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(How) Does Obesity Harm Academic Performance? Stratification at the Intersection of Race, Sex, and Body Size in Elementary and High School

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Abstract

In this study I hypothesize a larger penalty of obesity on teacher-assessed academic performance for white girls in English, where femininity is privileged, than in math, where stereotypical femininity is perceived to be a detriment. This pattern of associations would be expected if obesity largely influences academic performance through social pathways such as discrimination and stigma. In the Fragile Families and Child Wellbeing Study (~age 9) and the National Longitudinal Study of Youth 1997 (~age 18), I find obesity to be associated with a penalty on academic performance among white girls in English but not in math, while no association is found in either subject for white boys or for black students net of controls. Findings suggest that the relationship between obesity and academic performance may result largely from how educational institutions interact with bodies of different sizes, rather than primarily via constraints on physical health.

With obesity at record levels, understanding how body mass relates to socioeconomic outcomes such as educational achievement and attainment has become an increasingly pressing task for social scientists. While the majority of work on the relationship between obesity and education has assessed the extent to which educational performance predicts later-life body mass, a growing literature focuses on the reverse relationship, asking how body mass affects educational outcomes. Results suggest that while obesity is not associated with lower test scores (Canning and Mayer 1967; Shakotko, Edwards, and Grossman 1980; Datar, Sturm, and Magnabosco 2004; Kaestner and Grossman 2009), it does appear to cause lower grade point average (Ding et al. 2009; Nsiah and Joshi 2009; Sabia 2007; Crosnoe and Muller 2004). The question of why obesity would be associated with GPA but not with test scores remains a puzzle, and poses a unique juncture for consideration of how physical bodies are subject to varying social constraints at the intersection of race, sex, and body size in the classroom.

In this study I draw from theory on the interaction of body weight and both gender and race, combined with education research on gender and course subject, to posit the pattern of associations between obesity and teacher-assessed measures of academic performance that would be expected if the relationship operates primarily through social pathways such as

RESEARCH ETHICS
This study reports results from analysis of de-identified publicly released survey data, and is exempt from IRB review as per section 46.101(b) of NIH document 45 CFR 46.

discrimination and stigma. Regarding gender and course subject, the few studies addressing both correlation and causation in the association between obesity and GPA have considered GPA as a composite score across all classes. However, course subjects have long been culturally gendered, with individuals of both genders implicitly associating boys with science and math, and girls with arts and humanities (Kiefer and Sekaquaptewa 2007; Nosek, Banaji, and Greenwald 2002; Nosek and Smyth 2011; Correll 2001). Dubbed "gender-math" and "gender-science" stereotyping, these preconceptions predict a "natural" penchant for higher performance in subjects associated with one's gender (Kiefer and Sekaquaptewa 2007b). Such stereotypes are acquired early: boys as young as six associate themselves with math at a higher rate than their female peers, and both boys and girls report "math is for boys" by the same age (Cvencek, Meltzoff, Greenwald 2011). By the undergraduate level, women with strong math backgrounds have been found to dissociate themselves from feminine characteristics they perceive to be incongruent with being good at math, such as wearing makeup, flirtatiousness, emotionality, and wanting children (Pronin, Steele, and Ross 2004).

For assessing the relationship between obesity and academic performance, the gendering of course subjects is further complicated by the counter-normative gendering of obesity itself. In a culture where femininity is predicated on "appearing small, petite, frail, submissive or otherwise non-threatening" (Whitehead and Kurz 2008:345), an obese female body is a refusal to be disciplined (Foucault 1995 [1975]). Obesity in women is sanctioned accordingly, rendered unattractive and desexualized (Millman 1980; Bordo and Heywood 2004). The theory is supported empirically: as with gender-math stereotyping, the inverse association between obesity and femininity is acquired in youth, with obesity in women judged "unfeminine" by girls and boys alike as early as age nine (Pine 2001). Research on the relationship between obesity and perceptions of masculinity is less consistent, but generally suggests that being obese does not negate masculinity as it does femininity (Pine 2001).

Finally, the links between obesity, femininity, and subject-specific academic performance may also be expected to differ by race. Sabia (2007) found the association between obesity and GPA to hold for white students only, mirroring the differences by race found in the literature on obesity and wages (e.g. Cawley 2004). This pattern is commonly attributed to variation by race in social sanctioning of body size (Sabia 2007; Cawley 2004), wherein obesity among Black women is subject to less negative perceptions within-race than is obesity among white women (Hebl and Heatherton 1998; Brown et al. 1998). In addition, the majority of studies of gender-math and gender-science stereotypes use almost exclusively white samples. It is thus unclear that biases associating gender with subject-specific academic performance would be expected to hold among minorities, particularly since Black and Hispanic girls consistently outperform same-race boys in math (Riegle-Crumb 2006; Riegle-Crumb and Humphries 2012).

Combining these hypotheses, here I use data from the National Longitudinal Study of Youth 1997 and the Fragile Families and Child Wellbeing Study to test for differences in the association between obesity and teacher-assessed academic performance separately across course subjects, comparing between English (a "feminine" subject) and math (a "masculine" subject). The rationale here is that an obese white girl in an English lesson will be perceived differently from her normal-weight peers in terms of a specific socially salient characteristic—femininity—whereas since femininity is not privileged in math, the relevant difference between an obese white girl and her normal-weight peers would be less. This pattern of associations would be expected if obesity largely influences academic performance through differential treatment such as discrimination and stigma, yielding intuition about the pathways through which visible bodily characteristics such as obesity are rendered salient for educational outcomes.

BACKGROUND

While no consistent relationship has been found between obesity and drop-out status (Falkner et al. 2001; Kaestner, Grossman, and Yarnoff 2011) or test scores (Canning and Mayer 1967; Datar, Sturm, and Magnabosco 2004; Kaestner and Grossman 2009; Shakotko, Edwards, and Grossman 1980), the association between body mass and GPA has been strong and replicable across a range of samples internationally (Sigfúsdóttir, Kristjánsson, and Allegrante 2007; Mikkilä et al. 2003; Mo-suwan et al. 1999).[1] Four studies on U.S. samples have focused primarily on determining the direction of this relationship, asking whether obesity causes lower grades (Sabia 2007; Nsiah and Joshi 2009; Ding et al. 2009; Crosnoe and Muller 2004). As poor school performance is associated with depression (Schwartz et al. 2008), and depression is associated with increased risk of obesity among adolescents (Björntorp 2001; Goodman and Whitaker 2002), the reverse causal ordering of low academic standing leading to an increase in body mass seems possible. Nonetheless, findings across multiple datasets and methods affirm that obesity does appear to play a causal role in lowering GPA, rather than being solely a symptom of poor academic performance (Sabia 2007; Nsiah and Joshi 2009; Ding et al. 2009; Crosnoe and Muller 2004).

With causal direction established, the mechanisms driving this relationship remain an open question, as obesity could lead to lower academic performance through a number of plausible pathways (Crosnoe and Muller 2004; Sabia 2007; Nsiah and Joshi 2009; Ding et al. 2009). First, as a medical diagnosis associated with a range of physical ailments (Thompson et al. 1999), obesity has the potential to affect educational performance via poor health and a resulting decrease in work productivity (Finkelstein, Ruhm, and Kosa 2005). Of the four studies establishing causation in the relationship between obesity and GPA, only Ding et al. (2009) exclusively assumes this pathway, categorizing obesity as a physical health challenge alongside a host of other physical and cognitive problems such as depression and hyperactivity disorders.

The remaining three causal studies acknowledge that obesity is also a socially sanctioned characteristic of the physical body (Saguy 2013), and has the potential to alter academic performance via social pathways such as discrimination and stigma even in the absence of direct physical health consequences (Sabia 2007; Nsiah and Joshi 2009; Crosnoe and Muller

[1]Canning and Mayer (1967), Datar, Sturm, and Magnabosco (2004), Kaestner and Grossman (2009), and Shakotko, Edwards, and Grossman (1980) each studied the relationship between body mass and scores on a range of tests, some designed to assess aptitude or intelligence, others designed to assess learning and achievement. None found a robust relationship.

2004). Teachers might discriminate against obese students, grading them more harshly than a student of normal weight regardless of actual academic performance. Lower teacher expectations of obese students might affect grades indirectly (Skinner and Belmont 1993; Brophy 1982) if obese students underperform in class due to internalization of such lower expectations (Kuklinski and Weinstein 2001) or factors such as stereotype threat (Steele and Aronson 1995). Neumark-Sztainer, Story, and Harris (1999) found that teachers and school staff expected obese students to be more emotional, less tidy, and less likely to succeed at schoolwork than their normal-weight peers, while students as young as kindergarten associate obesity with being stupid, ugly, mean, sloppy, and having few friends (Brylinsky and Moore 1994). Consistent with the hypothesis that such stigmatization may motivate differential social interaction among overweight and obese students, Janssen et al. (2004) found overweight and obesity to be associated with bullying behaviors: victimization as early as age 11, and by age 15, also perpetration.

Even in the absence of a direct link between obesity and academic performance, a relationship could also appear as the result of unobserved variables that produce both poor educational outcomes and increased body mass. This possibility should be of particular concern given the number of factors that are not assessed in most social surveys but may be causally related to both educational performance and obesity, such as parenting style in the household where a student is raised or aspects of personality such as conscientiousness or self-regulation. Analyses of the relationship between body mass and wages have been particularly sensitive to the assumptions made about unobserved heterogeneity (Conley and Glauber 2007; Cawley 2004), and the same might be expected to hold when modeling the relationship between body mass and any other socioeconomic outcome. In addition to being difficult to disprove, this hypothesis is also highly contentious, as it easily translates into a narrative of blaming obesity on underlying biological or psychological dispositions of obese individuals. Evolutionary psychologist Geoffrey Miller recently caused an uproar by evoking this causal pathway, tweeting, “Dear obese PhD applicants: if you didn’t have the willpower to stop eating carbs, you won’t have the willpower to do a dissertation” (King 2013).

While the pathways described are not differentiable in the simple association between obesity and GPA, they may produce different patterns of associations across subgroups such as race and gender, or across varying educational contexts such as academic course subject. For example, to the extent that obesity directly constrains educational performance via physical health challenges, students with equivalent body mass would be expected to experience an equivalent academic penalty, net of relevant background factors. On the other hand, in the presence of social mechanisms such as direct teacher discrimination or internalized social stigma, the association between obesity and academic performance may well vary across social categories and educational contexts in which body mass is rendered more or less salient. A penalty of obesity may be felt most acutely among white girls in English, where their “unfeminine” physical appearance stands in sharpest contrast to the female gendering of the course subject itself; since femininity is not privileged in math, the relevant difference between an obese white girl and her normal-weight peers would be less. While omitted variable bias is difficult to ever definitively disprove, it is unclear why unobserved characteristics such as parenting or personality traits would be more strongly associated with performance in English than in math, let alone for white girls only.

Here I test for that pattern of associations, asking first whether the relationship between obesity and high school GPA in the National Longitudinal Study of Youth 1997 varies across course subjects perceived as masculine versus feminine in ways that would suggest discrimination and stigma as likely mechanisms. As prior studies of the relationship between obesity and academic performance have largely focused on high schoolers (Datar and Sturm 2006), I then ask whether the same pattern of associations holds in elementary school students in the Fragile Families and Child Wellbeing Study when the outcome is teacher reports of subject-specific academic ability. In addition to demonstrating the robustness of results across a range of data limitations and at two distinct points in the life course, high school GPA is a complex product of cognitive and non-cognitive academic behaviors (Kelly 2008) that leaves differences in teacher perceptions of obese versus non-obese students indistinguishable from differences by body mass in student behavior or academic performance. As assessments of academic performance at the elementary level frequently entail subjective teacher evaluation of student skills (McMillan, Myran, and Workman 2002), elementary school provides an intuitive context for assessing whether teacher perceptions of student ability are influenced by student body mass, in addition to better contextualizing results among older students.

DATA AND METHODS

National Longitudinal Study of Youth 1997

The 1997 National Longitudinal Study of Youth (NLSY97) is a nationally representative sample of approximately 9,000 respondents between the ages of 12 and 16 on December 31, 1996 (Horrigan and Walker 2001). Respondents were surveyed annually starting in 1997, with additional information collected from respondents' family members. The sample for the NLSY97 analysis includes the 4,485 native-born non-Hispanic white and Black respondents for whom subject-level transcript-coded GPA data are available for either English or math (about 65% of the initial respondent population within-race). Given that one outcome of interest in this study is academic performance in English, Hispanic children were excluded due to concern over an inability to effectively distinguish Hispanic ethnicity from other aspects of the immigrant experience, particularly since over half of all NLSY97 Hispanic children have at least one foreign-born parent (compared to <8% of Black and white children).[2] The 120 girls who reported having ever been pregnant prior to or during high school were dropped, leaving a final analytical sample size of 4,365. While response rates on the outcome and independent variables of interest ranged from 96–97%, response rates on control variables were somewhat lower, with the most data missing on the measure of household income (75% response rate). Missing data for all variables were imputed in Stata 13 using 30 imputations.[3]

[2]Supplemental analyses of Hispanic children in the NLSY97 sample largely mirror results for non-Hispanic Black respondents. Supplemental analyses of Hispanic children in the FFCW with native-born parents largely mirror results for non-Hispanic Black respondents, while in analyses of all Hispanic children the relationship between various background characteristics and academic skills (particularly language and literacy skills) differed even after controlling for English as the primary language spoken at home.
[3]Data were imputed using the option for multivariate normal regression with 100 burn-in iterations and 10 burn-between iterations (Allison 2012).

The dependent variables of interest are cumulative high school GPA in English and math, credit-weighted and calculated on a five-point scale, then normalized to have a mean of zero and standard deviation of one.[4] All grade data were taken from respondents' high school transcripts, which were provided by high schools after respondents were no longer enrolled. While lab science and social science GPA are also available, the courses that may be included under those labels are less clear with respect to the anticipated direction of gender bias than are the more narrowly defined subject areas of English and math. Cumulative lab science GPA includes both the female-dominated life sciences and the male-dominated physical sciences (Snyder and Dillow 2012; Bressoud 2009), while cumulative social science GPA includes a range of subjects such as history, government and politics, and more math-based courses such as economics.

As credit-weighted GPA is dependent on both in-class academic performance and also on the level of the course taken, any apparent difference in GPA among obese students could plausibly derive from those students being tracked into lower-level courses relative to non-obese students, rather than exclusively from differential experiences or performance in the classroom. The NLSY97 calculates measures of the overall level of coursework pursued within STEM and foreign language subjects, and from this I include indicators for math track (non- or low-academic, lower middle, upper middle, lower advanced, and upper advanced) (Burkham and Lee 2003). Consistent with prior studies finding no association between obesity and drop-out status (Falkner et al. 2001; Kaestner, Grossman, and Yarnoff 2011), supplemental models separately controlling for total academic course credits or high school graduation or excluding non-graduates yielded minimal variation in the coefficients of interest (obesity and overweight). Since a majority of U.S. states mandate four units of English but three or fewer units of math (ECS 2016), an additional set of models controlled for total math course credits when predicting cumulative math GPA, but again yielded no substantive differences in the coefficients of interest.

In keeping with prior work on the relationship between obesity and achievement, indicators of overweight and obesity are coded using the Centers for Disease Control and Prevention (CDC) categories of body mass index (BMI), calculated as weight in kilograms divided by height in meters squared (e.g. Garn, Leonard, and Hawthorne 1986).[5] Obesity is defined as being above the 95th percentile of the CDC's recommended distribution of weight for height, while overweight is defined as being above the 85th percentile, although the specific BMI associated with each of these percentiles varies by gender and age until age 20 (CDC). Although BMI is known to be problematic for determining body fatness in that it does not account for the ways in which body composition differs by factors such as muscularity, sex, and age (Gallagher et al. 1996; Smalley et al. 1989), it remains the best available approximation for body fatness in the vast majority of social science surveys.

BMI is calculated for each year of high school using self-reported weight and height, and students are then coded as "underweight," "normal weight," "overweight," or "obese". From the annual measures of BMI categories, I code a single indicator for whether a student was

[4]Models were substantively redundant when using non-standardized GPA measures as the outcome.

[5]Reported weights below 64 pounds were excluded in each wave, as were reported heights below 4′ and over 7′.

ever clinically obese in high school, with a second indicator for whether a student was ever overweight (but never obese) during high school included as a control. As the oldest students in the NLSY sample were already in their first or second year of high school at the time they were impaneled, BMI data for those students are missing for the years of high school before they entered the survey. In those cases, I coded the years of information available. Obesity is known to persist strongly from childhood through adulthood and even more so over shorter periods of time (Magarey et al. 2003), and so the likelihood of misclassifying a student who was obese in earlier waves but a normal weight in later waves is expected to be quite low.[6] Furthermore, randomly misclassifying obese students into lower BMI categories should effectively bias results away from observing significant differences between those categories. While being underweight may proxy unobserved health issues, supplemental analyses excluding the 26 individuals who were consistently underweight across all recorded years of high school yielded no differences in the coefficients of interest.

The self-reporting of weight and height in the NLSY97 can be expected to introduce some degree of error that may bias estimates. To adjust for some of this potential reporting bias, I use the correction suggested in Burkhauser and Cawley (2008), wherein true BMI is predicted using information on the relationship between measured BMI and self-reported weight and height data in the National Health and Nutrition Examination Survey (NHANES). NHANES is a stratified multistage probability sample of the US population collected by the Centers for Disease Control and Prevention for generating statistics on health measures such as obesity (CDC and NCHS 2011).[7] Respondent BMI calculated from measured weight and height in NHANES is regressed on self-reported height, weight, and age, the squares of these three variables, and a full set of interactions. This model is run separately by race and sex to account for variation across these categories in weight and height misreporting. The estimated coefficients were then used to predict true BMI in the NLSY97 sample. As NHANES asks only respondents who are 16 years or older to self-report weight and height, the correction is applied only to the BMI calculated for NLSY97 respondents in their junior and senior years of high school; since obesity rates increase with age and obesity persists strongly over short periods of time (Magarey et al. 2003), this should effectively capture students who are consistently underreporting. That said, differences between the results presented and estimates without this correction were substantively meager and in all cases non-significant.

Cognitive skills were assessed in 79.3% of NLSY97 respondents during the initial survey round using the computer-adaptive form of the Armed Services Vocational Aptitude Battery (ASVAB) (Horrigan and Walker 2001). The ASVAB is a set of ten multiple-choice tests, intended to provide a general measure of cognition. The NLSY97 provides a summary percentile score of four key subtests, and this variable is included in the model, transformed to have a mean of zero and a standard deviation of one.[8] To account for characteristics of a

[6]Supplemental models excluding respondents who are already in high school at the time they were impaneled yielded results that were substantively redundant to those presented, as did models using a measure of whether students were obese by their junior year as the independent variable.

[7]NHANES continuous data from 1999 through 2006 were used in order to match the birth years of the NLSY97 cohort. From those waves, 2,633 respondents were between the ages of 16 and 19 and had self-reported weight and height data.

[8]A detailed description of the ASVAB is provided in Appendix 10 of the NLSY97 codebook.

student's home and educational context that might be expected to influence both weight and academic performance, I include measures of mother's and father's years of education attained (from 1 to 20), household income, an indicator for whether a student attended a private school, and an indicator for whether a student's mother is herself obese (Chandola et al. 2006; Cournot et al. 2006). Income is transformed using the inverse hyperbolic sine (arsinh) function, which approximates the logarithm in its right tail but is symmetric and linear around the origin (Pence 2006).[9] Regional variation in obesity rates (Le et al. 2014) is captured by fixed effects on census region (northeast, north-central, south, or west), plus an additional indicator of whether a student lived in an urban or rural area (Sobal, Troiano, and Frongillo 1996).[10] Finally, I include a fixed effect on student age at the first survey wave.

Means and proportions for NLSY97 variables are presented in table 1.

Fragile Families and Child Wellbeing Study

Where the NLSY97 is a nationally representative longitudinal survey of school-aged children and their families, the Fragile Families and Child Wellbeing Study is a longitudinal survey of approximately 5,000 children of mostly unmarried parents—"fragile families"—in 20 U.S. cities with populations greater than 200,000 (Reichman et al. 2001). New mothers and fathers were first interviewed shortly after childbirth, and follow-up interviews were conducted when the child was 1, 3, 5, and 9 years old. At year 9, an additional interview was completed by a subsample of children's teachers (45%), including questions on student academic ability and classroom behavior and social skills. The analytical sample for the FFCW analysis includes the 1,040 non-Hispanic Black and 390 non-Hispanic white children for whom teacher survey data and year nine measured BMI are available. Mirroring the NLSY97 sample, Hispanic children were excluded due to the inability to distinguish Hispanic ethnicity from the immigrant experience more generally, as nearly half of FFCW Hispanic children (44%) have at least one foreign-born parent.

The dependent variables of interest are teacher responses to the question, "Overall, how would you rate this child's academic skills compared to other children of the same grade level?" Teachers rated students separately on "language and literacy skills" and on "mathematical skills" from 1 ("far below average") to 5 ("far above average"). Responses are approximately normally distributed, with a mean of 2.9 on both scales; in the models presented, these measures are transformed to have a mean of zero and a standard deviation of one. While a cumulative measure of "science and social studies" skills is also available, as discussed above, both of these subjects are less clear with respect to the anticipated direction of gender bias than are English language and math.

Weight and height were measured for all students in the FFCW at a date preceding the teacher survey, and obesity and overweight are again defined using CDC guidelines for weight and height by age (Centers for Disease Control and Prevention 2001).[11] In addition to direct measurement of weight and height alleviating the risk of response bias inherent in

[9]This avoids the problem that the logarithmic function is not defined for individuals with a household income of zero.
[10]Supplemental models excluding the fixed effects on census region and birth year yielded no meaningful differences in the outcomes of interest.
[11]The mean time lag between the home visit (when height and weight were measured) and the teacher survey is about two months.

the self-reported weight and height data collected in the NLSY97, concerns that BMI may conflate extreme muscularity with obesity should be less relevant among 9-year-olds than in older individuals.

Control variables in models predicting language ability include standard test scores intended to assess vocabulary (the Peabody Picture Vocabulary Test) and passage completion (Woodcock Johnson subtest 9), while models predicting mathematics ability include standard test scores intended to assess mathematics problem solving (Woodcock Johnson subtest 10) and memory and sequencing skills (Digit Span subtest of the Wechsler Intelligence Scale for Children).[12] To account for characteristics of a student's home and educational context that might be expected to influence both weight and academic performance, I include measures of mother's and father's education, self-reported on a four-category scale; mother's reported household income; whether a child was attending a private school at year 9; an indicator for whether a child's mother is herself obese, and a measure of mother's cognitive skills (the standard score from the Weschler Adult Intelligence Scale Similarities subtest) (Chandola et al. 2006; Cournot et al. 2006).[13] A continuous measure of child's age in months is included to capture age-related developmental differences, along with continuous measures of mother's and father's age at the child's birth.[14] Information on geographic location is unfortunately not available in the public-use FFCW data.

To account for the possibility that any association between obesity and teacher perception of ability could be driven by differential non-cognitive behaviors between obese and non-obese students, initial models controlled for a wide battery of student social and behavioral skills. Controls included a primary-caregiver-reported measure of problem behaviors; child-reported measures of connectedness at school, self-description, task completion behavior, delinquent behavior, and peer bullying; and teacher-reported measures of social skills and problem behaviors.[15] Each of these eight behavioral concepts corresponds to a set of survey questions defined in the FFCW scales documentation; summary measures were calculated for each concept by summing and averaging responses to all questions in that unit (e.g. Haskins 2014). Of the measures tested, none except for social skills were significant predictors of teacher-reported academic performance after controlling for test scores, and none including the social skills measure had any meaningful effect on the significance or magnitude of the parameter estimate on obesity.[16] Final models retain only the social skills measure, which captures teacher rankings of how frequently students engage in 37 social behaviors such as making friends, tidiness, cooperation, and self-control.

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[12]For more detail on the four tests used in the FFCW analyses, see the year 9 core scales documentation at http://www.fragilefamilies.princeton.edu/documentation/. Supplementary models included the WISC-Digit Span score as a control in models predicting language skills, with no meaningful effect on the parameters of interest.

[13]Household income was again transformed using the arsinh function (Pence 2006).

[14]Square terms on age were non-significant and yielded no variation in the coefficients of interest.

[15]In the primary caregiver survey, the problem behaviors unit is derived from the Achenbach Child Behavior Checklist (Achenbach and Rescorla 2001). In the child survey, units were adapted from the Child Development Supplement of the Panel Study of Income Dynamics (PSID-CDS-II and III), the Self Description Questionnaire (Marsh 1990), and the Things That You Have Done scale (Maumary-Gremaud 2000). In the teacher survey, the "social skills" unit was adapted from the ECLS-K, and the "problem behaviors" unit was adapted from the Conner's Teacher Rating Scale—Revised Short Form (Conners 2000). For more detail, see the FFCW documentation: http://fragilefamilies.princeton.edu/sites/fragilefamilies/files/ff_scales9.pdf .

[16]The summary measure of teacher-assessed student problem behaviors was also a significant predictor of skill ratings, but was omitted from the model due to multicollinearity with the social skills measure. Multicollinearity was not detected among any of the remaining controls.

Very little data was missing on any variable (~98% response rate) with the exception of fathers' education at year 9 (70% response rate), for which data was missing due to fathers who were not surveyed in that wave. Missing values of father's education at wave 5 were coded to values of father's education at baseline (wave 1), yielding a total response rate for father's education comparable to all other variables (98%), and an indicator was included to denote wave 5 missingness. Missingness on values of father's education at wave 5 does appear to be associated with values of the missing data themselves, since mean education at baseline among fathers who are missing at wave 5 is one-half standard deviation lower than the mean among fathers who responded in wave 5 (this difference is significant at p<0.001).

Means and proportions for FFCW variables are presented in table 2.

Analytic Strategy

I estimate the conditional association between obesity and academic performance using the OLS regression equation

$$y_i=\alpha+\beta_O O_i+ \beta_V V_i +\beta_T T_i + \beta_C C_i + \beta_L L_i +\varepsilon_i \quad (1)$$

wherein i denotes an individual respondent and y is a subject-specific achievement measure: language and math skill ratings in the FFCW, and English and math GPA in the NLSY97. The indicator of obesity for each individual i is denoted by O, while the indicator of overweight for each individual i is denoted by V. T denotes test scores. C is the vector of background controls detailed above (including math track indicators in the NLSY97, and the teacher-ranked social skills summary measure in the FFCW). L denotes controls for geographic location (region and urbanicity) in the NLSY97 models.

The regression is estimated using each English and math performance measures as the outcome, separately for white and Black respondents by sex. In tables 3 through 7, model 1 is the bivariate relationship between obesity and academic performance; model 2 introduces controls for test scores; and model 3 introduces the full battery of controls. Supplemental analyses affirm that as in prior research (Canning and Mayer 1967; Datar, Sturm, and Magnabosco 2004; Kaestner, Grossman, and Yarnoff 2011; Shakotko, Edwards, and Grossman 1980), obesity is not significantly associated with any of the test score measures used in either the FFCW or the NLSY97 models after controlling for background factors.

Where the OLS regression results establish whether obesity is associated with educational performance in English or math, the quantity of interest in this study is the difference between β_O in the models predicting English versus math achievement within each race-by-sex subgroup. I assess the significance of these differences using a series of Wald tests. I then run an additional set of Wald tests to assess the significance of the between-subgroup differences in those differences.

RESULTS

Regression results for high school students in the NLSY97 sample are presented in tables 3 and 4. For white girls, the predicted larger penalty of obesity in English than in math is indeed observed. The bivariate association between obesity and GPA is significant for both course subjects, with obesity associated with about a one-half standard deviation lower English GPA relative to normal-weight peers, and a one-quarter standard deviation lower math GPA. After inclusion of all controls, the association between obesity and math GPA is reduced to a non-significant 5.2 percent of a standard deviation, while obesity remains associated with just over one-quarter of a standard deviation lower English GPA. In the metric of a four-point grading scale, that penalty of obesity in English is equivalent to .19 grade points—just over half a letter grade.

Although obesity is associated with lower GPA among white boys (table 3) even net of test scores, these associations are reduced in magnitude and to non-significance after controlling for math track and sociodemographic factors. Supplemental models introducing controls for math track and sociodemographics separately suggested that differential tracking of obese versus non-obese white boys may explain much of the relationship between obesity and credit-weighted GPA in both subjects net of test scores. That obesity is not considered consistently unmasculine for white boys (Pine 2001) lends no reason to expect divergent associations between obesity and achievement by course subject, but does not preclude the possibility that obese boys are still subject to different constraints and social pressures than their normal-weight peers across subjects similarly, such as through processes like tracking.

Obesity is associated with lower GPA among Black girls (table 4) in the bivariate models for both English and math, but these associations are reduced in magnitude and to non-significance after controlling for test scores. Obesity is not associated with GPA among Black boys in any model.

As per Wald tests of the differences in β_O by course subject within race-by-sex subgroups (table 5), the one-fifth standard deviation difference between the parameter estimates on obesity in English versus math is statistically significant for white girls (p=0.009). This stands in contrast to the near-zero between-subject differences in all other subgroups, none of which reach significance at standard thresholds. Additional Wald tests affirm that the difference in differences between white girls and the other three subgroups are also significantly different from zero (p~0.037 for all three comparisons), affirming that the difference by course subject in the association between obesity and GPA is exclusive to white girls.

While findings for GPA in the NLSY97 were as hypothesized, GPA remains a complex measure of cognitive and non-cognitive academic behaviors (Kelly 2008), leaving differences in teacher perceptions of obese versus non-obese students indistinguishable from differences in student behavior or academic performance. The FFCW data, on the other hand, enables a direct investigation of the relationship between obesity and teacher perceptions of subject-specific academic ability, in addition to addressing the question of whether the pattern of associations observed among high schoolers is already apparent by elementary school.

For white girls in the FFCW (table 5), the predicted penalty of obesity on teacher perception of English language skills is again observed: in the bivariate model, being obese is associated with a .42 standard deviation lower language and literacy skills score relative to one's normal-weight peers. This association is reduced to about one-third of a standard deviation after controlling for same-subject test scores, socioeconomic factors, and teacher assessments of student social skills. As noted, additional specifications of model 3 included controls for seven other measures of student behavior and school experience, none of which meaningfully altered either the magnitude or significance of the parameter estimate on obesity.

As hypothesized, obesity is again only associated with teacher perceptions of student skills for white girls in language and literature; by contrast, associations between obesity and teacher-assessed skills ratings are smaller in magnitude and non-significant among white girls in math, as well as among white boys and Black girls and boys in both subjects. While the parameter estimate on obesity in the model predicting language skills for white girls is significant and meaningfully larger than the parameter estimate on obesity in the model predicting math skills, unlike in the far larger NLSY97 sample, the difference between the two parameters in the FFCW is not itself significant at standard thresholds (p=0.190). This is perhaps unsurprising, as obesity is a relatively low-frequency treatment among white girls (14%) in a relatively small sample (n=188). While the pattern of associations in the FFCW sample mirrors the significant differences in the far larger NLSY97 sample, replication in a larger sample of elementary-age students would be useful to affirm the observed between-subject difference at standard significance thresholds. A power analysis suggests that a sample of white girls about the size of the sample of black girls in the FFCW (~500) would be needed for the between-subject difference among white girls to reach significance at p<0.05.

In both the NLSY97 and FFCW, for no subgroup is being overweight (but not obese) associated with a lower GPA relative to normal-weight peers net of test scores. For white girls in both samples, the differences between the parameter estimates on obesity and overweight in the models predicting English performance were statistically significant.

While lab science and social science GPA in the NLSY97 were excluded from the main analysis due to lack of clear direction in anticipated gender bias, the association between obesity and GPA in these course subjects for white girls do follow the pattern expected if one were to consider social science a generally female-leaning subject and lab science a generally male-leaning subject (table 8). Net of all controls, the associations between obesity and GPA are statistically significant only for the "feminine" subjects of English and social science and not for the "masculine" subjects of lab science or math, although the difference is significant only between the most clearly gendered subjects of English and math. For white boys and Black boys and girls, magnitudes of the associations between GPA and obesity are generally stable across all course subjects, mirroring the results reported for math and English GPA. No comparable analysis was possible in the FFCW data, where academic ability in "science and social studies" was evaluated as a single rating.

DISCUSSION

As higher rates of obesity have become a modern reality, understanding the pathways through which obesity is associated with lower socioeconomic outcomes such as educational performance remains an important task for social scientists. This study contributes at that juncture, hypothesizing a larger negative association between obesity and teacher-assessed academic performance for white girls in English, where femininity is privileged, than in math, where stereotypical femininity is perceived to be a detriment. This pattern of associations would be expected if obesity largely influences academic performance through differential treatment such as discrimination and stigma, while posing new explanatory challenges to alternative hypothesized mechanisms.

For white girls in both elementary school (FFCW) and high school (NLSY97), the hypothesized pattern of associations was observed: obesity is associated with lower teacher-assessed academic performance in English, a traditionally female-gendered subject, but not in math, a traditionally male-gendered subject. Although the difference in the associations between obesity and academic performance in English and math was in the direction hypothesized, the magnitude of this difference, and particularly the non-significant and substantively meager association between obesity and math performance, were surprising. All studies of the relationship between obesity and GPA in U.S. samples have used a measure of GPA averaged across course subjects, and all have found a significant association for white respondents (Ding et al. 2009; Sabia 2007; Nsiah and Joshi 2009; Crosnoe and Muller 2004). The results presented here suggest that past analyses may be underestimating the true association between obesity and academic performance for white high school girls in English—where obesity yields over half a letter grade lower GPA on average—while overestimating a potentially null association in math. No similar gap in the association between obesity and academic performance by course subject net of controls was found for any group besides white girls, and in no case was there a significant association between being merely overweight and lower academic performance.

In light of the findings presented, I revisit the causal pathways set out at the beginning of this paper, as the pattern of associations observed poses new explanatory challenges to a number of the hypothesized mechanisms. To begin, the suggestion that obese students perform at a lower level due to weight-related health problems that affect attendance or productivity seems perhaps the least likely mechanism, as differences by race or sex would not be expected to moderate the negative physical consequences of obesity to the extent observed. Rather, if obesity leads to poor health and a resulting decrease in work productivity—as the literature on obesity and employment suggests that it might (e.g. Finkelstein, Ruhm, and Kosa 2005)— it is unclear why this relationship would be visible only among white girls in English.

Building on prior studies affirming that obesity does appear to cause lower GPA (Ding et al. 2009; Sabia 2007; Nsiah and Joshi 2009), the findings here also emphasize the implausibility of the reverse causal hypothesis that obesity results from poor performance in school via stress- and depression-driven weight gain. For reverse causation to be at work, it would have to be the case that only white girls experience such weight-gain-inducing stress in the face of poor academic performance, while Black students and white boys do not. Furthermore, one would have to assert that only poor performance in English is sufficiently stressful as to result in weight gain for white girls, while poor performance in math is not.

Next is the hypothesis that students who are obese also do poorly in school because obesity and low academic performance are both caused by unobserved characteristics, such as aspects of parenting behavior or specific child psychological traits not sufficiently assessed in the FFCW. Although this pathway is difficult to definitively disprove, it is unclear why such characteristics would be more strongly associated with performance in English than in math. To the contrary, studies have found that psychological traits associated with academic performance and effort, such as conscientiousness (Trautwein et al. 2009) and self-regulation (Wolters and Pintrich 1998), have relatively stable effects across course subjects. Furthermore, even if the causal unobserved characteristics were to operate differently by course subject, it is unclear why they would do so only for white girls. In future research, unobserved family-invariant characteristics that might cause both obesity and poor academic performance could be better controlled using sibling fixed effects in a larger sibling sample than was available here.[17]

Results do follow the pattern expected in the presence of discrimination based on gendered course subjects interacting with the counter-normative gendering of obesity in white girls. While the specific mechanisms may still be many and varied, the results from the FFCW analysis suggest teacher bias in perceptions of obese white girls as one possible factor. By high school, course subjects are typically taught by different teachers in different classrooms, leaving more room for variation in student behavior between teachers to potentially influence GPA measures differently by course subject in the NLSY97. In the FFCW, however, the same teacher ranks student skill level in language and literacy and in math, controlling for the possibility of differences in student behavior between different teachers and classrooms. Furthermore, the included control for teacher-reported social skills should account for a range of non-cognitive factors that might be otherwise hypothesized to motivate differential perceptions of student ability. That said, while the penalty of obesity on teacher perceptions of language and literacy skills in the FFCW is clear, a larger sample of white elementary-age girls would be needed to affirm significance of the difference between that effect and the null association in math.

While the FFCW findings pose lower teacher perceptions of obese white girls' academic ability in feminine course subjects as one plausible mechanism driving the pattern of associations between obesity and high school subject-specific GPA observed in the NLSY97, that such differences in teacher-reported skill ratings may emerge as early as elementary school lends reason to hypothesize a more complicated and iterative dynamic as those children age. Decades of research on teacher expectancies finds that students as young

[17]Although data on siblings is available in the NLSY97, only about 30% of respondents in the analytical sample defined here also had sibling data, leaving an insufficient sample size for sibling fixed effects (particularly among Black respondents).

as elementary school are well aware of differential teacher perceptions of student ability, and that teacher expectations do predict differences in students' academic performance (Kuklinski and Weinstein 2001; Rubie-Davies 2006; Skinner and Belmont 1993). By the time an obese white third-grader becomes an obese high schooler (Magarey et al. 2003), although her test scores stay on par with her normal-weight peers, years of potential exposure to teachers who perceived her to be a poor English student may manifest as differences in her actual behavior in an English classroom (Steele and Aronson 1995; Pronin, Steele, and Ross 2004), a recursive cause and consequence of persistent lower teacher-assessed academic performance (e.g. Brophy 1982).

Such differential perceptions of obesity by course subject were hypothesized as a reflection of the discord between the unfeminine gendering of an obese white girl's physical body (Whitehead and Kurz 2008) and the female gendering of an English class itself. Functionally, this may mean that an obese white girl simply doesn't look like her teacher's mental image of the normative white female student in feminine course subjects and is thus perceived as less academically able, whereas since femininity is not privileged in math, a white girl's body size is less relevant. Since the association between obesity and academic performance is a comparison between obese white girls and their non-obese peers, variation in this association by course subject could also reflect differences by course subject in how *all* white girls are perceived more generally. As white girls are known to be penalized in high school math (Riegle-Crumb and Humphries 2012), the null effect of obesity on math performance may be due to a penalty of obesity being rendered either irrelevant or undetectable relative to the penalty of simply being a white girl. In either case, that white girls are the only subgroup penalized differently for obesity across differently gendered educational contexts suggests that the salience of visible physical characteristics such as body mass for educational outcomes may be best understood at the intersection with race and gender, which are often simultaneously inferred when one's body is observed by others.

While no significant association between obesity and academic performance was found for white elementary school boys in the FFCW, the association between obesity and GPA in the NLSY97 was significant in both course subjects until the inclusion of controls for academic track. More detailed exploration of this finding is beyond the scope of this paper, particularly since academic tracking in math has no true equivalent in English, precluding between-subject comparisons such as are possible for GPA. However, while the lack of consistent association between obesity and masculinity among white boys (Pine 2001) leaves little reason to hypothesize divergent associations between obesity and academic performance by course subject, obese white boys may still be subject to different constraints and social pressures than their normal-weight peers more generally. To that end, future research should further investigate the question of whether obese white boys are consistently tracked into lower math courses than normal-weight peers with equivalent test scores, considering factors at the intersection of race, gender, and body size that might be expected to influence that process.

The null associations between obesity and academic performance net of controls among Black students are as hypothesized, given the lack of clear relationship between gender and subject performance among minorities, as well as the lower social sanctioning of obesity

(Brown et al. 1998). As an additional explanation for the differences observed by race, social psychological research has consistently demonstrated that individuals perceive more variation among social categories of which they are members than among social categories to which they do not belong (Linville, Fischer, and Salovey 1989; Quattrone and Jones 1980). Termed the "out-group homogeneity effect," this phenomenon describes the bias expressed in phrases such as "they all look alike, but we don't" (Quattrone and Jones 1980:142). The out-group homogeneity effect has been demonstrated to hold for cross-racial perceptions of skin color, where more variation is perceived among individuals of one's own race than among individuals of a different race (Hill 2002). If this pattern of interaction holds for obesity as well, given that 84% of public school teachers in the United States are white (Feistritzer 2011), obesity could well be more readily *perceived* by educational gatekeepers in white students than in students outside a teacher's own race. This hypothesis could be tested qualitatively, experimentally, or in a large dataset with richer school-level detail than is available in the NLSY97 (the limited sample size combined with the small percentage of minority teachers precluded a direct test of an obesity-by-same-race-teacher effect in the FFCW). If occupational gatekeepers are also predominantly white, the explanation of obesity being more heavily sanctioned within-race could also help explain the larger penalty of obesity on wages for white relative to minority women (Cawley 2004).

The finding of a penalty on GPA of obesity but not of overweight may reflect a misalignment between medical guidelines and popular understandings of what constitutes a healthy weight, wherein overweight students are perceived similarly to their normal-weight peers and only those approaching obesity experience social sanctioning. Such misalignment has been documented among parents of overweight and even obese pre-schoolers, of whom a vast majority nonetheless report their child to be "about the right weight" (Duncan et al. 2015). However, supplemental analyses of the relationship between a continuous measure of BMI and English GPA for white girls does appear linear, and so it may be the case that a smaller but statistically significant effect of overweight would be detectable for white girls in English in a larger sample.

While the consistency of the pattern of associations between obesity and teacher-assessed academic performance in the NLSY97 and the FFCW speaks to the plausible persistence of this effect across age groups, pairing these samples is particularly useful in establishing robustness of the hypothesized effect to a range of data limitations. The FFCW represents predominantly "fragile families," while the NLSY97 is nationally representative; the FFCW measures student weight and height, whereas the NLSY97 relies on self-reports; the FFCW offers a rich battery of questions on student social skills and behavior not available in the NLSY97; and the NLSY97 respondents were in high school a decade and a half ago, while the year nine FFCW data was collected more recently (between 2007 and 2010). As noted, the FFCW data is also limited by a relatively small sample size, while the NLSY97 is far larger; this point merits particular caution, as although the penalty of obesity for white girls in English is clear across both samples, tests of the difference by course subject are significant in the NLSY97 but underpowered in the meager FFCW sample of white girls. To that end, a replication of this analysis in a larger sample of elementary school students would be useful to affirm the findings presented in that age cohort.

Two additional limitations persist across both studies. First is the use of BMI as merely a proxy for body fatness, since better measures of obesity, such as percent body fat, are not available in the majority of social science datasets. As obesity continues to be of interest to scholars of social inequality, improved measurements of body fat such as are available in many surveys of health and health behaviors (such as NHANES) would be a marked improvement over the use of BMI at all, let alone BMI derived from self-reports of height and weight such in the NLSY97. Second is the issue of temporal ordering in the measurements of obesity and academic performance. Although the FFCW and NLSY97 are longitudinal studies, the FFCW does not collect data annually, and while the obesity measurements in wave 9 precede the teacher surveys in all cases, ideally obesity would be assessed before the student had any exposure to the teacher in question. In the NLSY97, GPA measures in which grades from all schools in the sample are converted to a uniform scale and credit weighted are only available by course subject cumulatively across all years of high school (measures of cumulative GPA across all course subjects are available annually). As noted, prior studies of the relationship between obesity and GPA have consistently affirmed that obesity does appear to cause lower GPA (Ding et al. 2009; Sabia 2007), including in the NLSY97 sample when the outcome is annual cumulative GPA across all subjects (Nsiah and Joshi 2009); the present study is intended to build on that work, providing a better understanding of the race-by-sex subgroups and academic contexts in which the association between obesity and achievement holds.

This study emphasizes the need to better engage theories of the body in education research, as doing so may alter not only the interpretation of results, but also the questions that are asked. The findings presented add to a growing literature framing the obesity crisis as both a medical and a social problem, where negative socioeconomic consequences of obesity result in part from how institutions such as schools interact differently with bodies of different sizes (Saguy 2013). While reducing obesity levels would be one method of addressing the differential in teacher-assessed academic performance between obese and non-obese white girls, the results here suggest that social interventions, such as obesity-related sensitivity training for teachers, may also reduce that gap even absent any change in student body mass. Teachers at all grade levels should be considered for such interventions, as negative perceptions of obese white elementary school girls' academic performance have the potential to generate persistent lower academic self-perception among these students as they progress to later grades (e.g. Brophy 1982). As efforts to combat rising rates of obesity continue, such simultaneous efforts to counter negative social understandings of obesity have advantages in terms of both educational outcomes and social equity more generally.

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Table 1

NLSY97: Means and Proportions for Select Variables by Race and Sex

	FULL	WHITE		BLACK	
		Girls	Boys	Girls	Boys
Obese	0.184	0.110	0.192	0.268	0.234
Overweight	0.189	0.166	0.199	0.199	0.196
GPA (std)					
English	−0.010	0.376	−0.108	−0.050	−0.573
	(0.014)	(0.024)	(0.026)	(0.035)	(0.036)
Math	−0.010	0.239	0.029	−0.152	−0.497
	(0.014)	(0.026)	(0.025)	(0.037)	(0.039)
Test Scores (std)					
ASVAB	−0.010	0.391	0.339	−0.463	−0.625
	(0.014)	(0.024)	(0.025)	(0.036)	(0.035)
Math track					
Non/Low-academic	0.086	0.063	0.085	0.094	0.129
Lower middle	0.266	0.213	0.265	0.281	0.369
Upper middle	0.295	0.302	0.276	0.310	0.313
Lower adv.	0.194	0.233	0.190	0.190	0.124
Upper adv.	0.159	0.189	0.185	0.126	0.065
Mother's education	13.215	13.474	13.579	12.577	12.521
	(0.034)	(0.063)	(0.062)	(0.086)	(0.081)
Father's education	13.221	13.611	13.667	12.395	12.198
	(0.043)	(0.077)	(0.072)	(0.102)	(0.102)
Income (arsinh)	10.392	11.010	11.060	9.226	9.061
	(0.072)	(0.104)	(0.105)	(0.271)	(0.296)
Private School	0.064	0.083	0.077	0.033	0.034
Mother obese	0.244	0.172	0.197	0.372	0.372
Urban	0.703	0.642	0.671	0.829	0.782
Age impaneled	14.363	14.387	14.340	14.360	14.348
	(0.021)	(0.036)	(0.035)	(0.053)	(0.052)

	FULL	WHITE		BLACK	
		Girls	Boys	Girls	Boys
White	0.691	1.000	1.000	0.000	0.000
Black	0.309	0.000	0.000	1.000	1.000
Female	0.486	1.000	0.000	1.000	0.000
N	4365	1431	1584	691	659

Note: Data were drawn from the National Longitudinal Study of Youth 1997 cohort. Sample includes non-Hispanic black and white respondents with transcript data reported. All missing values imputed. Proportions of obese and overweight respondents are corrected for self-reporting bias using estimates from the National Health and Nutrition Examination Survey. Standard deviations in parentheses.

Table 2

FRAGILE FAMILIES: Means and Proportions for Select Variables by Race and Sex

	FULL	WHITE		BLACK	
		Girls	Boys	Girls	Boys
Obese	0.219	0.138	0.155	0.286	0.211
Overweight	0.176	0.204	0.139	0.183	0.174
Skill ratings (std)					
Language	0.000	0.464	0.240	0.065	−0.302
	(1.000)	(0.890)	(0.936)	(0.984)	(0.979)
Math	0.000	0.282	0.412	−0.046	−0.203
	(1.000)	(0.865)	(0.928)	(0.973)	(1.029)
Test Scores (std)					
Peabody Picture Vocabulary Test	0.000	0.722	0.657	−0.218	−0.292
	(1.000)	(0.896)	(0.965)	(0.887)	(0.908)
Woodcock-Johnson: Verbal	0.000	0.478	0.335	0.045	−0.326
	(1.000)	(0.879)	(0.799)	(0.877)	(1.089)
Digit Span	0.000	0.140	0.199	−0.007	−0.113
	(1.000)	(0.955)	(0.956)	(0.948)	(1.058)
Woodcock-Johnson: Math	0.000	0.395	0.445	−0.040	−0.262
	(1.000)	(0.965)	(0.820)	(0.899)	(1.056)
Mother's education	2.674	3.056	3.041	2.541	2.527
	(0.939)	(0.951)	(0.965)	(0.921)	(0.869)
Father's education	1.919	2.679	2.660	1.662	1.616
	(1.446)	(1.364)	(1.439)	(1.346)	(1.373)
Mother's income (arsinh)	1 0.885	11.597	11.544	10.536	10.708
	(1.497)	(0.869)	(1.531)	(1.678)	(1.331)
Mother's age	25.297	27.327	28.103	24.676	24.143
	(6.137)	(6.499)	(6.652)	(5.772)	(5.648)
Father's age	27.984	29.901	30.349	27.831	26.621
	(7.095)	(6.981)	(7.407)	(7.190)	(6.581)
Child's age (months)	110.875	110.837	110.588	111.035	110.849

	FULL	WHITE		BLACK	
		Girls	**Boys**	**Girls**	**Boys**
	(4.404)	(3.885)	(4.401)	(4.505)	(4.493)
Social skills (std)	−0.070	0.421	0.094	0.060	−0.413
	(1.006)	(0.869)	(0.946)	(0.980)	(0.984)
Private School	0.093	0.143	0.201	0.066	0.061
Mother obese	0.467	0.301	0.351	0.552	0.493
Mother's Cognition					
Wechsler Adult	7.182	8.295	8.380	6.735	6.735
Intelligence Scale	(2.558)	(2.448)	(2.478)	(2.445)	(2.466)
Missingness (Father)					
Education (wave 5)	0.285	0.133	0.160	0.326	0.348
White	0.273	1.000	1.000	0.000	0.000
Black	0.727	0.000	0.000	1.000	1.000
Female	0.474	1.000	0.000	1.000	0.000
N	1430	196	194	482	558

Note: Data were drawn from the Fragile Families and Child Wellbeing Study. Sample includes non-Hispanic black and white respondents with measurements of weight and height and teacher survey data. Standard deviations in parentheses.

Table 3

NLSY97: Regression of Obesity on White Students' English and Math Cumulative High School GPA (~Age 18)

	GIRLS						BOYS					
	English GPA			Math GPA			English GPA			Math GPA		
	Model 1 **Bivariate**	**Model 2** **+test scores**	**Model 3** **+controls**	**Model 1** **Bivariate**	**Model 2** **+test scores**	**Model 3** **+controls**	**Model 1** **Bivariate**	**Model 2** **+test scores**	**Model 3** **+controls**	**Model 1** **Bivariate**	**Model 2** **+test scores**	**Model 3** **+controls**
Obese	−0.475***	−0.327***	−0.256***	−0.270**	−0.130	−0.052	−0.294***	−0.230***	−0.110	−0.241***	−0.187**	−0.106
	(0.081)	(0.073)	(0.069)	(0.086)	(0.079)	(0.078)	(0.069)	(0.062)	(0.059)	(0.067)	(0.060)	(0.059)
Overweight	−0.090	−0.034	0.003	−0.176*	−0.122	−0.091	−0.089	−0.028	−0.002	−0.138*	−0.086	−0.065
	(0.069)	(0.060)	(0.056)	(0.072)	(0.066)	(0.062)	(0.069)	(0.060)	(0.057)	(0.067)	(0.061)	(0.058)
Test scores (std)												
ASVAB		0.496***	0.239***		0.471***	0.253***		0.513***	0.261***		0.439***	0.276***
		(0.025)	(0.031)		(0.028)	(0.034)		(0.025)	(0.031)		(0.025)	(0.032)
Academic track (math)												
Ref: Low academic												
Lower middle			0.091			−0.171			−0.311***			−0.484***
			(0.091)			(0.106)			(0.088)			(0.091)
Upper middle			0.470***			0.044			0.112			−0.299**
			(0.091)			(0.106)			(0.092)			(0.096)
Lower adv.			0.879***			0.615***			0.441***			0.059
			(0.099)			(0.114)			(0.105)			(0.110)
Upper adv.			1.001***			0.723***			0.672***			0.371**
			(0.106)			(0.122)			(0.112)			(0.117)
Constant	0.417***	0.256***	−0.584**	0.224**	0.072	−0.060	−0.098	−0.246***	−0.834***	−0.069	−0.197**	−0.078
	(0.072)	(0.065)	(0.181)	(0.077)	(0.071)	(0.210)	(0.075)	(0.068)	(0.190)	(0.073)	(0.067)	(0.193)
R^2	0.037	0.271	0.386	0.015	0.196	0.302	0.025	0.251	0.350	0.020	0.197	0.283
N	1431	1431	1431	1431	1431	1431	1584	1584	1584	1584	1584	1584

Note: Data were drawn from the National Longitudinal Study of Youth 1997 cohort. Sample includes non-Hispanic white respondents with transcript data reported. Model 3 includes controls for parents' education, household income, whether a student attended a private school, whether the mother is obese, and whether the student lives in an urban area. All models include fixed effects on census region and birth year; supplemental models without the fixed effects yielded no substantive difference in the coefficients of interest. All missing values imputed.

* $p < .05$,

** $p < .01$,

*** $p < .001$ Standard errors in parentheses.

Table 4

NLSY97: Regression of Obesity on Black Students' English and Math Cumulative High School GPA (~Age 18)

	GIRLS						BOYS					
	English GPA			Math GPA			English GPA			Math GPA		
	Model 1 Bivariate	Model 2 +test scores	Model 3 +controls	Model 1 Bivariate	Model 2 +test scores	Model 3 +controls	Model 1 Bivariate	Model 2 +test scores	Model 3 +controls	Model 1 Bivariate	Model 2 +test scores	Model 3 +controls
Obese	−0.181*	−0.132	−0.063	−0.199*	−0.160	−0.104	−0.040	−0.068	−0.075	−0.080	−0.099	−0.116
	(0.087)	(0.081)	(0.083)	(0.091)	(0.087)	(0.089)	(0.096)	(0.093)	(0.092)	(0.103)	(0.102)	(0.103)
Overweight	−0.141	−0.054	−0.015	−0.107	−0.037	−0.004	0.044	0.018	0.050	−0.014	−0.031	−0.005
	(0.095)	(0.088)	(0.087)	(0.103)	(0.099)	(0.098)	(0.107)	(0.104)	(0.101)	(0.116)	(0.114)	(0.113)
Test scores (std)												
ASVAB		0.423***	0.263***		0.344***	0.225***		0.307***	0.188**		0.201***	0.116
		(0.041)	(0.054)		(0.044)	(0.058)		(0.046)	(0.057)		(0.050)	(0.060)
Academic track (math)												
Ref: Low academic												
Lower middle			−0.238			−0.385**			−0.371**			−0.344*
			(0.128)			(0.139)			(0.120)			(0.134)
Upper middle			0.032			−0.251			−0.031			−0.153
			(0.133)			(0.144)			(0.127)			(0.143)
Lower adv.			0.298			0.118			0.350*			0.340
			(0.153)			(0.166)			(0.160)			(0.180)
Upper adv.			0.335*			0.283			0.221			0.027
			(0.169)			(0.182)			(0.185)			(0.207)
Constant	−0.167	0.061	−0.519	−0.307*	−0.122	0.063	−0.536**	−0.358*	−0.687	−0.452**	−0.336	−0.280
	(0.145)	(0.137)	(0.339)	(0.153)	(0.150)	(0.367)	(0.165)	(0.161)	(0.362)	(0.173)	(0.174)	(0.393)
R^2	0.039	0.194	0.251	0.042	0.135	0.193	0.021	0.092	0.167	0.033	0.060	0.112
N	691	691	691	691	691	691	659	659	659	659	659	659

Note: Data were drawn from the National Longitudinal Study of Youth 1997 cohort. Sample includes non-Hispanic black respondents with transcript data reported. Model 3 includes controls for parents' education, household income, whether a student attended a private school, whether the mother is obese, and whether the student lives in an urban area. All models include fixed effects on census region and birth year; supplemental models without the fixed effects yielded no substantive difference in the coefficients of interest. All missing values imputed.

* $p < .05$,

** $p < .01$,

*** $p < .001$ Standard errors in parentheses.

Table 5

NLSY97: Wald tests of the differences in the association between obesity and English GPA versus math GPA, by race and sex

	WHITE	BLACK
GIRLS	−0.201*	0.055
	(0.082)	(0.081)
	p=0.015	*p*=0.501
BOYS	−0.014	0.033
	(0.062)	(0.099)
	p=0.823	*p*=0.736

Note: Data were drawn from the National Longitudinal Study of Youth 1997 cohort. Sample includes non-Hispanic white and black respondents with transcript data reported. All missing values imputed. Differences are calculated based on Model 3 in Tables 3 and 4. Standard errors in parentheses.

* p < .05,

** p < .01,

*** p < .001

Table 6

FRAGILE FAMILIES: Regression of Obesity on White Students' Teacher-Rated Language and Math Skills (~Age 9)

	GIRLS						BOYS					
	Language and Literacy Skills [1]			Math Skills [1]			Language and Literacy Skills			Math Skills		
	Model 1 Bivariate	Model 2 +test scores	Model 3 +controls	Model 1 Bivariate	Model 2 +test scores	Model 3 +controls	Model 1 Bivariate	Model 2 +test scores	Model 3 +controls	Model 1 Bivariate	Model 2 +test scores	Model 3 +controls
Obese	−0.417*	−0.342*	−0.335*	−0.192	−0.153	−0.145	0.008	0.095	0.159	−0.062	0.014	0.064
	(0.188)	(0.150)	(0.154)	(0.187)	(0.159)	(0.163)	(0.201)	(0.166)	(0.171)	(0.196)	(0.157)	(0.165)
Overweight	0.092	−0.016	0.000	0.114	0.046	0.073	−0.029	−0.022	0.031	−0.130	−0.082	−0.105
	(0.163)	(0.130)	(0.133)	(0.160)	(0.137)	(0.140)	(0.201)	(0.166)	(0.174)	(0.199)	(0.159)	(0.167)
Test scores (std)												
WJ 9		0.394***	0.362***					0.504***	0.429***			
		(0.092)	(0.095)					(0.094)	(0.098)			
PPVT		0.333***	0.294***					0.187*	0.195*			
		(0.074)	(0.075)					(0.077)	(0.078)			
WJ10					0.322***	0.277***					0.549***	0.503***
					(0.064)	(0.070)					(0.074)	(0.078)
Digit span					0.223***	0.203**					0.191**	0.205**
					(0.065)	(0.067)					(0.064)	(0.064)
Social skills (std)			0.202**			0.193**			0.266***			0.211***
			(0.063)			(0.067)			(0.065)			(0.063)
Constant	0.521***	0.084	−0.683	0.290***	0.136*	−1.211	0.244**	−0.053	−0.336	0.463***	0.164*	−0.918
	(0.078)	(0.075)	(1.705)	(0.077)	(0.069)	(1.849)	(0.082)	(0.077)	(1.501)	(0.081)	(0.072)	(1.458)
R^2	0.031	0.394	0.451	0.010	0.290	0.359	0.000	0.328	0.413	0.003	0.370	0.436
N	188	188	188	190	190	190	183	183	183	184	184	184

Note: Data were drawn from the Fragile Families and Child Wellbeing Study. Sample includes non-Hispanic white respondents with measurements of weight and height and teacher survey data. Model 3 includes controls for parents' education, parents' age, child's age in months, mother's income, whether a student attended a private school, mother's cognition, and whether the mother is obese. Standard errors in parentheses.

* $p < .05$,

** $p < .01$,

*** $p < .001$

[1] Wald tests do not establish significance of the difference between the coefficients on obesity in the full models predicting language and math skills for white girls ($p = .190$).

Table 7

FRAGILE FAMILIES: Regression of Obesity on Black Students' Teacher-Rated Language and Math Skills (~Age 9)

	GIRLS						BOYS					
	Language and Literacy Skills			Math Skills			Language and Literacy Skills			Math Skills		
	Model 1 Bivariate	Model 2 +test scores	Model 3 +controls	Model 1 Bivariate	Model 2 +test scores	Model 3 +controls	Model 1 Bivariate	Model 2 +test scores	Model 3 +controls	Model 1 Bivariate	Model 2 +test scores	Model 3 +controls
Obese	0.057	0.060	0.065	−0.127	−0.114	−0.100	0.136	0.049	−0.012	0.175	0.096	0.038
	(0.109)	(0.092)	(0.090)	(0.106)	(0.092)	(0.090)	(0.108)	(0.086)	(0.082)	(0.116)	(0.095)	(0.091)
Overweight	0.026	0.077	0.067	−0.065	−0.019	−0.032	−0.174	−0.175	−0.103	−0.126	−0.036	0.042
	(0.125)	(0.106)	(0.101)	(0.123)	(0.107)	(0.101)	(0.119)	(0.094)	(0.090)	(0.124)	(0.102)	(0.097)
Test scores (std)												
WJ 9		0.440***	0.335***					0.444***	0.399***			
		(0.055)	(0.054)					(0.042)	(0.041)			
PPVT		0.233***	0.188***					0.248***	0.195***			
		(0.054)	(0.053)					(0.045)	(0.044)			
WJ 10					0.456***	0.378***					0.501***	0.424***
					(0.049)	(0.047)					(0.042)	(0.040)
Digit span					0.139**	0.080					0.124**	0.104**
					(0.047)	(0.045)					(0.041)	(0.039)
Social skills (std)			0.286***			0.304***			0.286***			0.310***
			(0.041)			(0.041)			(0.036)			(0.038)
Constant	0.044	0.071	−0.140	−0.017	−0.008	−0.047	−0.274***	−0.062	0.286	−0.187**	−0.049	−0.274
	(0.063)	(0.055)	(0.333)	(0.062)	(0.054)	(0.325)	(0.055)	(0.045)	(0.344)	(0.059)	(0.049)	(0.377)
R^2	0.001	0.295	0.385	0.003	0.253	0.359	0.010	0.385	0.466	0.008	0.333	0.433
N	450	450	450	451	451	451	503	503	503	507	507	507

Note: Data were drawn from the Fragile Families and Child Wellbeing Study. Sample includes non-Hispanic black respondents with measurements of weight and height and teacher survey data. Model 3 includes controls for parents' education, parents' age, child's age in months, mother's income, whether a student attended a private school, mother's cognition, and whether the mother is obese. Standard errors in parentheses.

* $p < .05$,

** $p < .01$,

*** $p < .001$

Table 8

NLSY97: Association between Obesity and White Girls' Cumulative High School GPA by Course Subject (~Age 18)

SUBJECT	COEFFICIENT ON OBESITY
English	−0.256***
	(0.069)
Social Science	−0.179**
	(0.069)
Lab Science	−0.136
	(0.0711)
Math	−0.052
	(0.078)

Note: Data were drawn from the National Longitudinal Study of Youth 1997 cohort. Sample includes non-Hispanic white girls with transcript data reported. All missing values imputed. Models include controls for parents' education, household income, whether a student attended a private school, whether the mother is obese, and whether the student lives in an urban area, as well as fixed effects on census region and birth year. Standard errors in parentheses.

* $p < .05$,

** $p < .01$,

*** $p < .001$