studying how different aspects of school and family life impact a child's health status. Section III examines the question in the theoretical frame work, addressing how schools and families can impact children's health. Section IV provides information on the data set used as well as descriptive statistics on the sample of children in the study. The empirical methodology section of the paper, section V, explains the statistical model that will be used in the regression as well as clarifies the economic methods employed in the analysis. Section VI presents the results, while section VII concludes the paper; summarizing and providing policy implications of this analysis.

II. Literature

Childhood obesity is studied by a wide variety of researchers. There is substantial literature on childhood obesity outside of economics; however, the literature within economics is often inconclusive or non-generalizable. When observing childhood obesity, economists often turn to the significance of parental weight and working status (Danielzik, et al., 2004; Anderson, 2003), and school programs such as physical education classes and school lunch participation on weight variation (Datar, 2004; Menschik, et al., 2008; Trudeau and Shephard, 2008; Marsh, 1992; Whitmore, 2005)

Because children spend a significant amount of their time in school, schools are often criticized for their lack of healthy food options and physical education programs. Schools are potentially the first place children learn about the significance of healthy living, and physical education programs are an important channel through which physical fitness can be promoted to young children. As more schools face tighter budgets, they find themselves forced to cut physical education programs. Datar (2004) examines the effect of physical education programs on the prevalence of obesity among kindergartners. Using data from the ECLS-K, Datar finds that among kindergartners, 16% receive PE in school daily, and 13% receive PE less than once a week or never. The majority of kindergartners (64%) have PE class between 16 and 30 minutes per day. Datar finds evidence to suggest that physical education can play a substantial role in controlling obesity for overweight or at-risk-of-overweight girls, estimating that a 1-hour increase in PE instruction per week between kindergarten and first grade results in a 0.31-point greater reduction in BMI. However, Datar finds no statistically significant effect for boys or normal to low weight girls. Extending her results, Datar finds that expanding existing PE instruction time so that every kindergartner gets at least 5 hours of PE instruction per week could decrease the prevalence of overweight among girls by 4.2 percentage points, and the prevalence of children who are at-risk-of-overweight by 9.2 percentage points. Additionally, Menschik, et al. (2008) find that for each weekday that normal weight adolescents participate in physical activity, the odds of becoming an overweight adult decreases by 5 percent. Trudeau and Shephard (2008) conclude that up to an hour of daily physical programs can be added to school curriculum by taking time from other subjects without hurting students' academic achievement in those subjects, and conversely, Marsh (1992) finds that taking time from physical education and adding it to the academic curriculum does not improve grades. These studies imply that physical education in school is detrimental to a student's health outcome and taking time from academics and applying it toward physical activity may not negatively impact the student's learning.

Schools offer many opportunities to develop strategies to prevent childhood obesity; not only by creating an environment in which kids can actively engage in regular physical activity but also an environment in which children eat healthfully. Gleason and Suitor (2001) estimate that children consume between 19 and 50 percent of their daily calories at school, potentially allowing for the school environment to have a significant effect on children's health. Whitmore (2005) recognizes the prevalence of school lunches and observes the impact school lunch programs have on childhood overweight. Almost three quarters of school children eat a national school lunch program lunch, consuming about one-third of their total calories from this meal. Using NHANES and CSFII food recall data Whitmore (2005) finds that children who consume school lunches are about 2 percentile points more likely to be obese than those who bring their lunches from home ("brown baggers"). These children who eat school lunches consume about 40 to 120 more calories at lunch than those who brown bag. A significant observation is that while school lunch consumers intake more calories at lunch, both groups consume the same amount of calories throughout the rest of the day. The additional calories consumed at lunch can lead to a 2 to 4 percentage point higher obesity rate among school lunch eaters. Whitmore's findings reflect the results of Gleason and Suitor (2003) who find that participation in the National School Lunch Program (NSLP) leads to an increase in children's intake of key vitamins and minerals, and a decrease in added sugars, but that also NSLP participation leads to an increase in the intake of dietary fat. Whitmore (2005), and Gleason and Suitor's (2003) studies imply that making school lunches healthier could potentially impact a large number of children across socio-economic groups, race, and geographic backgrounds.

The popular press routinely links working mothers with poor health and social outcomes for children. A 1999 Boston Herald article cited a pediatric nutrition specialist who "noted in particular that dual-career couples are spending less time monitoring their latchkey children, who consequently snack after-school, using their often liberal allowances on candy, ice cream, or soda pop" (Anderson 2003).

Anderson (2003) examines the effect of maternal employment on childhood overweight. She finds that the amount of working hours only matter for higher socioeconomic status mothers. Anderson argues that intuitively one might think that higher socioeconomic status mothers would be those for whom working matters the least, because they are in the position to purchase high quality child care in their absence. However, her findings imply that when these mothers spend less time working and more time with their children they are doing activities that promote nutritious diets and active lifestyles for their children. Anderson finds that a 10 hour increase in the average hours worked per week over a child's lifetime increases the likelihood that their child is overweight by 1 to 4 percentage points. Anderson's study suggests that maternal work is only related to childhood overweight status among advantaged families, thus there are other factors besides working mothers that are contributing to the childhood obesity epidemic.

While Whitmore (2005) and Datar (2004) find evidence to suggest that some school environments are better than others, they fail to find a significant contributor to the childhood obesity epidemic. In addition, Anderson (2003) suggests that maternal work is only significant to children of high socioeconomic status. In 2008 Anderson, et al. tries to address the significance of the role of genetics in childhood obesity. Using data from the NHANES, they aim to answer the question by observing how the parent-child correlation in BMI has changed over time. Focusing on children aged 2-11 years, they find that the elasticity between mothers' and children's BMI has increased since the 1970s. This increase suggests that shared genetic-environment factors are becoming more important in determining obesity (Anderson, 2003). Anderson, et al. determines that the increase in parent's BMI between the early 1970s and the early 2000s can explain 37% of the increase in children's BMI. In combination, previous research suggests that although common environmental and genetic factors play a larger role in children's BMI now than it did in earlier decades, schools and other child specific environments play a significant role in determining children's health status.

III. Theory

At the very basic level a person's body mass index, BMI, is a function of calories in and calories out; people get heavier if they consume more calories and expend fewer calories. Unlike adults who self determine their consumption and expenditure of calories, children's activities are often determined directly or indirectly by their parents. Parents prepare meals, choose their child's diet, and direct their leisure time by enrolling their children in clubs and organizations and setting rules at home pertaining to watching television, playing video games and similar sedentary activities. While parents play a significant role in their child's health, children also spend a significant amount of their time in school. Schools can influence a child's health just as parents can; they serve children lunch and provide mandatory physical activities such as physical education class time and recess. Therefore, both school and nonschool inputs influence a child's BMI growth. Formally, let BMI be a function of school inputs, A, and parental inputs P:

$$BMI=f\,(A, P) \tag{1}$$

It can be assumed that both parents and the school administration want children to be healthy, deriving utility from a child's health. With the growing commitment of schools to healthy kids the school administration may derive utility from both student achievement and their health, while parents derive utility from their children's health and the consumption of composite goods:

$$A=U(\text{student achievement, student health}) \tag{2}$$

$$P=U(X, \text{child's health}) \tag{3}$$

Both parents and schools gain utility from children's health, however both face budget and time constraints. Because utility is a measure of satisfaction with various combinations of goods, and more utility is always preferred to less, both parents and schools will seek to maximize their utility subject to their independent budget constraints.

Schools often find themselves without significant funding; with teachers demanding more pay, parents desiring more attention for their children, and the necessity to provide for underprivileged students. Especially today, with the No Child Left Behind Act, schools need to divert more resources toward student achievement often forcing them to cut physical education, healthy lunch options, and after-school programs (Trickey, 2006; Wechsler, 2004). Hence, a school with a higher marginal utility for children's health will focus more efforts into improving the health of their students and we would expect to see healthier BMI growth, signifying healthier children.

Parents also face budget and time constraints. Parents must work in order to generate income to provide for their children; however there are only so many hours in a day in which parents can share their time between their work and their children. If parents work more hours they generate larger incomes, shifting the budget constraint out allowing for the purchase of more health inputs, whether it be healthier snacks and meals, or more physical activities. However, while working more hours allows for parents to provide healthier lifestyles for their children, it also consumes more of their time, thus parents have less time to physically provide for their children (prepare meals, and take them to different activities). Parents must balance their time and budgets with their desires for their children's health. As with schools, parents with a higher marginal utility for their child's health will focus more efforts into providing healthier lifestyles for their children. Thus, the question over whether school or nonschool (parent) influences impact the prevalence of childhood obesity can be a question of whether schools or parents have a higher marginal utility for children's health.

Von Hippel (2007), Anderson (2003) and Whitmore (2005) suggest that the school environment promotes healthier BMI growth, and that the unstructured home environment during the summer results in unhealthy weight gain. Thus, while it is expected that a five-year-old's BMI will grow as they get older, it is expected that the per-month weight gain during kindergarten and first grade will be smaller than during the summer.

To observe the effects of school influences versus nonschool influences on the growth of children's BMI it is necessary to observe the changes to BMI over the amount of time the child spends in school and not in school. The months the child spends in school and in summer between the interview dates allows for the observation of per monthly BMI changes. However, it is not enough to simply observe the changes in BMI throughout the structure of two school years. Previous research has suggested that other factors can influence a child's BMI growth, and thus need to be included as controls. The equation below depicts the fundamental model where BMI is a function of the three variables of interest; the amount of time spent in kindergarten, summer, and first grade, controlling for demographic and school characteristics.

BMI=f (months in kindergarten, months in summer, months in first grade, household income, race, gender, parents' education, mothers working status, region of residence, family size, school type) (4)

A higher education is often related to better health; economists believe that education improves the efficiency with which one can produce investments for health (Grossman, 1972). Educated people have better knowledge of the harmful effects of an unhealthy lifestyle and discount the future less than uneducated people thus implying that higher educated individuals demand more health. Likewise, educated parents demand more "health" for themselves and for their children; therefore parents' education should negatively impact children's BMI growth. Zhang (2007) observes that teenage girls with more education are less likely to be overweight, further promoting the concept that education promotes healthier habits.

Anderson (2003) examines the effect of maternal employment on child overweight and finds a positive correlation between hours worked and child's overweight status. A mother's employment status pivots the time constraint inward, as more labor hours frees up less time to prepare meals and interact with the children. Therefore, while a mother's employment status positively adds to the household income, it may negatively impact the health of the child because the mother is more constrained for time.

Having less time to dedicate to the family, the mother may rely on fast-food or pre-packaged meals, while also having less time to involve her kids in extracurricular activities. Another important aspect of mother's employment status is that the opportunity cost of spending time with their kids is greater when mothers are generating income for the family and thus they will be more likely to invest more time in their careers and less time in providing healthy lifestyles for their family. Anderson notes that as parents increase their employment outside of the home, children are more likely to be unsupervised, allowing them to make poor nutritional choices and spend more time indoors (Anderson, 2003). However, unlike adolescents to whom this may occur, kindergartners and first graders are affected by their child care providers who may be more likely to offer children food that is highly caloric or of poor nutritional value[1].

Rather than looking at the family size, the number of children living in the household of the child is observed. The more children in a household the wider the income has to spread, thus parents have less money to spend on food or activities per kid. An increase in family size should therefore have a negative effect on BMI growth.

Region of residence is also included because different areas of the United States are known to have varying lifestyles, creating children with differing rates of BMI growth due to their natural environment. Private versus public school is necessary to control for because parents who send their children to private schools have the financial means to provide healthier lifestyles and may value their child's education thus placing a larger emphasis on the child's future well-being. Also, schools in wealthier neighborhoods may have more resources to provide physical education programs and healthier lunches; these schools may also place a greater emphasis on healthy lifestyles.

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[1] Father's employment status is not included in this model. Previous research has shown that a change in mothers' employment status has a greater effect on the child's health, primarily because they have traditionally been the primary care givers.

Unfortunately this data set does not include a reliable variable for household income, however, the data does have an indicator for whether the child receives a free or reduced-price lunch. The National School Lunch Program is a federally funded program that provides nutritionally balanced, free or low-cost lunches to more than 31 million children each school day. Children from families with incomes at or below 130% of poverty are eligible for free lunch and those from families with income between 130% and 185% of poverty are eligible for reduced-priced meals[2]. By indicating whether or not a child participates in the NSLP controls for the bottom end income distribution.

Finally, race and gender are necessary controls because previous research has shown that black and Hispanic children are more likely to be overweight than are other races. Anderson (2007) finds that black children have significantly higher BMIs than white children; the difference is almost 2.1 percent. She also finds that Hispanic children have BMIs about 3.5 percent higher than those of white non-Hispanic children.

IV. Data

The data used in the analysis comes from the Early Childhood Longitudinal Study-Kindergarten Cohort 1998 (ECLS-K) administered by the National Center for Education Statistics. The ECLS-K follows 17,212 children in 992 private and public schools in the United States from when they enter kindergarten in 1998 through the end of fifth grade. The ECLS-K collects detailed information on child, parent, teacher, and school characteristics twice a school year. The baseline collection, wave 1, was taken in the fall of kindergarten, wave 2 in the spring of kindergarten, wave 3 in the fall of first grade, and wave 4 in the spring of first grade. After first grade, interviews were conducted at two-year intervals. Our

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[2] United States Department of Agriculture, http://www.fns.usda.gov/cnd/lunch/

analysis follows children from kindergarten through first grade, therefore using observations from waves 1 through 4. While data was collected for all children during waves 1, 2 and 4, wave 3 is only a 30% subsample of the schools, thus about 27% of the base year children who were eligible to be interviewed during first grade attended this subsample of school. Wave 3 observes about 5,300 students.

The focus of this paper is to examine children's change in BMI over a two year period, specifically focusing on the change in growth between time spent in school and summer vacation. Because we want to evaluate the impact of two different influences it is imperative that the children we observe have a distinctively different environment during the summer, thus children that attend year-round schools are dropped from our sample. Additionally, I drop students that repeat kindergarten in the fall of 1998.

The key variable of interest is a child's BMI growth. BMI is measured as weight in kilograms divided by height in meters squared, thus allowing for comparisons of weight holding height constant. Childhood BMI follows a J-Shaped trajectory, falling from birth until the age of 5 or 6 and then rising through young adulthood. At the beginning of kindergarten children's BMIs are near lifetime lows or are just starting to gain at a slow rate.

A pertinent feature of the survey is that the measures of children's height and weight were collected by trained professionals. This measure, therefore, does not rely on parent reports, where weight is commonly underreported. The ECLS-K measured height and weight twice for each child in each wave to correct for measurement error. If the two recorded height values were less than two inches apart, then the average was computed and recorded. Otherwise the measurement that was closest to the average height for that age was recorded. If the two weight values were less than five pounds apart, the average of the two was computed and recorded. Otherwise, the value closest to the average weight for that age was recorded. From the composite height and weight, the ECLS-K computed BMI for each child in each wave. BMI is calculated as the child's weight in kilograms divided by the square of their height in meters.

Table 1 provides a brief summary of the sample. Notice that the sample is fairly representative of the population. About 50% of the sample is female, 63% white and there is an even distribution of observations across the four U.S. Census regions. Table 1 also includes a summary of the distribution of the children's initial BMI measurements. The CDC classifies "underweight" as having a BMI below the 5^{th} percentile for a specified gender and age, "normal weight" as being between the 5^{th} and 85^{th} percentiles, "overweight" as falling between the 85^{th} and 95^{th} percentiles, and "obese" as having a BMI larger than the 95^{th} percentile. For boys and girls between the ages of 5 and 6, these ranges are estimated to be a BMI measurement of less than 13.8, between 13.8 and 17.1, between 17.1 and 18.2, and greater than 18.2, respectively. We notice that about 5% of the sample is underweight, 11% is overweight, and 12% is obese. The majority of the sample, 68% is classified as having a healthy weight.

Table 1. Descriptive Statistics

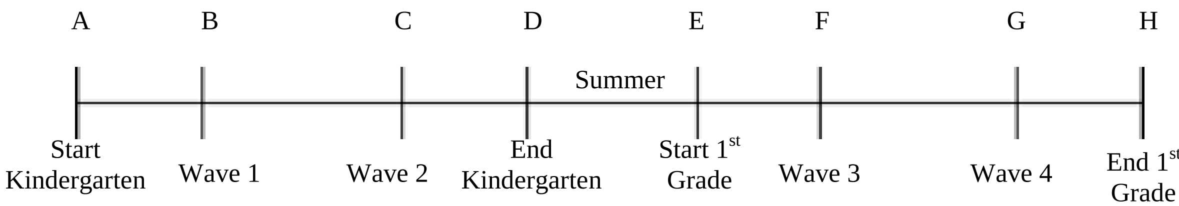
Variable	Mean	Std. Dev.
Initial BMI		
Underweight	0.054	0.807
Normal Weight	0.681	0.843
Overweight	0.109	0.304
Obese	0.120	2.394
Missing	0.036	
Female	0.499	0.500
Race		
White	0.629	
Black	0.124	0.329
Hispanic	0.142	0.349
Other	0.105	0.307
U.S Census Region		
Midwest	0.265	0.441
South	0.357	0.479
West	0.207	0.405
Northeast	0.172	
Number of Observations		29780

Notes:
a) Per NCES restricted-data regulations, all sample sizes are rounded to the nearest ten.

V. **Empirical Methodology**

To observe the effects of school influences versus nonschool influences on the growth of children's BMI it is necessary to observe the changes to BMI over the amount of time the child spends in school and not in school. In the ECLS-K, interviews were conducted, on average, in mid-October and mid-May, thus allowing for the generation of values for the number of months children spend in school and out of school over the two year span. For instance when wave 1 was conducted the child had been in school for about 1.5 months, by wave 2 the child had been in kindergarten for about 8.5 months, and then by wave 3 the child had been in kindergarten for about 9.5 months, in summer for about 2.5 months, and had around 1.5 months of first grade. By wave 4, the child had been in school for about 9.5 months of kindergarten, been in summer for about 2.5 months, and then been in first grade for about 8.5 months. Figure 1 illustrates the timing of survey dates.

Figure 1. The two year timeline



Calculating the amount of time the children spent in school and in summer during each wave allows for the regression of BMI on those three time periods. Fortunately, the dataset includes the exact date of the child interviews as well as each child's respected school's beginning and ending date for each school year. This information allows for the creation of three variables: *kindergarten*, *summer*, and *first*. These three variables measure the number of months each child spends in school or in summer between their observation dates. Figure 2 illustrates how the values are calculated based on the timing of interviews and school dates displayed in figure 1 above.

Figure 2. Calculation of months

	Kindergarten	Summer	First Grade
Wave 1	B-A	0	0
Wave 2	C-A	0	0
Wave 3	D-A	E-D	F-E
Wave 4	D-A	E-D	G-E

The following model is used to estimate the relationship between the time a child spends in school and in summer on BMI.

(5)

BMI represents the BMI of child[3], *i*, at time, *t*. *Kindergarten*, *summer* and *first* are the variables of interest and represent the amount of time the child spends in school and in summer between observation dates. *X* is a vector that includes controls for the child and school characteristics as displayed in equation 4.

OLS versus Fixed Effects

The ECLS-K data set is a panel data set which permits the researcher to study the dynamics of changes within a short amount of time (in this case, a change in BMI growth over a two year period). The problem with ignoring the nature of the data is one of simultaneity; if an individual is observed multiple times, there is a covariance between their observations and their error terms. This covariance is due to unobserved heterogeneity. Each child has unobserved characteristics that are unique to that child, therefore, the error terms for each of that child's observations are going to be correlated, violating a defining assumption for the standard OLS model. Instead, this analysis exploits the nature of the panel dataset using a fixed effects model. Fixed effects methods control for all of the stable characteristics of the individuals in the study thereby eliminating the potentially large biases seen in OLS estimates. This methodology ignores the between person variation and relies instead on the within person variation for identification. Therefore it is a good procedure for investigating the effects of variables that vary within an individual over time. This paper aims to analyze how BMI changes under different settings within a child, thus fixed effects is a more appropriate model. Because fixed effects models examine within person variation, they cannot estimate coefficients of variables that do not vary within an individual. Because there is no variation in certain variables included in equation 4, all fixed effects models solely control for mothers employment status and the number of household children under the age of 18.

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[3] In some economic literature, the log BMI is used. Von Hippel (2005) and Whitmore (2005) note that logging or linearlizing BMI has no difference on the results, and both choose to linearlize BMI for interpretation reasons. Because the variables of interest, *kindergarten, summer,* and *first,* are in months it is easier and more comprehendible to evaluate a linearlized model. Using a linear BMI is also consistent with growth trends of 5 and 6 year olds.

Additionally, the fixed effects models employed in this analysis use a robust standard errors specification. Specifying "robust" implies that the standard errors are robust to the misspecification of intragroup clustering. The models treat each individual as a cluster, thus controlling for the correlation of error terms within an individual.

VI. Results

This section is set up with a progression of results comparing the differing rates in children's BMI growth. First, to provide a baseline, I estimate a standard OLS model. Then, a fixed effects model. Additionally, the fixed effects model is estimated separately for the following four categories based on the child's initial BMI measurement: underweight, normal weight, overweight, and obese. Lastly, the four groups are divided even further, and observations are split based on whether or not they participate in a free or reduced-price lunch program.

Impact of School on Child BMI

Table 2 represents the monthly changes in BMI when the child is in kindergarten, summer, and first grade. The first model is a standard OLS, regressing the three variables of interest; *kindergarten*, *summer*, and *first*, on the child's BMI measurement. This model demonstrates that on average, children's BMI increases 0.016 kg/m^2 per month in kindergarten, decreases 0.011 kg/m^2 per month of summer break, and then increases 0.063 kg/m^2 per month of first grade. However, previous research has shown that other variables can influence a child's BMI. For instance, Anderson (2003) argues that a mother's employment status can negatively affect children's weight, thus model 2 includes controls for child and school specific characteristics. The OLS results demonstrate that children may actually lose weight over the summer, concluding one to believe that schools are, in fact, "obesity zones". OLS estimates are unbiased if all factors influencing a child's BMI growth can be observed however, that is seemingly impossible, and it is likely that there are unobserved characteristics that affect a child's weight gain. Due to unobserved heterogeneity the OLS estimates can be assumed to be biased.[4]

Due to the nature of the data and the probability of unobservable characteristics, the fixed effects model is more reliable than the OLS at evaluating the differences in BMI growth under school and home settings. Model 3 displays that on average, as the number of months a child spends in kindergarten increases by one month, the child's BMI will increase on average 0.018 kg/m^2. As the child spends one more month under summer influences the child's BMI increases 0.052 kg/m^2, and as a child spends one more month in first grade the child's BMI will increase 0.041 kg/m^2, all else equal. Our goal is to examine the relationship between these three parameters. We see that during kindergarten a child's BMI increases at an average rate of 0.018 kg/m^2 per month. Due to the natural biological growth in BMI at this age, it is expected that a child's BMI increases as they age over this period. The substantial difference in the magnitude of the coefficients on *kindergarten* and *summer* could be mistaken as maturation, however it is necessary to notice that the coefficient on *first* decreases from *summer*. If the change in BMI growth is purely due to maturation, we would expect to see BMI to continue to grow over the two years, thus per month growth in BMI during first grade would be larger than that of kindergarten and summer. Therefore, at first glance we see that the differences in BMI growth over the two years are not solely due to maturation, but rather, there is some unnatural shock during summer vacation.

[4] Unobserved heterogeneity can cause what appears to be autocorrelation and heteroscedasticity in the OLS model. Thus, using a fixed effects model, which corrects for unobserved heterogeneity, will correct for the spacial autocorrelation and heteroscedasticity problem.

Table 2. The Impact of School on BMI

Variable	OLS (1)	OLS (2)	FE (3)
Kindergarten	0.016	0.066	0.018
	(0.006)***	(0.142)	(0.002)***
Summer	-0.011		0.052
	(0.026)		(0.010)***
First	0.063	0.144	0.041
	(0.008)***	(0.064)	(0.004)***
Numer of Observations	29780	8280	29780

Notes:
a) Robust standard errors are in parentheses and *,**, and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.
b) OLS (2) includes controls for gender, race ,region, household children under 18, mom working status, private school, parent's marital status, parent's education status.
c) FE model includes child-level fixed effects and controls for mother's working status and household children under 18.
d) Per NCES restricted-data regulation, all sample sizes are rounded to the nearest ten.

Results by Initial Weight

Biologically, a child’s BMI will hit its nadir anywhere between 4.5-years-old and 6-years-old, after which a child’s BMI will grow at an increasing rate. The age at which BMI hits its nadir is determined by the child’s BMI. According to the CDC’s clinical growth charts, a child that is obese will begin to experience a growth in BMI at around 4.5-years-old, while a child who is underweight will not begin to experience such a change until they are about 7-years-old. A child of healthy weight will reach their BMI’s nadir anywhere between 5-years and 6-years-old, based on whether they are on the heavier or lighter end of the spectrum. Since a child’s initial BMI (their BMI measurement at the beginning of kindergarten) may impact the rate at which BMI grows throughout kindergarten and first grade, I perform separate regressions, based on the child’s initial BMI. Table 3 displays the regression results.

From, Table 3, it quickly becomes apparent that school and summer affect the four groups differently. For children that are initially underweight, kindergarten appears to significantly increase their

BMI, increasing 0.214 kg/m^2 per month. However, during summer, BMI growth actually decreases 0.019 kg/m^2 per month, and then slowly grows again during first grade. These results suggest that kindergarten is beneficial for underweight children's health, possibly bringing them into a healthy weight percentile. The effects of first grade and summer are not statistically significant from zero but the trend suggests that there may be food insufficiency at home that allows for school to have a significant effect on children's BMI growth.

A child that is initially of a healthy and normal weight displays results showing almost a natural progression in BMI growth. On average, BMI grows 0.011 kg/m^2 per month of kindergarten, 0.028 kg/m^2 per month of summer break, and 0.028 kg/m^2 per month of first grade. This relatively extreme growth during the summer could be explained by the fact that healthier weight children do not begin to experience a biological increase in BMI until they are 5 ½ to 6-years-old. It appears that healthy weight children are unaffected by the different influences of school and home. This conclusion could be made because it is often inferred that wealthier families have the ability to provide healthier lifestyles for their children, thus their home life will be healthy and may be able to offset any negative effects school could have on BMI growth. This idea is tested in the next subsection (Table 4).

Finally, children that are initially overweight display results that indicate that a child's home life is likely to be the cause for today's unhealthy youth. On average, children's BMI decrease 0.017 kg/m^2 per month during kindergarten, then BMI sees a rapid increase in growth during summer, where BMI increases, on average, 0.113 kg/m^2 per month, an increase of more than 6.5 times that of kindergarten's growth. During first grade, BMI grows at a per monthly rate of 0.063 kg/m^2, a decline of 0.05 kg/m^2, or roughly 1.8 times slower than summer's growth. Thus, a child loses weight during kindergarten and then gains weight during the summer. This result, combined with the fact that BMI grows at a greater rate during summer than during first grade, implies that a child's home environment induces weight gain while school influences cause healthier changes in BMI. Obese children follow a similar pattern, experiencing significantly greater BMI growth during the summer than during the school year. On average, these children experience per-monthly BMI growth of 0.007 kg/m^2, 0.168 kg/m^2, and 0.103 kg/m^2 in kindergarten, summer, and first grade, respectively. In summary, Table 3 demonstrates that school provides a healthier environment for underweight, overweight, and obese children, while children of normal weight experience an increasing trend in BMI growth that closely matches expected growth due to maturation.

Table 3. Effects of School on BMI by Child's Initial BMI

Variable	Underweight	Normal	Overweight	Obese
	(1)	(2)	(3)	(4)
Kindergarten	0.214	0.011	-0.017	0.007
	(0.013)***	(0.002)***	(0.006)***	(0.011)
Summer	-0.019	0.028	0.113	0.168
	(0.041)	(0.010)***	(0.031)***	(0.048)***
First	0.005	0.028	0.063	0.103
	(0.015)	(0.004)***	(0.010)***	(0.016)***
Number of Groups	590	7390	1200	2270
Number of Observations	1610	20290	3250	4620

Notes:
a) Robust standard errors are in parentheses and *,**, and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.
b) All models include student fixed effects and control for mother's working status and household children under18.
c) Per NCES restricted-data regulation, all sample sizes are rounded to the nearest ten.

Results by Initial Weight and Income Level

The influence income has on health status has long been contested. To some extent a greater income is associated with a better health status. Families with higher incomes are able to purchase a greater quantity and quality of food. Families in penury are financially constrained and cannot afford a nutritionally adequate diet. This situation can cause children to either be significantly underweight or overweight. To examine how school and summer influences BMI growth differently for children of different economic situations, the previous regressions are each further divided into two subcategories: children that participated in free or reduced-price lunch programs and children who did not. I use participation in a free or reduced-priced lunch program to identify the two groups because in order to qualify for a free lunch the child's family's income must be at or below 130 percent of poverty, and to qualify for a reduced-price lunch income must between 130 and 180 percent of poverty, therefore controlling for bottom end income distribution. Table 4 displays the results.

Whether or not underweight children participated in free and reduced-price lunches appears to have a significant impact on their BMI growth. Both groups experience significant growth in kindergarten, much larger than any of the other three BMI categories. Non-participants experience a growth of 0.197 kg/^{2} per month in kindergarten while participants saw an increase of 0.204 kg/m^2 per month. The magnitude of these changes is very similar. What is most interesting is what happens to BMI from kindergarten into summer. Poorer children still experience growth in BMI (0.064 kg/m^2 per month), although much smaller of a growth. However, children from wealthier families experience a decrease in BMI over the summer, BMI decreasing 0.027 kg/m^2 per month. What we may be able to conclude here is that the two groups of children have very different family environments. The wealthier children may come from families that stress extremely active lifestyles or strict diets, which cause the children to have significantly low BMIs. The poorer children most likely come from families that simply do not have the financial means to provide a healthy diet, which allows for the continuing increase in BMI in the summer, although at a much slower rate. Another interesting point of the relationship between BMI growth between the three periods and the two groups of children is how BMI growth changes in first grade. We see that for wealthier children BMI increases 0.013 kg/m^2 per month, back up again from the loss of growth in summer. However, for the poorer children, BMI actually decreases during first grade, decreasing, on average, 0.039 kg/m^2 per month.

The two groups for children that are considered normal weight display contrasting results. Children who do not participate in a school lunch program show results that depict a natural progression in BMI growth, one that we could attribute to maturation. However, for free and reduced-price lunch participants, notice the increased rate of growth in summer compared to kindergarten and first grade. In kindergarten, BMI grows at a rate of 0.017 kg/m^2, and then BMI increases its rate of growth in the summer to 0.048 kg/m^2 per month. However, once the child returns to school, entering first grade, BMI grows only 0.022 kg/m^2 per month. The significant changes in growth imply that their home environment fosters an unhealthy lifestyle, resulting in increased weight gain, in comparison to their peers whose families exceed 185 percent of poverty and thus do not participate in the lunch programs. We can guess that these poorer families are providing their children with adequate amounts of food; however the evidence suggests these foods are not nutrient rich foods.

The two groups of overweight children show comparable trends in growth. Both experience negative growth in kindergarten, and then see a significant increase in growth during summer, only to continue to grow monthly, but at a lesser rate during first grade. The magnitudes of their monthly growths and changes between the three periods are similar. Because overweight children of both poorer families and economically secure, families show similar results we can conclude that it is not so much income that affects these children, rather it is the similarity in their family environments. As formally shown with healthy weight children, poorer families are most likely providing their children with unhealthy, energy-dense foods that are causing them to gain more weight when primarily under home influences. The lack of disparity in results based on income implies that children that are overweight live in family environments that provide unhealthy foods or inactive lifestyles. Therefore, while the wealthier families may have the financial ability to provide a nutritious diet, they may not value healthy lifestyles as highly as other aspects of their life.

Obese children show comparable results to overweight children. Like overweight children, both groups follow similar trends, however, the magnitude in the differences between the wealthier and the poorer are larger. For both groups, BMI growth in kindergarten is neither statistically nor economically significant from zero. Participants of the school lunch program experience a growth in BMI of 0.252 kg/m^2 per month in summer and then a smaller increase of 0.116 kg/m^2 per month in first grade. Non-participants experience a growth in BMI of 0.173 kg/m^2 per month in summer and then a smaller increase of 0.083 kg/m2 per month in first grade. Notice, the difference in the magnitude of summer growth between the two groups. While both groups see significant growth in their BMI, school lunch program participants' BMI grows almost 1.5 times greater per month than non-participants' BMI. Further, both groups experience a reduction in growth in first grade of a little more than 2 times their growth in summer. Therefore, the magnitudes of their changes from summer to first grade are comparable. But, the fact that BMI growth is so much larger in the summer for children of poorer families implies that home life is more detrimental to health for poorer children (however, it is important to recognize that home life proves to be extremely detrimental to wealthier children as well). These children's families don't have the financial ability to provide nutritious diets or active lifestyles for their children.

Overall, the results suggest that schools provide healthier environments for children than their home lives. Underweight children experience an increased rate of growth while they are in school, while healthy weight, overweight, and obese children experience either decreasing growth while in school or growth that is significantly less than the growth they experience over summer break.

Table 4. Effects by Intital BMI and Free and Reduced-Price Lunch Participation

Variable	Underweight		Normal		Overweight		Obese	
	Free/Reduced-Price Lunch Participant	Not a Participant	Free/Reduced-Price Lunch Participant	Not a Participant	Free/Reduced-Price Lunch Participant	Not a Participant	Free/Reduced-Price Lunch Participant	Not a Participant
Kindergarten	0.204	0.197	0.017	0.009	-0.028	-0.021	0.005	0.002
	(0.030)***	(0.016)***	(0.005)***	(0.002)***	(0.017)*	(0.007)***	(0.022)	(0.013)
Summer	0.064	-0.027	0.048	0.019	0.132	0.128	0.252	0.173
	(0.08)	(0.058)	(0.027)*	(0.012)*	(0.059)**	(0.038)***	(0.092)***	(0.065)***
First	-0.039	0.013	0.022	0.028	0.078	0.052	0.116	0.083
	(0.029)	(0.02)	(0.009)**	(0.004)***	(0.019)***	(0.013)***	(0.025)***	(0.022)***
Number of Groups	190	410	2230	5180	380	820	790	1500
Number of Observations	370	1060	4480	14000	750	2190	1310	2920

Notes:

a) Robust standard errors are in parentheses and *,**, and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

b) All models include student-level fixed effects and control for mother's working status and the number of household children under 18 years old.

c) Per NCES restricted-data regulation, all sample sizes are rounded to the nearest ten.

VII. Discussion and Conclusion

The goal of this paper is to identify which environmental influence, school or home life, has a greater impact on child's BMI growth. Using data from the ECLS-K, which followed 17,212 American children from the beginning of kindergarten in 1998 through the end of their first grade year, fixed effects methods are employed to compare the time children spend in kindergarten, in summer break, and in first grade on their BMI growth. Children are further separated into initial weight classes and income level. The results of this study suggest that the school provides a healthier and more stable environment for children's BMI growth. Underweight children experience an increasing growth in their BMI while mainly under school influences, while normal weight, overweight, and obese children experience a lesser increase in BMI growth during the school year as compared to the rapid growth most children experienced during summer vacation. These results qualitatively match those of Von Hippel (2007), who finds that growth in BMI is especially faster and more variable during summer vacation for children that were already overweight before entering kindergarten. Because the results show an increase in BMI growth from kindergarten to summer and then a decrease in BMI growth from summer to first grade, it proves that maturation is not the only factor inducing BMI growth.

Whitmore (2005) finds that children who consume school lunches consume about 40 to 120 more calories at lunch than those who brown bag. Therefore, the fact that even children who receive a free or reduced-price lunch, and thus participate in the school lunch program and consume more calories during school, still experience increased growth in the summer, further strengthens the argument that the home environment is significantly less healthy than the school environment. Therefore, while schools may not provide ideal environments for healthy BMI growth, the evidence suggests that they are healthier than most children's nonschool environments. This conclusion implies that the non-structured home environments promote sedentary lifestyles and excessive or unhealthy eating.

Children participating in the school lunch program come from families who most likely do not have the financial ability to provide nutritious diets or active lifestyles for their children. Therefore, it may be interesting to further study the choices these families make when purchasing food. Are they purchasing less nutritious foods, resulting in weight gain, because of a lack of financial stability or are they making poor decisions because of a lack of education about food nutrition?

The analysis suggests that, for the average child, the school environment provides the necessary structure and atmosphere to provide healthier weight growth when compared to a child's home environment. While these results support the literature on the influences of childhood weight gain, it is important to recognize the limitations to the model. While it would be nice to be able to identify all of the environmental factors that contribute to childhood weight gain, that objective is almost impossible. Therefore, it is likely that there are omitted variables in this model. Omitted variables cause a major problem in regression analysis, as they bias the parameter estimates. The fixed effects methods applied to this paper control for differences within the child, therefore the only omitted variables that would matter are time varying. For instance, if a school implemented a new initiative to increase the health of their students, therefore supplying healthier lunches or increasing physical activity. Such policy changes act as an unobserved shock in the child's environment; biasing the results.

Another variable that may seem obvious to the model but that is missing is age. Of course age should influence a child's BMI; however it is not included into this model for two reasons. First, the children observed are all kindergartners in 1998 and those same students are followed through first grade, thus there is not enough variance in the age of the observations. Also, age is a measurement of time and the time is already controlled for within the progression of time a child spends in school and summer between observation dates; the kindergarten, summer and first grade variables. The paper tries to control for the effect age has on biological BMI growth by separating the analysis into four regressions based on the child's initial BMI measurement. The CDC clinical growth charts suggest that age is not so much a factor in and of itself but rather the child's weight determines when the child's BMI will begin to grow naturally.

Lastly, one may wonder if the growth in summer that is experienced by all of the children is due to seasonality rather than a change in environment. While, this study does not attempt to identify whether that is true or not it is a necessary extension to the present research.

Despite the limitations of this study, this paper provides evidence to suggest that the nature of the school day may inhibit excessive BMI growth due to the structured periods and activities, as well as the planned exercise; while home environments may not have the resources or time to provide such activities. This result is pertinent to today's policy makers. The current administration is working towards improving the school environment with the hopes of curbing childhood obesity. While it is important to have a healthy school environment the results of this paper demonstrate that the home environment may be more detrimental to childhood obesity. Thus policy makers may want to focus their attention on improving a child's home environment. Improving a child's home environment is more difficult than improving a school environment however some possible ideas could be providing more playgrounds and recreational areas, or building more sidewalks and streetlights that could keep kids active longer without the worry of safety. This model successfully defends the original hypothesis and further adds to the claim that a child's health is greatly affected by their home environment.

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