ORIGINAL ARTICLE

The academic penalty for gaining weight: a longitudinal, change-in-change analysis of BMI and perceived academic ability in middle school students

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BACKGROUND/OBJECTIVES: Worse educational outcomes for obese children regardless of academic ability may begin early in the life course. This study tested whether an increase in children's relative weight predicted lower teacher- and child-perceived academic ability even after adjusting for standardized test scores.
SUBJECTS/METHODS: Three thousand three hundred and sixty-two children participating in the Early Childhood Longitudinal Study–Kindergarten Cohort were studied longitudinally from fifth to eighth grade. Heights, weights, standardized test scores in maths and reading, and teacher and self-ratings of ability in maths and reading were measured at each wave. Longitudinal, within-child linear regression models estimated the impact of a change in body mass index (BMI) z-score on change in normalized teacher and student ratings of ability in reading and maths, adjusting for test score.
RESULTS: A change in BMI z-score from fifth to eighth grade was not independently associated with a change in standardized test scores. However, adjusting for standardized test scores, an increasing BMI z-score was associated with significant reductions in teacher's perceptions of girls' ability in reading (−0.12, 95% confidence interval (CI): − 0.23, − 0.03, P = 0.03) and boys' ability in math (−0.30, 95% CI: − 0.43, − 0.17, P < 0.001). Among children who were overweight at fifth grade and increased in BMI z-score, there were even larger reductions in teacher ratings for boys' reading ability (−0.37, 95% CI: − 0.71, − 0.03, P = 0.03) and in girls' self-ratings of maths ability (−0.47, 95% CI: − 0.83, − 0.11, P = 0.01).
CONCLUSIONS: From fifth to eighth grade, increase in BMI z-score was significantly associated with worsening teacher perceptions of academic ability for both boys and girls, regardless of objectively measured ability (standardized test scores). Future research should examine potential interventions to reduce bias and promote positive school climate.

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INTRODUCTION

Educational attainment is a key component of socioeconomic status,[1] which in turn is a strong and consistent predictor of overall health, including obesity and its sequelae.[2–4] However, in a damaging feedback loop, obese individuals have diminished educational attainment, wages, and social and economic standing.[5–6] This disparity is more pronounced for obese women than obese men. Compared with non-obese women, obese women complete fewer years of schooling and have decreased likelihood of marriage, higher risk of household poverty and lower household income, regardless of intelligence or ability.[7] Obese women have lower wages[6] and less likelihood of being hired[8] than obese men, and show higher rates of body dissatisfaction, report more symptoms of psychological distress and have more problems with self-esteem than obese men.[9–11]

Weight bias, or weight-based discrimination, is a key mechanism linking obesity and diminished social and educational opportunities.[12] Weight bias in the United States is rooted in widely held stereotypes that present obese individuals as possessing several negative characteristics, most typically including laziness and lack of motivation, self-discipline, competence and morality.[13] Stigmatization based on weight can also lead to increases in energy intake and body mass index (BMI).[14–16]

Although overweight and obesity have become more normative, weight-related discrimination has increased over time.[17] Children tend to exhibit weight-related biases toward other children from an early age, and estimates of the past-year prevalence of weight-based teasing and bullying among children and adolescents range from 24 to 36%.[18–19] Children may be subjected to weight bias from adults as well; physical education instructors have been shown to have negative beliefs and attitudes about obese individuals[20–21] and parents may offer fewer resources to obese compared with non-obese daughters.[22] Less is known about whether children are likely to experience weight-related discrimination and biases from classroom teachers.[23]

Several studies have examined the possible relationship between weight status and academic performance in children and adolescents. In general, studies that use objective measures of ability, such as standardized test scores, find no association between weight and academic performance[24–26] (with some exceptions[27]), whereas other studies that have used more subjective measures such as teacher-assigned grades have found that obesity is associated with poorer academic achievement.[28] Three studies have examined both test scores and teacher assessments of ability in the same study participants across a wide range of age groups and found that obesity is not

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associated with test scores but is associated with lower teacher assessments.[29–31]

Subjective measures of ability matter. Teachers' perceptions of children's academic abilities can have lasting consequences on student's educational trajectories, boosting the academic performance of children perceived as better-performing and diminishing the performance of those perceived as worse-performing; the impact of teacher expectations is even stronger for lower-income and racial minority children.[32] Students' perceptions of their own ability can also impact their performance; when students perceive themselves to be less academically able or are part of a marginalized group that is subject to a stereotype of being less academically able, they tend to perform worse, regardless of previously measured ability.[33–35] More directly, teacher-assigned ratings of ability in the form of grades have a direct and tangible impact on student's futures—grades are examined as a key indicator of ability by secondary schools and colleges.

This study aims to evaluate simultaneously the relationship between student body size, standardized test scores and teacher- and self-perceived academic ability, and to determine whether differences in teacher and student perceptions of ability associated with body size are observed even when there is no difference in objectively measured ability. This analysis focuses on children's weight status and academic outcomes from fifth to eighth grade, as prior studies suggest that middle school is a critical period for overall reductions in academic performance, children's self-concept and perceptions of academic competence,[36,37] and body dissatisfaction; it is important to understand how weight status may affect academic outcomes and teacher and self-perceptions during this crucial stage. We hypothesize that children with higher BMI z-scores in middle school experience lower subjective ratings of achievement even after any potential differences in objective measures of achievement are taken into account. Given gender differences in the relationship between obesity and educational outcomes observed previously, all analyses were stratified by gender.

SUBJECTS AND METHODS

Data collection and sample
The study sample consisted of children who participated in the Early Childhood Longitudinal Survey–Kindergarten Cohort (ECLS-K), a nationally representative, longitudinal study of children's educational experiences and development from kindergarten to eighth grade. The ECLS-K used a three-stage probability sampling method, originally sampling 22 666 children within 1277 public and private kindergartens within 100 counties. Data collection began in 1998–1999 and continued to 2006–2007. A total of 8960 children were assessed by study personnel at both fifth and eighth grade; of this group, we excluded children with missing information on weight status or academic outcomes, as well as children with implausible BMI values, resulting in a sample of 3626. Although we had intended to separately model outcomes for underweight children, as they have also been shown to have poorer school experiences, the number of underweight children in the sample was relatively small ($n = 269$) and so were excluded. This resulted in a final sample consisting of 3362 children, or 37.5% of the sample that was available for fifth to eighth grade and 14.8% of the original sample taken in kindergarten. Excluded children were slightly older and were more likely to be male than children who remained in the sample. This research does not meet the definition of human subjects research; therefore, Institutional Review Board approval was not obtained.

Measures
BMI z-score and weight status. At each wave, children's heights were measured to the nearest quarter-inch using a Shorr board. Children's weights were measured to the nearest half-pound using a Seca digital scale. BMI at each time point was calculated and BMI z-scores for age and sex were computed by comparing to the Centers for Disease Control and Prevention's 2000 Growth Charts.[38] Children were classified as overweight if their BMI was at or above the 85th percentile for their age and sex, obese

if their BMI was at or above the 95th percentile and underweight if their BMI was below the 5th percentile.

Covariates. The following constructs have been demonstrated to be empirically associated with both childhood obesity and academic achievement: race/ethnicity and socioeconomic status,[39,40] physical activity,[41,42] television watching,[43] maternal depression,[44] overall child health and family characteristics such as family structure and parent–child interaction.[45–47] Race/ethnicity, annual family income and highest parental education (as proxies for socioeconomic status), number of days per week in which a child was physically active for more than 20 min, hours of TV watched per week, single-parent household status, maternal depression, overall child health and parental disciplinary behaviors were all recorded via parent interview at fifth grade; parents also reported these variables at eighth grade, except for physical activity and hours of television watched, which were reported by the child.

Academic ability: objectively measured. At each wave, children took standardized tests, designed by the ECLS-K, to measure their aptitude in maths and reading. The tests consisted of two stages. First, children took a routing test to place them into a test with the appropriate level of difficulty; next, children took the test for which the routing test had qualified them. To account for these differences in the tests (that is, a child taking a more difficult maths test might be more likely to get a lower raw score than a child taking an easier maths test, even though they may have higher aptitude in maths), children's responses were scaled according to Item Response Theory, using patterns of correct and incorrect answers to create a standardized and comparable score across different assessments. The scores are also comparable from wave to wave so that a child's academic progress over time can be assessed. Maths scores could range from 0 to 174, whereas reading scores could range from 0 to 212. The ECLS-K assessments demonstrated internal consistency reliability (Cronbach's a) ranging from 0.70 to 0.88. They also demonstrated content validity, as the frameworks guiding the tests are largely the same as those used by the National Assessment of Educational Progress, widely viewed as the gold standard measure of achievement in the field of education.[48]

Academic ability: subjectively measured. In fifth grade, each child's primary classroom teacher rated his or her performance on maths and reading separately using the Academic Rating Scale. Teachers were asked about specific skills (for example, ability to reduce fractions), knowledge (for example, recognition of concepts such as area and volume) and behavior (for example, how often the child works to the best of his or her ability), and for each item were asked to rate children's performance with regard to the specific skill or knowledge tapped by the item as 'Outstanding (5),' 'Very Good (4),' 'Good (3),' 'Fair (2)' or 'Poor (1).' An overall score was calculated by ECLS-K study staff and scale to have a low value of 1 and a high value of 5. The Academic Rating Scale demonstrated very good internal consistency reliability, with Cronbach's a ranging from 0.93 to 0.95,[48] and also demonstrated criterion validity as the ratings are significantly positively correlated with standardized test scores. In the eighth-grade wave, subject-matter teachers completed similar subject-specific scales.

Beginning in the third-grade wave of data collection, children also completed three scales, each with eight items, designed to measure children's rating of their perceived interest and competence in reading, maths and all subjects in general. These scales demonstrated acceptable internal consistency reliability, with Cronbach's a ranging from 0.79 to 0.90,[48] and are also significantly and positively correlated with standardized test scores, demonstrating criterion validity.

Statistical analysis
To evaluate the relationships between children's weight and subjective and objective measures of academic achievement, linear within-child change-in-change models (also known as fixed effects regression models[49]) were used. The key benefit to regression of within-child changes is that it removes the influence of confounders that are stable over time whether the confounders are measured or unmeasured. Although a typical regression model compares study participants who are as similar as possible on as many measurable confounders as possible, trying to isolate the impact of an exposure by comparing an exposed individual to a similar unexposed individual, this approach has each individual serve as his or her own control, eliminating the influence of between-individual differences in confounding variables.[49]

These models were based on the fifth and eighth grade waves and examined the impact of changes in BMI z-score between the two waves on changes in objectively and subjectively measured academic outcomes in reading and maths. Although change in obesity status (that is, changing to either below, or at or above the 95th BMI percentile from fifth to eighth grade) was considered as an exposure, very few children in our sample actually changed according to this metric from fifth to eighth grade, reducing our statistical power to detect any differences in academic achievement using a fixed effects approach. Using this binary cutoff also eliminates the possibility of examining changes in relative BMI within weight categories, potentially missing children whose appearances may have changed in such a way that others would perceive them as more or less overweight. Therefore, BMI z-score, a continuous measure of relative BMI in childhood, was chosen as a more precise measure of relative weight. Modeling BMI z-score continuously assumes, however, that an increase in BMI z-score among healthy-weight children would have the same impact on others' perceptions of weight status as a change among overweight or obese children. Therefore, we also estimated models that included an interaction term between fifth grade overweight or obese status and BMI z-score change, to see whether or not an increase in relative BMI had a larger effect among children who were already at risk for being perceived as overweight or obese.

The primary outcomes were changes in teacher ratings of student ability and student self-ratings of ability (subjective measures of academic ability) after adjusting for standardized test scores (objective measure of academic ability). To enable comparisons of these measures, all measures were standardized to a mean of 0 and s.d. of 1. Changes in potential time-varying confounders, including changes in family structure, family income, child health status, days per week in which a child had at least 20 min of vigorous activity and hours per week of TV watching were also calculated but were ultimately not included in the fixed effects model, because they were not significantly associated with the exposures or outcomes in these data (possibly because the magnitude of changes for these variables tended to be small); age was the only time-varying confounder included in the models and time-stable covariates such as race/ethnicity or socioeconomic status were not included, as they are differenced out of change-in-change models. All models were stratified by gender. All tests were two-sided. Models were estimated using PROC SURVEYREG in SAS v. 9.3 (SAS Institute, Cary, NC, USA), to account for the complex sampling design.

RESULTS

Sample characteristics from fifth to eighth grade

Weighted averages and frequencies of fifth grade (baseline) characteristics are shown in Table 1. The sample was over half White, followed by Hispanic (18%) and Black or African American (16%); smaller numbers of children were identified as Asian–American–Pacific Islander, American Indian, or Multiracial. Nearly a quarter lived in a single-parent household at baseline. Most children lived in families with a total income of < $75,000 per year. Over one-fifth of the sample was classified as obese in fifth grade, whereas about 41% was overweight or obese; these percentages changed only slightly from fifth to eighth grade, although about a fifth of the sample changed their weight status either to or from overweight between the two time points. Children watched a substantial amount of television at baseline (15.8 h per week) and also substantially increased their TV watching from fifth to eighth grade, by an average of almost 7 additional hours per week. On average, both objective and subjective measures of achievement appeared to decrease slightly from fifth to eighth grade.

Primary analysis: change in perceptions of ability associated with change in BMI z-score

A change in BMI z-score was not associated with changes in standardized test scores for either boys or girls, in any subject (Table 2). However, increases in BMI z-score were significantly

Table 1. Sociodemographic characteristics, standardized test scores, academic ratings and prevalence of overweight and obesity

	Fifth grade (baseline) N (weighted%) or mean (s.e.)	Eighth grade (follow-up)	Change (if applicable)
Female	1700 (49.4%)	No change	
Age range (years)	9.17–13.83		
Race/ethnicity		No change	
Non-Hispanic White	2157 (57.8%)		
Black/African American	328 (16.5%)		
Hispanic	521 (18.2%)		
Asian-American/Pacific Islander	226 (4.1%)		
American Indian	60 (1.6%)		
Multiracial	70 (1.7%)		
Single-parent household	623 (25.3%)	584 (24.0%)	265 (11.0%)
Highest parental education			
< High school	190 (7.8%)	162 (7.2%)	
High school to some college	1696 (55.3%)	1554 (53.3%)	
College and beyond	1353 (36.9%)	1319 (39.5%)	
Family income			
< $75,000 per year	2166 (71.6%)	1849 (63.8%)	481 (15.6%)
Days per week of >20-min exercise	3.80 (0.06)	4.60 (0.06)	0.78 (0.06)
TV hours per week	15.78 (0.34)	24.06 (0.71)	8.09 (0.44)
Overweight	1328 (41.0%)	1201 (37.0%)	677 (21.0%)
Obese	682 (20.1%)	622 (20.1%)	296 (8.8%)
BMI z-score	0.70 (0.03)	0.71 (0.03)	0.03 (0.01)
Standardized test score, reading	148.51 (0.80)	166.23 0.96)	17.41 (0.49)
Standardized test score, maths	122.04 (0.83)	138.62 (0.77)	16.55 (0.25)
Teacher rating, reading	3.40 (0.02)	2.93 (0.02)	− 0.49 (0.02)
Teacher rating, maths	3.40 (0.02)	2.99 (0.03)	− 0.41 (0.02)
Self-rating, reading	2.99 (0.02)	2.52 (0.01)	− 0.48 (0.01)
Self-rating, maths	2.92 (0.01)	2.60 (0.02	− 0.31 (0.01)

Abbreviations: BMI, body mass index; ECLS–K, Early Childhood Longitudinal Study–Kindergarten Cohort. Sociodemographic characteristics, standardized test scores, academic ratings and prevalence of overweight and obesity at fifth grade (baseline) among sub-sample (n = 3362) of the ECLS–K.

Table 2. Changes (95% CI) in standardized test scores and teacher- and self-ratings of academic ability

	Change in test score	Change in teacher ratings		Change in self-ratings	
	Minimally adjusted[a]	Minimally adjusted[a]	Fully adjusted[b]	Minimally adjusted[a]	Fully adjusted[b]
Girls (n = 1700)					
Reading					
BMI *z*-score change	− 0.03 (−0.13, 0.07)	− 0.12 (− 0.23, − 0.01)*	− 0.12 (− 0.23, − 0.01)*	−0.03 (−0.20, 0.13)	−0.03 (−0.20, 0.13)
Standardized test score change	—	—	0.20 (0.08, 0.31)**	—	0.12 (−0.008, 0.24)
Maths					
BMI *z*-score change	− 0.01 (−0.08, 0.06)	− 0.13 (−0.27, 0.01)	− 0.13 (− 0.27, 0.01)	− 0.10 (−0.27, 0.07)	− 0.10 (−0.27, 0.07)
Standardized test score change	—	—	0.11 (−0.03, 0.25)	—	0.19 (0.03, 0.35)*
Boys (n = 1662)					
Reading					
BMI *z*-score change	− 0.09 (−0.10, 0.02)	− 0.07 (−0.24, 0.10)	− 0.06 (−0.24, 0.11)	− 0.15 (−0.32, 0.02)	− 0.14 (−0.31, 0.03)
Standardized test score change	—	—	0.12 (0.02, 0.22)*	—	0.14 (0.02, 0.26)*
Maths					
BMI *z*-score change	0 (−0.08, 0.08)	− 0.30 (− 0.43, − 0.17)***	− 0.30 (− 0.43, − 0.17)***	− 0.17 (−0.35, 0.01)	−0.17 (−0.35, 0.01)
Standardized test score change	—	—	0.12 (−0.005, 0.25)	—	0.11 (−0.06, 0.28)

Abbreviations: BMI, body mass index; CI, confidence interval; ECLS–K, Early Childhood Longitudinal Study–Kindergarten Cohort. Changes (95% CI) in standardized test scores and teacher- and self-ratings of boys' and girls' maths and reading abilities from fifth to eighth grade and impact of change in BMI *z*-score, ECLS–K. *$P < 0.05$, **$P < 0.01$, ***$P < 0.001$. [a]Minimally adjusted model regresses change in BMI *z*-score from fifth to eighth grade on change in teacher or self-ratings from fifth to eighth grade, adjusting for age. [b]Fully adjusted model includes a term for change in standardized test score from fifth to eighth grade in addition to change in BMI *z*-score.

associated with lower teacher ratings of ability in reading for girls and maths for boys (Table 2), with a one-unit increase in BMI *z*-score associated with a 0.12 s.d. decrease in teacher ratings of girls' reading ability (95% confidence interval (CI) − 0.23, − 0.01, $P = 0.03$) and a 0.30 s.d. decrease in teacher ratings of boy's maths ability (95% CI: − 0.43, − 0.17, $P < 0.001$).

The observed reductions in teacher ratings of girls' academic ability in reading and boys' ability in maths for increases in BMI *z*-score persisted even after taking standardized test scores into account, with little to no attenuation (Table 2). In other words, teachers appeared to be rating children with higher BMI *z*-score as having less ability even if their objectively measured ability did not change. Adjusting for standardized test score also did not change the estimated relationships between BMI *z*-score and student self-perceptions.

Change in perceptions of ability accounting for overweight status at baseline

After introducing an interaction term for overweight status at fifth grade and BMI *z*-score change, we found that there was not a significant interaction between baseline overweight status and BMI *z*-score change for most gender and outcome relationships. This interaction was significant, however, among girls with regards to self-ratings of maths ability. For girls starting out overweight, an increase in BMI *z*-score was associated with an extra reduction in self-ratings of maths ability by − 0.47 more units (95% CI: − 0.83, − 0.11, $P = 0.01$) compared with non-overweight girls increasing in BMI *z*-score. The interaction was also significant for boys with regards to teacher ratings of reading ability, so that boys who started as overweight at fifth grade and gained in BMI *z*-score had teacher ratings that decreased by an average of − 0.37 units (95% CI: − 0.71, − 0.04, $P = 0.03$) more than ratings for a non-overweight boy who increased in BMI *z*-score.

DISCUSSION

This study demonstrates that teachers tend to rate girls with higher BMI *z*-score as having lower abilities in reading compared with their same-gender, thinner peers, whereas boys with higher BMI *z*-score are rated by teachers as having lower ability in maths. To put these penalties for higher BMI *z*-score in perspective, the

change in girls' teacher reading ratings associated with BMI *z*-score change was about half of the magnitude of change in teacher ratings associated with an increase in standardized test scores, whereas the change in boys' teacher maths ratings was nearly three times the change associated with an increase in standardized test scores. These perceptions of lower academic ability for heavier girls and boys persisted even after adjusting for objectively measured ability, suggesting that teachers may perceive heavier students as less academically capable than their thinner peers. Although we hypothesized that children who began the study period overweight would have even larger reductions in teacher ratings with an increase in BMI *z*-score compared with non-overweight children who increased in BMI *z*-score, this was not generally the case. The exception to this was among boys with regards to teacher ratings of reading ability, where we found that the effect of an increase in BMI *z*-score was more profound for boys who started out overweight compared with boys who were not overweight. It may be that girls are perceived as gaining excess weight at a lower threshold than boys, whereas boys tend to be perceived as having excess weight gain at a higher BMI. Although there is no known literature on others' perceptions of excess weight at various BMI cutpoints, research on boys' and girls' own body image perceptions at various BMI cutpoints demonstrates a similar pattern among healthy weight and overweight boys and girls.[50] It is also interesting to note that the apparent gender-specific penalties for weight gain found in this study were consistent with gender-based stereotypes about reading and maths performance; heavier girls were perceived as performing worse in a subject that, stereotypically, girls are supposed to do well in (reading),[51] whereas heavier boys were perceived as performing worse in a subject that boys are supposed to do well in (maths).[52] Future research should explore the intersection of weight- and gender-based stereotypes with regards to academic performance.

These results are consistent with the majority of studies of child weight status and academic achievement in other populations and among other age groups, which have also demonstrated no association between weight status and standardized test scores, while finding an association between weight status and teacher ratings.[24–26,28–31] Our study differs slightly from a similar cross-sectional analysis conducted recently in a sample of English childrens aged 7 years, which concluded that there was no overall

relationship between high child waist circumference and lower teacher perceptions of academic ability after finding inconsistent relationships between deciles of waist circumference and the likelihood of a teacher rating a child as above average in reading or maths.[53] Our study may have found a stronger and consistent pattern due to several factors: its longitudinal design, which helps mitigate problems of reverse causation; its within-child change-in-change design, which eliminates the impact of potentially influential sociodemographic confounders; its use of continuous BMI and test score measures, which increase statistical power; and its focus on children later in the life course, when negative perceptions based on weight may be more prevalent.

Although we found that girls who started as overweight at fifth grade had a larger reduction in self-ratings of reading associated with an increase in BMI *z*-score compared with those who were not overweight and increased in BMI *z*-score, we did not see a consistent pattern overall linking increasing BMI to worsening self-ratings of ability. It is possible that gaining weight does not result in reduced perceptions of one's own ability for most children. It may also be that reductions in self-perceived ability associated with excess weight gain emerge later in adolescence. Future research should evaluate discrepancies between heavier students' test scores and self-perceptions from eighth grade onward.

Weight bias is a potential explanation for the observed gap between objectively measured academic abilities among heavier students and teacher perceptions of their abilities, in particular considering that many of the prevalent negative stereotypes about obese individuals, especially laziness, lack of motivation or competence, could be relevant for assessments of classroom performance. One study that measured student-reported experiences of weight-related stigma directly found it to influence obese students' grades.[54] However, we were unable to assess student experiences of weight bias or teacher attitudes about obesity in this study and thus other explanations cannot be ruled out. For example, it is possible that heavier students are likelier to participate less in classroom activities and discussions due to apprehension about unfair judgment from peers or teachers,[12] or may be perceived as having emotional or behavioral problems that affect teachers' assessments of ability independently of weight.

Although the effect sizes in our study were subtle in most cases, these apparent negative perceptions of heavier students are still a cause for concern. Teacher evaluations and expectations are important in predicting future student success.[32–35] In the most practical way, teacher-assigned grades, decisions to promote students to higher level courses and recommendations for students for applications to college can have a substantial role in determining what educational and ultimately economic opportunities are available to students. Teachers are members of a society where weight bias is highly prevalent and may be no more or less likely to hold biased attitudes based on weight than any other adults. These results suggest that schools may need support in increasing awareness of weight-related discrimination and reducing it. Pilot studies have suggested that reducing weight bias in healthcare professionals and psychology students is possible with brief interventions;[55–56] future research should evaluate the impact of similar interventions with classroom teachers.

The use of a fixed-effects regression design was a key strength of this study. Examining within-child change in BMI *z*-score and in academic outcomes allowed us to isolate the impact of change in BMI *z*-score, eliminating the influence of time-constant confounders such as race/ethnicity and socioeconomic status. A limitation, however, is that we were not able to adjust for unmeasured time-varying confounders that could have influenced the observed relationships; in particular, the onset of puberty was not measured in this study and thus we were unable to adjust for it. Puberty may have had an influence on both weight gain and academics.

The inclusion of children from across the United States in our study sample is another strength, as is the utilization of valid, reliable measures of academic ability and teacher and student perceptions of ability. However, we were unable to directly evaluate weight bias in teachers and students; thus, we cannot be certain that weight bias is the mechanism through which heavier children have lower teacher ratings. An additional limitation is that because ECLS-K measured very few characteristics of the adults in study children's lives, we cannot evaluate whether teacher characteristics, in particular their own weight status, have a role in their evaluations of children's academic abilities.

CONCLUSION

There is no significant relationship between children's weight and objectively measured academic ability from fifth to eighth grade. However, the more relative weight a girl gains, the more likely a teacher will rate her abilities in reading as lower than her standardized test score would indicate. As boys gain more relative weight, teacher rate their maths abilities as lower and an increase in BMI *z*-score is associated with an even larger reduction in teacher ratings of boys' reading abilities among boys who start out as overweight compared with those who start out at a healthy weight. This may have implications for diminished educational opportunities for heavier girls and boys as they transition into high school and college. Future research should evaluate whether teacher perceptions of more overweight students tend to be worse in high school as well, and should also evaluate strategies for reducing weight bias in school settings.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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