Childhood Overweight and Academic Performance: National Study of Kindergartners and First-Graders

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Abstract

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Objective: To examine the association between children's overweight status in kindergarten and their academic achievement in kindergarten and first grade.

Research Methods and Procedures: The data analyzed consisted of 11,192 first time kindergartners from the Early Childhood Longitudinal Study, a nationally representative sample of kindergartners in the U.S. in 1998. Multivariate regression techniques were used to estimate the independent association of overweight status with children's math and reading standardized test scores in kindergarten and grade 1. We controlled for socioeconomic status, parent-child interaction, birth weight, physical activity, and television watching.

Results: Overweight children had significantly lower math and reading test scores compared with nonoverweight children in kindergarten. Both groups were gaining similarly on math and reading test scores, resulting in significantly lower test scores among overweight children at the end of grade 1. However, these differences, except for boys' math scores at baseline (difference = 1.22 points, $p = 0.001$), became insignificant after including socioeconomic and behavioral variables, indicating that overweight is a marker but not a causal factor. Race/ethnicity and mother's education were stronger predictors of test score gains or levels than overweight status.

Discussion: Significant differences in test scores by overweight status at the beginning of kindergarten and the end of grade 1 can be explained by other individual characteristics, including parental education and the home environment. However, overweight is more easily observable by other students compared with socioeconomic characteristics, and its significant (unadjusted) association with worse academic performance can contribute to the stigma of overweight as early as the first years of elementary school.

Key words: academic performance, kindergarten

Introduction

Childhood obesity has become one of the most prominent public health concerns in the U.S (1,2). Numerous studies have documented the dramatic rise in obesity and overweight in both adults and children (3–7). According to recent estimates, the prevalence of overweight (BMI ≥ 95th percentile for age and gender) is 15.3% in 6- to 11-year-old children and 10.4% among 2- to 5-year-old children, compared with 11.3% and 7.2%, respectively, in 1988 to 1994 (4).

Childhood obesity has been shown to be associated with several immediate health risk factors such as orthopedic, neurological, pulmonary, gastroenterological, and endocrine conditions (8). Maybe even more importantly, obesity also affects children's psychosocial outcomes, such as low self-esteem and depression, resulting from overweight concerns (9–17). These mechanisms may affect other aspects of children's lives, such as academic performance (18–22), with potentially even more serious adverse social outcomes in the long term. Although it is well known that lower educational achievement among adults is associated with obesity, recent research has also reported that obese adolescents consider themselves worse students (23). It is less known whether these findings hold for younger children or when objective measures of school performance are used. To our knowledge, there are only two international studies that have examined related issues. Li used data on primary

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school children in China and found that severely obese children had significantly lower IQ (intelligence quotient) scores than the controls (24). However, IQ is a measure of ability, and although it would be likely to affect school performance, it is not an indicator of academic achievement. Mo-suwan et al. examined the relationship between overweight status and academic performance in children from grades 3 to 6 and 7 to 9 using data from Thailand (25). They found that being overweight during adolescence (grades 7 to 9) was associated with poor school performance, whereas such an association did not exist in children (grades 3 to 6).

This paper is the first study, to our knowledge, to examine the relationship between childhood overweight and academic performance among younger children using data from the U.S. We used a national probability sample of kindergartners in the U.S. to examine whether overweight status in kindergarten was associated with poor academic performance during the first 2 years in school after controlling for socioeconomic characteristics and other potential confounders.

Research Methods and Procedures

We analyzed data from the Early Childhood Longitudinal Study-Kindergarten Class (ECLS-K).[1] (For a description of the ECLS-K, see http://nces.ed.gov/ecls/pdf/essaysmisc/ksum.pdf.) The ECLS-K surveyed a nationally representative cohort of kindergartners in the U.S. during the 1998 to 1999 school year. The sample was selected using a multistage cluster sampling design, where first schools were selected, and subsequently children within schools were selected. (For more information on the survey design and instruments, see 26.) The study collected detailed information on children and parent, teacher, and school characteristics at multiple time points. Baseline data were collected in fall of kindergarten (wave 1) followed by additional waves in spring kindergarten (wave 2), fall grade 1 (wave 3), and spring grade 1 (wave 4). We used data from waves 1, 2, and 4 for our analysis. (The fall grade 1 wave surveyed only a 30% subsample of baseline children; therefore, we did not use this wave for our analysis.) The average time between data collection in waves 1 and 4 was 18 months.

From the original sample of children assessed in fall kindergarten, 5% dropped out of the sample by spring kindergarten. An additional 17% dropped out between spring kindergarten and spring first grade. Most of the children lost to follow-up between kindergarten and first grade were those who changed schools. The ECLS followed up all movers from a random 50% of schools in the sample. Therefore, most of the children lost to follow-up were those randomly selected for no follow-up and would be unlikely to bias the results. In addition, data on the parent questionnaire were available for only 80% of the original sample. The nonresponse rates on the parent questionnaire tended to be higher among nonwhites. Finally, we included only children who were first time kindergartners. Our analysis sample consisted of 11,192 children for whom math and reading test scores were available for all the three waves and BMI was available at baseline. Among children for whom baseline data were available, there were no significant differences between those for whom test scores were available in later waves and those for whom test scores were not available in later waves, except that the former were more likely to be from high-income families.

The ECLS-K data are one of the first to collect information on school performance and childhood overweight status. An important feature of the ECLS-K is that it measured children's height and weight at each data collection period, instead of relying on parent reports of children's height and weight. Self-reported height and weight are not very reliable, and, among adults, there is a well-known tendency toward underreporting of weight and overreporting of height (27–29). For children, whose height and weight change rapidly, parent reports could introduce such high measurement error that even large substantial effects could be rendered statistically insignificant.

Dependent Variables

The dependent variables in our analysis were the child's reading and math test scores in waves 1, 2, and 4. Children surveyed in the ECLS-K were given individually administered math and reading assessments at each data collection point. In each subject area, assessments consisted of a two-stage assessment. In the first stage, children received a 12- to 20-item routing test. Performance on the routing items guided the selection of one of the several alternative second stage tests. The second stage test contained items of appropriate difficulty for the level of ability indicated by the routing test. Because not all children took the exact same test, item response theory (IRT) scale scores were computed for all children. IRT scores represent estimates of the number of items students would have answered correctly if they had taken all of the 92 questions in the first and second stage reading forms and the 64 questions in all of the mathematics forms. These scores are comparable across students within a wave and also across waves enabling comparison of children's performance over time. The reliability of test scores was very high: 0.93 for reading and 0.92 for math. (For detailed information on the tests administered, see 26.) We used standardized IRT scale scores in reading and mathematics to measure children's cognitive skills. These scores are an indicator of the child's performance relative to his or her peers. The standardized scores were rescaled to a mean of 50 and SD of 10. Therefore, a standardized score of 55 on the reading test represents a reading achievement

[1] Nonstandard abbreviations: ECLS-K, Early Childhood Longitudinal Study-Kindergarten Class; IRT, item response theory; HS, high school.

level that is one-half of an SD higher than the mean for fall kindergarten population represented by the tested sample of ECLS-K participants.

Explanatory Variables

The key explanatory variable was an indicator variable for the child's overweight status at baseline. We used the Centers for Disease Control-recommended definitions of overweight in children to construct our overweight measure (30–32). Children who had a BMI $\geq$ 95th percentile for their age and gender were classified as overweight. The ECLS collected children's height and weight measurements in each wave, and these were used to compute the BMI. The height and weight measurements were recorded by the assessor using the Shorr Board and a digital bathroom scale, respectively. All children were measured twice to minimize measurement error. If the two height values from the instrument were $<$2 inches apart, the average of the two height values was computed and used as the composite measure of height. Otherwise, the value that was closest to 43 inches (the average height for a 5-year-old child) was used as the composite. For the weight composite, if the two weight values from the instrument were $<$5 pounds apart, the average of the two values was computed. Otherwise, the value that was closest to 40 pounds (the average weight for a 5-year-old child) was used as the composite value. A composite BMI was calculated using the composite height and weight values and was multiplied by the appropriate factor to convert into kilograms per meter squared.

We used multivariate regression to control for socioeconomic factors and other potentially confounding factors that may be correlated with both childhood overweight and academic performance. There is some evidence that television watching among children is associated with greater likelihood of childhood overweight (33–36). We included a parent-reported measure of child's television watching—number of hours that the child watched television or videos on a typical school day. (Typically, the respondent for parent interviews was the child's mother. If the mother was not available, then the next selected respondent was another parent or guardian followed by another household member.) In addition, children's physical activity has also been linked to childhood overweight (36–38). More active children are less likely to be overweight. We included in our regressions the parent-reported physical activity of the child measured by the number of days in a week the child got exercise that caused rapid breathing, perspiration, and a rapid heart beat for 20 minutes or more. In addition, we included a variable that captured the level of parent-child interaction. The ECLS asked parents how often they participated in certain activities with their child, such as reading books to children, telling stories, playing sports, and singing songs. Our measure of parent-child interaction was defined as the number of activities that the parent participated in with the child at least once a week. Finally, we included the child's birth weight because there is evidence that low birth weight is associated with poor academic performance and may also be related to overweight status (39–41). Other explanatory variables in our analysis included race/ethnicity (white, black, Hispanic, Asian, others), mother's education [less than high school (HS) diploma, HS diploma, some college, bachelor's degree, and more than a bachelor's degree], annual family income, and urbanicity.

We present separate analyses for boys and girls. First, we obtained cross-sectional estimates of the effect of overweight status using only the fall kindergarten data. Next, we conducted a longitudinal regression analysis where we estimated the effect of overweight status on test scores in later waves, controlling for baseline test scores on entry into kindergarten, sociodemographic factors, and potential confounders. This model is identical to one where change scores are regressed on baseline test scores. Controlling for baseline test scores would partial out effects of other factors that determine school readiness and would allow us to examine the independent effect of obesity on academic achievement as a result of being in school. We also ran interaction models to examine whether the association between overweight status and test scores varied by race/ethnicity. Because of the clustered sample design, we adjusted the SEs of the regression using the Huber/White correction as implemented in the cluster option in Stata 7.0 (Stata Corporation, College Station, TX).

Results

The ECLS-K data show that about 1 in 10 kindergartners (11.1%) was overweight when he or she entered kindergarten in 1998. The prevalence of overweight was slightly higher in boys (12%) than girls (10.2%) ($p = 0.003$). Table 1 presents descriptive statistics for boys and girls separately, by overweight status. Overweight children were significantly more likely ($p < 0.05$) to be Hispanic and poor, and had less educated mothers compared with nonoverweight children. Overweight boys and girls also had significantly higher ($p < 0.05$) birth weight and watched more hours of television or videos per day compared with nonoverweight children. Boys living in suburban areas were less likely to be overweight ($p < 0.05$), whereas boys living in small towns or rural areas were more likely to be overweight ($p < 0.05$).

The simple bivariate estimates from Table 1 show that overweight boys scored 1.42 points lower ($p < 0.05$) in reading than nonoverweight boys at the beginning of kindergarten, with a similar difference among girls (1.66 points, $p < 0.05$). In math, the test score difference between overweight and nonoverweight boys was greater (1.99 points, $p < 0.05$), but it was lower among girls (1.21 points, $p < 0.05$).

Table 1. Descriptive statistics by gender and overweight status

	Boys			Girls		
	Not overweight	Overweight	Difference	Not overweight	Overweight	Difference
Fall kindergarten reading scores	50.55	49.12	1.42* (0.41)	52.28	50.62	1.66* (0.43)
Spring kindergarten reading scores	50.88	49.20	1.67* (0.40)	52.57	51.55	1.01* (0.40)
Spring grade 1 reading scores	51.14	49.85	1.30* (0.38)	52.65	51.84	0.81* (0.38)
Fall kindergarten math scores	52.28	50.29	1.99* (0.41)	52.07	50.86	1.21* (0.40)
Spring kindergarten math scores	52.47	50.84	1.63* (0.40)	52.06	50.81	1.24* (0.39)
Spring grade 1 math scores	52.34	50.87	1.46* (0.38)	51.57	50.32	1.26* (0.37)
White§	0.66	0.59	0.07* (0.02)	0.65	0.57	0.08* (0.02)
Black§	0.13	0.13	−0.00 (0.01)	0.14	0.18	−0.04* (0.01)
Hispanic§	0.12	0.16	−0.05* (0.01)	0.11	0.16	−0.05* (0.01)
Asian§	0.03	0.05	−0.02* (0.01)	0.04	0.03	−0.01 (0.01)
Mother's education§						
Less than high school diploma	0.09	0.11	−0.02* (0.01)	0.08	0.09	−0.01 (0.01)
High school diploma	0.29	0.31	−0.01 (0.02)	0.29	0.37	−0.08* (0.02)
Some college	0.34	0.35	−0.01 (0.02)	0.34	0.34	−0.00 (0.02)
Bachelor's	0.18	0.16	0.02 (0.02)	0.19	0.14	0.05* (0.02)
More than bachelor's	0.10	0.07	0.02* (0.01)	0.09	0.06	0.03* (0.01)
Family income ($)§						
<15,000	0.11	0.12	−0.01 (0.01)	0.12	0.15	−0.03* (0.01)
>15,000 and <25,000	0.11	0.15	−0.04* (0.01)	0.11	0.14	−0.03* (0.01)
>25,000 and <35,000	0.12	0.15	−0.03* (0.01)	0.11	0.14	−0.03* (0.01)
>35,000 and <50,000	0.17	0.17	−0.01 (0.02)	0.16	0.16	−0.00 (0.02)
>50,000 and <75,000	0.23	0.22	0.01 (0.02)	0.24	0.23	0.01 (0.02)
>75,000	0.27	0.19	0.08* (0.02)	0.26	0.18	0.08* (0.02)
Central city§	0.37	0.36	0.01 (0.02)	0.38	0.38	0.00 (0.02)
Urban fringe and large town§	0.21	0.17	0.04* (0.02)	0.20	0.19	0.01 (0.02)
Small town and rural§	0.23	0.26	−0.03* (0.02)	0.22	0.24	−0.01 (0.02)
Number of activities parent does with child at least once a week	8.40	8.35	0.05 (0.04)	8.29	8.27	0.02 (0.05)
Number of days per week child exercises for 20 minutes or more	4.18	4.19	−0.01 (0.09)	3.77	3.60	0.17* (0.10)
Birth weight (pounds)	7.06	7.45	−0.39* (0.05)	6.78	7.10	−0.31* (0.06)
Number of hours per day child watches TV or videos on weekdays	1.83	2.07	−0.24* (0.05)	1.75	1.91	−0.16* (0.05)
Number of observations	4,932	671	5,603¶	5,016	573	5,589¶

* $p < 0.05$; figures in parentheses are SEs of difference in means.
§ Figures reported are proportions in the population.
¶ The total sample size for the *t* tests.

The cross-sectional estimates from fall kindergarten, controlling for sociodemographics and other potential confounders, are reported in Tables 2 and 3 for boys and girls, respectively. Among boys, overweight status at the beginning of kindergarten was not significantly associated with reading test scores ($p = 0.088$), but overweight boys scored 1.22 points lower than nonoverweight boys ($p = 0.001$) in math. However, test scores of overweight girls did not differ

Table 2. Cross-sectional regression results for boys

	Fall kindergarten reading test scores		Fall kindergarten math test scores	
	Coefficient	**SE**	**Coefficient**	**SE**
Overweight at baseline	−0.640	(0.375)	−1.221**	(0.366)
Number of hours per day child watches television or videos	−0.289*	(0.146)	−0.303**	(0.116)
Number of days per week child exercises for 20 minutes or more	−0.110*	(0.054)	−0.024	(0.055)
Number of activities that parent participates in with child at least once a week	0.508**	(0.118)	0.491**	(0.110)
Child's birth weight (pounds)	0.166	(0.090)	0.308**	(0.088)
Black (reference = white)	−1.815**	(0.442)	−3.986**	(0.446)
Hispanic	−2.881**	(0.424)	−3.036**	(0.412)
Asian	2.142**	(0.744)	0.896	(0.661)
Other	−1.846**	(0.576)	−2.753**	(0.547)
Less than high school (reference = some college)	−4.556**	(0.438)	−4.781**	(0.494)
High school diploma	−1.881**	(0.303)	−1.855**	(0.306)
Bachelor's degree	2.595**	(0.384)	2.457**	(0.365)
More than bachelor's degree	3.755**	(0.536)	3.184**	(0.468)
<$15,000 (reference = >$75,000 family income)	−4.953**	(0.517)	−5.208**	(0.509)
$15,000 to $25,000	−3.167**	(0.495)	−3.518**	(0.460)
$25,000 to $35,000	−3.362**	(0.477)	−3.757**	(0.469)
$35,000 to $50,000	−2.242**	(0.413)	−2.630**	(0.394)
$50,000 to $75,000	−1.524**	(0.367)	−1.639**	(0.346)
Central city (reference = urban fringe and large town)	0.358	(0.360)	0.605	(0.342)
Small town and rural	−2.149**	(0.395)	−1.457**	(0.372)
Observations	5,603		5,603	
F statistic	52.95**		64.65**	
R^2	0.19		0.22	

* $p < 0.05$ and ** $p < 0.01$.
All regressions included a constant.

significantly from nonoverweight girls in either reading ($p = 0.064$) or math ($p = 0.355$). It is not surprising that the association between overweight status and academic performance weakened when we controlled for socioeconomic differences. In our study, children with family income greater than $75,000 and mothers with more than a bachelor's degree were significantly less likely ($p < 0.05$) to be overweight and also had significantly higher test scores ($p < 0.05$). Therefore, not controlling for socioeconomic status overestimated the association between overweight status and test scores. However, there may still exist other unobserved differences between overweight and nonoverweight children that may influence their academic performance when they enter kindergarten. As a result, cross-sectional estimates may still suffer from bias.

The longitudinal regression estimates are presented in Table 4 for boys and Table 5 for girls. Among boys, we found that after controlling for baseline test scores, overweight status did not have a significant effect on math scores in two subsequent waves. In reading, overweight boys scored 0.61 points lower at the end of kindergarten ($p = 0.017$). However, this difference became statistically insignificant at the end of first grade ($p = 0.142$). Among girls, overweight status did not have a statistically significant effect on either math or reading scores in subsequent waves after controlling for baseline test scores. Figures 1

Table 3. Cross-sectional regression results for girls

	Fall kindergarten reading test scores		Fall kindergarten math test scores	
	Coefficient	**SE**	**Coefficient**	**SE**
Overweight at baseline	−0.680	(0.366)	−0.324	(0.350)
Number of hours per day child watches television or videos	−0.474**	(0.127)	−0.372**	(0.103)
Number of days per week child exercises for 20 minutes or more	−0.008	(0.053)	−0.057	(0.050)
Number of activities that parent participates in with child at least once a week	0.444**	(0.111)	0.557**	(0.108)
Child's birth weight (pounds)	0.433**	(0.094)	0.605**	(0.092)
Black (reference = white)	−0.704	(0.441)	−2.510**	(0.370)
Hispanic	−1.884**	(0.410)	−2.598**	(0.358)
Asian	2.375**	(0.682)	0.436	(0.578)
Other	−1.900**	(0.708)	−2.324**	(0.590)
Less than high school (reference = some college)	−4.694**	(0.439)	−3.821**	(0.442)
High school diploma	−1.634**	(0.302)	−1.659**	(0.277)
Bachelor's degree	2.396**	(0.348)	2.041**	(0.320)
More than bachelor's degree	4.535**	(0.494)	3.605**	(0.448)
<$15,000 (reference = >$75,000 family income)	−6.184**	(0.512)	−5.767**	(0.481)
$15,000 to $25,000	−4.884**	(0.511)	−4.032**	(0.439)
$25,000 to $35,000	−3.233**	(0.462)	−2.904**	(0.415)
$35,000 to $50,000	−2.264**	(0.400)	−1.947**	(0.369)
$50,000 to $75,000	−1.427**	(0.361)	−1.291**	(0.320)
Central city (reference = urban fringe and large town)	−0.022	(0.346)	0.084	(0.310)
Small town and rural	−1.186**	(0.418)	−1.049**	(0.367)
Observations	5,589		5,589	
F statistic	66.46**		69.59**	
R^2	0.23		0.23	

* $p < 0.05$ and ** $p < 0.01$.
All regressions included a constant.

and 2 show the estimated test score differences at the end of kindergarten and first grade between overweight and nonoverweight children for boys and girls, respectively. These estimates were computed assuming no baseline test score differences between overweight and nonoverweight children. The "adjusted" scores are based on the estimates from the longitudinal models, whereas the "unadjusted" scores capture the raw mean scores for the overweight children. The figures emphasize the importance of sociodemographic factors and other controls in the models in explaining the test score differentials between overweight and nonoverweight children. In fact, in all cases, the score differential by overweight status was completely explained by these factors.

We also examined whether the association between overweight status and test scores varied by race/ethnicity by including interactions between overweight status and race/ethnicity in the previous regressions (data not shown). We did not find any statistically significant differences by race/ethnicity in the effect of overweight on test scores. However, the main effects of race/ethnicity on test scores in later waves, controlling for baseline scores, remained large and statistically significant.

Other variables included in the models had much stronger effects on children's academic performance compared with overweight status (Tables 4 and 5). Mother's education was a stronger predictor of test scores compared with overweight status in boys and girls. For example, boys with

Table 4. Longitudinal regression results for boys

	Spring kindergarten reading test score		Spring grade 1 reading test score		Spring kindergarten math test score		Spring grade 1 math test score	
	Coefficient	**SE**	**Coefficient**	**SE**	**Coefficient**	**SE**	**Coefficient**	**SE**
Overweight at baseline	−0.608*	(0.253)	−0.427	(0.291)	0.011	(0.224)	−0.078	(0.266)
Number of hours per day child watches television or videos	−0.262**	(0.073)	−0.011	(0.074)	−0.261**	(0.063)	−0.176*	(0.074)
Number of days per week child exercises for 20 minutes or more	−0.005	(0.037)	−0.036	(0.044)	−0.015	(0.033)	−0.018	(0.041)
Number of activities that parent participates in with child at least once a week	0.079	(0.083)	0.113	(0.092)	0.075	(0.069)	0.088	(0.088)
Child's birth weight (pounds)	0.093	(0.064)	0.122	(0.071)	0.023	(0.056)	0.016	(0.069)
Baseline test score (fall kindergarten)	0.732**	(0.010)	0.571**	(0.011)	0.776**	(0.010)	0.633**	(0.011)
Black (reference = white)	−0.622	(0.362)	−1.785**	(0.378)	−1.557**	(0.287)	−2.223**	(0.323)
Hispanic	0.803*	(0.339)	0.553	(0.339)	−0.198	(0.257)	0.088	(0.314)
Asian	1.402**	(0.440)	1.390**	(0.505)	0.416	(0.396)	−0.270	(0.441)
Other	−0.101	(0.369)	−0.117	(0.458)	−0.507	(0.347)	−0.791	(0.422)
Less than high school (reference = some college)	−1.161**	(0.367)	−2.072**	(0.436)	−0.226	(0.324)	−0.836*	(0.407)
High school diploma	−0.219	(0.220)	−0.351	(0.238)	−0.099	(0.182)	−0.163	(0.214)
Bachelor's degree	−0.013	(0.232)	0.437	(0.240)	0.134	(0.213)	0.097	(0.238)
More than bachelor's degree	0.551	(0.281)	0.437	(0.307)	0.848**	(0.293)	0.578*	(0.279)
<$15,000 (reference = >$75,000 family income)	−0.979**	(0.371)	−1.680**	(0.428)	−0.314	(0.324)	−0.787*	(0.400)
$15,000 to $25,000	0.017	(0.337)	−0.705	(0.386)	−0.215	(0.299)	−0.119	(0.320)
$25,000 to $35,000	0.081	(0.328)	−0.284	(0.349)	0.350	(0.274)	−0.285	(0.312)
$35,000 to $50,000	0.323	(0.290)	0.077	(0.307)	0.148	(0.239)	−0.074	(0.269)
$50,000 to $75,000	0.042	(0.228)	0.003	(0.250)	0.246	(0.211)	0.083	(0.226)
Central city (reference = urban fringe and large town)	0.269	(0.264)	0.199	(0.261)	0.315	(0.217)	0.103	(0.233)
Small town and rural	0.020	(0.327)	−0.178	(0.341)	0.121	(0.257)	−0.384	(0.296)
Observations	5,603		5,603		5,603		5,603	
F statistic	344.00**		165.31**		406.74**		205.66**	
R^2	0.62		0.47		0.69		0.54	

* $p < 0.05$ and ** $p < 0.01$.
All regressions included a constant.

mothers who had less than HS education scored 1.16 points and 2.07 points lower on reading tests at the end of kindergarten and first grade, respectively, compared with boys with mothers who had some college education. This finding held for both math and reading scores for boys and girls. Race/ethnicity also had a much stronger effect on test scores compared with overweight status. Specifically, blacks scored significantly lower over time compared with whites

Table 5. Longitudinal regression results for girls

	Spring kindergarten reading test score		Spring grade 1 reading test score		Spring kindergarten math test score		Spring grade 1 math test score	
	Coefficient	**SE**	**Coefficient**	**SE**	**Coefficient**	**SE**	**Coefficient**	**SE**
Overweight at baseline	0.184	(0.225)	0.210	(0.268)	−0.252	(0.239)	−0.431	(0.257)
Number of hours per day child watches television or videos	−0.093	(0.083)	−0.049	(0.080)	−0.228**	(0.063)	−0.061	(0.075)
Number of days per week child exercises for 20 minutes or more	0.033	(0.035)	−0.091*	(0.037)	0.028	(0.032)	−0.034	(0.036)
Number of activities that parent participates in with child at least once a week	0.100	(0.075)	0.334**	(0.085)	−0.003	(0.068)	0.133	(0.079)
Child's birth weight (pounds)	0.262**	(0.061)	0.165*	(0.070)	0.202**	(0.055)	0.271**	(0.064)
Baseline test score (fall kindergarten)	0.722**	(0.010)	0.569**	(0.010)	0.755**	(0.009)	0.609**	(0.012)
Black (reference = white)	−1.156**	(0.291)	−1.481**	(0.301)	−1.551**	(0.283)	−2.144**	(0.307)
Hispanic	0.876**	(0.295)	0.659*	(0.284)	0.202	(0.268)	0.096	(0.297)
Asian	1.373**	(0.369)	1.193**	(0.357)	0.157	(0.347)	−0.261	(0.376)
Other	0.128	(0.386)	−0.542	(0.422)	−0.275	(0.338)	−0.918*	(0.414)
Less than high school (reference = some college)	−0.749*	(0.363)	−1.334**	(0.393)	−1.113**	(0.297)	−1.078**	(0.360)
High school diploma	−0.231	(0.194)	−0.172	(0.214)	−0.167	(0.183)	−0.418*	(0.206)
Bachelor's degree	0.023	(0.206)	0.076	(0.234)	0.059	(0.194)	0.291	(0.223)
More than bachelor's degree	−0.223	(0.266)	−0.137	(0.305)	0.219	(0.248)	0.265	(0.298)
<$15,000 (reference = >$75,000 family income)	−0.489	(0.344)	−1.213**	(0.364)	−0.157	(0.313)	−0.394	(0.352)
$15,000 to $25,000	−0.245	(0.315)	−0.787*	(0.339)	−0.566	(0.305)	−0.531	(0.331)
$25,000 to $35,000	−0.044	(0.300)	−0.139	(0.310)	0.175	(0.279)	0.386	(0.304)
$35,000 to $50,000	0.182	(0.247)	0.070	(0.252)	−0.206	(0.235)	−0.091	(0.264)
$50,000 to $75,000	0.123	(0.205)	−0.253	(0.211)	0.084	(0.199)	0.236	(0.224)
Central city (reference = urban fringe and large town)	0.284	(0.236)	0.149	(0.229)	0.287	(0.208)	0.030	(0.219)
Small town and rural	0.205	(0.300)	−0.041	(0.268)	0.330	(0.240)	−0.087	(0.275)
Observations	5,589		5,589		5,589		5,589	
F statistic	307.56**		189.77**		404.01**		177.38**	
R^2	0.63		0.50		0.67		0.53	

SEs in parentheses.
* $p < 0.05$ and ** $p < 0.01$.
All regressions included a constant.

in reading and math. The numbers of hours of television or video watched per day was also an important predictor of test scores in later waves. For example, boys who watched 2 additional hours of television or videos per day scored 0.52 points lower ($p = 0.00$) in reading at the end of kindergarten.

Discussion

This paper provides new evidence on the relationship between childhood overweight and academic performance using a nationally representative data set of kindergartners in the U.S. Simple comparisons of mean test scores in reading and math by overweight status indicate that there is

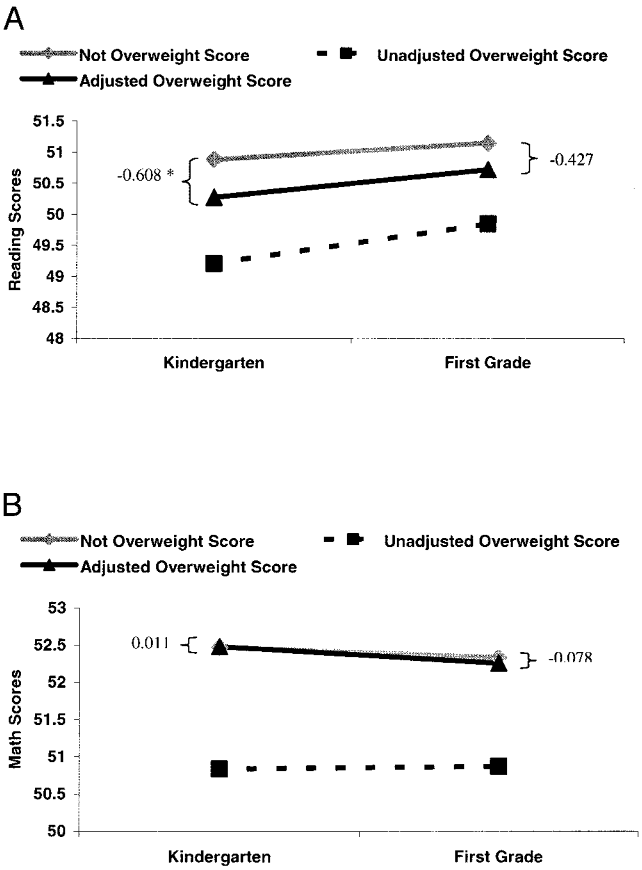

Figure 1: Standardized reading (A) and standardized mathematics (B) test scores by overweight status for boys. Bracketed values indicate difference in scores for adjusted nonoverweight (gray lines and diamonds) and overweight (black lines and triangles) boys. Unadjusted overweight scores are also shown (hatched lines and squares).

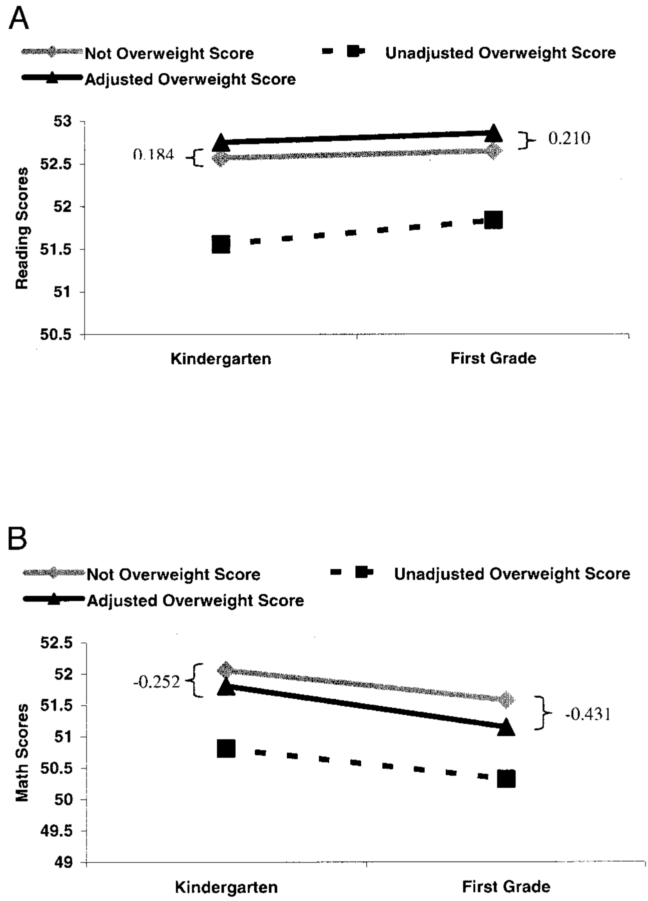

Figure 2: Standardized reading (A) and standardized mathematics (B) test scores by overweight status for girls. Bracketed values indicate difference in scores for adjusted nonoverweight (gray lines and diamonds) and overweight (black lines and triangles) girls. Unadjusted overweight scores are also shown (hatched lines and squares).

a statistically significant association between childhood overweight and test scores—overweight kindergartners scored lower than their nonoverweight peers on standardized tests. Controlling for socioeconomic differences and other potential confounding factors weakened the association between overweight and test scores at baseline among boys and girls, although it remained statistically significant for boys' math test scores. Our controls were more comprehensive than prior studies because the ECLS-K also measured behavioral factors that may be associated with both overweight status and poorer academic performance, such as a cognitively stimulating home environment (42), exercise (36–38), and television watching (33–35). In fact, it might even be argued that we overcontrolled for some factors, especially physical activity and television watching, for which obesity may be as much a cause as a consequence.

Even with a rich set of controls, a cross-sectional analysis may not control for unobserved differences between overweight and nonoverweight children that affect their test scores. For example, lifestyle and quality of home environment are hard to observe and may not be fully captured by the measures included in our study. Moreover, a cross-sectional analysis does not help in establishing the directionality of the effect. Lower test scores may cause overweight among children just as overweight status may lead to lower test scores.

The ECLS-K data allowed us to examine the relationship between childhood overweight and test scores longitudinally. Our longitudinal approach tried to control for some of these unobserved differences that may exist between overweight and nonoverweight children by controlling for children's baseline test scores. By doing so, this approach placed all children at the same achievement level at baseline and examined whether future test scores were related to baseline overweight status.

The results from our longitudinal approach are identical to a model where gain scores are regressed on baseline scores. Our findings suggest that after controlling for socioeconomic characteristics, there was no statistically significant difference in test score gains during the first 2 years in school between overweight and nonoverweight children. As a result, the baseline test score gap that existed between overweight and nonoverweight children persisted even at the end of first grade. We found no differences by race/ethnicity in the relationship between overweight and test scores.

The effect sizes associated with overweight among boys were between SDs of 0.06 and 0.12. These estimates suggest that overweight in boys may be a greater risk factor for academic performance than other childhood health risks, such as food insufficiency, diabetes, or asthma. Studies that have examined the relationship between academic performance and other childhood health risks have tended to find effect sizes that are lower than those found in this paper. Alaimo et al. found that food insufficiency among 6- to 11-year-old children is associated with a 0.02 and 0.07 SD decrease in reading and math standardized test scores, respectively (43). The effect of diabetes on children's cognitive skills has been shown to be insignificant (44). Even asthma, which is known to be a major cause of morbidity in childhood, has been found to have no significant association with children's academic performance (45–48). However, some other socioeconomic factors, especially mother's education and race/ethnicity, seem to have a far stronger association with test scores than overweight status.

It is also important to bear in mind that small or insignificant associations between overweight status and academic performance do not necessarily imply that overweight is not important for academic performance, because the effects of overweight may appear with a time lag. For example, Erickson et al. showed that overweight in adolescent girls is significantly associated with negative psychological outcomes, which may, in turn, affect their academic performance (9). Although we found no differences by overweight status in test score gains, we observed only the first 2 years of schooling. Future waves of the ECLS-K data will allow the examination of whether these relationships become important as children grow older.

In summary, we found a significant test score gap in math and reading between overweight vs. nonoverweight children at baseline and, because both groups gain similarly over time, at follow-up. However, these differences, except for boys' math scores at baseline, became insignificant after including socioeconomic and behavioral variables. These findings indicate that overweight is a marker, but not a causal factor, affecting academic performance. In addition, race/ethnicity and mother's education are stronger predictors of test score gains or levels than overweight status. However, even though the significant differences in test scores by overweight status can be explained with other individual characteristics, especially parental education and the home environment, overweight is more easily observable by students compared with other socioeconomic characteristics, and its significant (unadjusted) association with worse academic performance can contribute to the stigma of overweight as early as the first years of elementary school.

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