The Effect of Relative Weight Status On Education Accumulation

The research developed in this paper estimates the role of relative weight status during high school in lifetime educational attainment. Previous studies have indicated that obesity has asymmetric consequences between genders on socioeconomic outcomes such as income, wealth and education. This project attempts to discern some of the potential underlying reasons for this differential effect of obesity on educational attainment across genders.

Specifically, I examine the role of relative weight status within one's high school to consider whether having weight levels at higher points in one's local distribution of weight is associated with lower levels of education accumulation. I find that females with relatively higher weight levels (compared to other females within their high school) are less likely to attend college than their peers. There appears to be a much weaker relationship between weight status and education accumulation among males. Contrary to previous findings, measures of relative weight status indicate that males with higher BMI levels may be less likely to attend college. These results for investments in education are consistent with the evidence that obese women face a wage penalty relative to their non-obese peers, while obese males do not.

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The goal of this paper is to provide estimates of the influence of weight status relative to one's high school peers on lifetime education accumulation. The influence of obesity on income, wealth and other measures of economic status has been documented in recent research. These results generally find asymmetric consequences between genders of obesity on economic outcomes, with obese women generally faring worse than their non-obese counterparts, with little or no effect on status for obese males. The research in this paper seeks to consider whether such disparities exist in the level of education obtained since this a key factor in determining economic outcomes later in life. Previous work has found lower propensities for obese females to attend college with no significant difference among obese and non-obese males. This paper considers how relative weight levels for students during high school may impact the decision to accumulate additional education.

Educational attainment may be influenced by weight problems for several reasons.[1] For children who are obese early in life, peer discrimination or social isolation from classmates may limit their desire to invest in education beyond the compulsory level.[2] Parents may invest less in obese children's post-secondary education due to a reduced rate of return from lower expected future wages (or parental discrimination against their obese children, as postulated by Crandall (1995)). As well, the negative correlation between weight and income implies that obese parents have fewer resources to invest into their children's human capital formation.

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[1] One of the first studies documenting the relationship of obesity and education accumulation is provided by Canning and Mayer (1966) who studied the effect of weight problems on admission to highly selective colleges in the Northeast. They found that access to more prestigious higher education may be limited for obese students.
[2] See Dietz (1998) for a discussion of the social effects of obesity on children.

The relationship of health outcomes to levels of acquired education has generated a substantial literature since Michael Grossman's seminal work on health and human capital in the early 1970s. The usual direction of causality considered following Grossman is how higher education accumulation enhances the quality of health outcomes. However, the question asked here is not whether adults with higher levels of education have better health outcomes later in life, but whether one's health status during high school (specifically one's BMI[3] relative to other students) affects how much education individuals accumulate.

In this paper, I find that women with relatively higher BMI levels compared to other female students in their high school accumulate less education than their peers. This is consistent with findings that obese women are more likely to face a wage penalty than obese men (thus, reducing the returns to education). I also find that males with elevated BMI levels relative to their peers during high school may have a somewhat diminished likelihood of attending college.

The paper is organized as follows. Section 1 reviews previous research on the role of obesity in shaping economic outcomes. The data from the National Longitudinal Survey of Adolescent Health (Add Health) used to estimate the relationships of interest are discussed in Section 2. Section 3 develops a model in which the effect of weight problems on wages can influence parental investments in the education of their offspring. Estimates of the role of relative weight status on education accumulation are considered in Section 4. Finally, Section 5

[3] BMI is calculated as weight/(height^2) where weight is measured in kilograms and height is measured in meters. Adults with a BMI above 30 are typically classified as obese, while those with BMI levels above 25 are classified as overweight. BMI levels below 18.5 indicate underweight adults.

summarizes the findings of this research and suggests possibilities for future studies of the role of health in considering investments in education.

I. Previous Research on the Relationship of Obesity to Economic Outcomes

This section provides a review of prior research on the relationship of obesity to educational attainment and other measures of economic status, with emphasis on any asymmetric findings in this relationship between genders.

Sargent and Blanchflower (1994) estimate the relationship between obesity at age 16 and total years of education as well as wages at age 23 using a panel of individuals from the British National Child Development Study. They find that both males and females who are obese at age 16 obtain fewer years of education than their non-obese counterparts. As well, they find an inverse correlation between wages at age 23 and obesity at age 16 for females.

In a similar study, Gortmaker et. al. (1993) use the 1979 sample from the National Longitudinal Survey of Youth (NLSY79) to estimate the influence of overweight status in late adolescence on education accumulation seven years later. While only three percent of their sample of females is classified as overweight (BMI greater than the 95^{th} percentile for gender and age), they find that overweight women obtain roughly 2.5 percent less education than their non-overweight peers.

The causal influence of education on obesity and smoking patterns is studied using data from the NLSY79 in Kenkel et. al. (2006). With the direction of the relationship hypothesized as higher levels of education leading to lower rates of obesity, they do not find consistent evidence that the completion of high school leads to lower probabilities of being obese or overweight among either gender.

Karnehed et. al. (2006) study a large sample of men in Sweden to estimate the influence of BMI at age 18 on the likelihood of obtaining a university education. They find that obese men in their sample are 52 percent less likely to attain a high level of education (equivalent to completion of a university degree) than their desirable weight peers. Using a similar measure for university education employed in this paper, the authors find that obese men are 37 percent less likely to attend at least one year of college. It is important to note that the obesity rate among men in Sweden in the sample used is much lower than the rates of obesity considered in this paper.

Baum and Ruhm (2007) also use the NLSY79 data to examine changes in the relationship between obesity and socioeconomic status (SES) at different stages of life. With maternal education as a measure of SES, their research finds that BMI and rates of obesity increase from late adolescence to middle age more rapidly at lower SES levels. A significant portion of the transmission of benefits from growing up in a high SES household to a lower likelihood of becoming obese later in life is found to result from corresponding higher levels of education accumulation for children in higher SES households.

Using data from the Add Health survey used in the present paper, Sabia (2007) considers the effect on academic performance (measured by grade point average) of elevated BMI levels. He finds evidence of reduced academic performance among obese white females, controlling for unobserved individual heterogeneity that may influence both weight status and academic performance jointly. He employs both an instrumental variable approach (including parental obesity as an instrument for the adolescent's obesity) and an individual-level fixed effect approach in which changes in GPA are related to changes in BMI over multiple waves of the survey. Crosnoe and Muller (2004) find similar results of the influence of obesity on academic performance in a study also employing Add Health data.

Kaestner and Grossman (2007) critique the validity of parental obesity status as an instrument for offspring obesity (as in Sabia (2007) and Classen (2007)) and then relate measures of academic ability among children of women in the NLSY79 to weight status using BMI levels to explain changes in achievement test scores. They do not find any significant differences in educational achievement for obese or overweight children relative to peers with recommended BMI levels after controlling for individual unobserved heterogeneity with a variety of techniques.

The study most similar to the research discussed in this paper is Crosnoe (2007) who considers the influence of obesity on college attendance for Add Health survey participants. Using indicator variables for condition of obesity among high school students, he allows for this influence to vary depending on the percentage of all students in a given school who are classified as obese. A significant reduction in the likelihood of college attendance is found for obese females and the size of this reduction is largest in schools where obesity is relatively uncommon. Crosnoe finds no significant effects of obesity status on education accumulation for male students.

In comparison to these previous studies, this paper provides measures of a student's relative weight status within their high school to consider the influence of weight problems on education accumulation. This allows for the consideration of the influence of relative (i.e., position within the *local* distribution of BMI at one's school) versus absolute (i.e., BMI relative to cutoffs indicating weight problems in the *national* distribution of adolescent BMI) measures of weight status on education attainment. The hypothesis is that having an elevated BMI that indicates a weight problem is likely to have a larger influence on education outcomes in schools where such weight problems are rare (so that an elevated BMI places the student further into the right tail of the local distribution of BMI).

II. Description of Data

To estimate the influence of relative weight status on education accumlation, I use data from multiple waves of the National Longitudinal Survey of Adolescent Health (Add Health). The structure of these surveys provides the highly desirable feature of being able to measure obesity weight status during high school (in Wave I of the survey) and eventual education attainment (in Wave III of the survey).

The Add Health survey began in 1994 with interviews of students in a nationally-representative sample of 80 high schools and 52 middle schools. In-school paper surveys were conducted with a population of more than 90,000 students and follow-up in-home interviews were conducted with a subsample of 20,745 students in Wave I of the Add Health survey during the 1994-95 school year. Interviews were also conducted with a parent or legal guardian of the student during Wave I. A second round of in-home interviews was conducted with 14,738 students in Wave II the following year. The most recent available data from Add Health consist of Wave III data collected in 2001-02 from a sample of 15,197 students from the original Wave I sample.

I utilize data on education accumulation from the Wave III sample linked to measures of weight status and other relevant covariates collected during high school in Wave I. I limit the sample for this study to individuals who are at least 19 years old by the Wave III survey and were grades 9-12 in one of the 80 high schools during Wave I of the survey. Thus, this analysis does not attempt to measure the effect of relative weight status during middle school on education accumulation (as was done in Crosnoe (2007)).

These restrictions provide a data set of 4,947 female and 4,881 male participants in Add Health with at a minimum data on education accumulation by age 19 and measured BMI during high school. The inclusion of covariates with non-response in some instances will reduce the size of the sample accordingly.[4] In the regression analysis of Section 4, I include variables for the student's race/ethnicity, ability (a percentile score on a modified Peabody Picture Vocabulary Test), English and Math grades, maternal education, grade in school during Wave I along with a measure of family income (whether the interviewed parent responded that they had trouble paying bills) and school-level variables including whether the school is public, in an urban or rural location (as opposed to suburban) and the region of country. The sample means for these variables are provided in Table 1.

A. Relationship of Adolescent BMI Measures to Weight Problems

The use of BMI as a measure of body fatness has sometimes been criticized on the basis of the possibility for misclassification of individuals as obese due to its reliance on measures only of height and weight and the somewhat arbitrary cutoffs for this classification.[5] The problem is exacerbated when attempting to classify adolescents into categories associated with weight problems. The typical method for identifying weight problems among adolescents is the

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[4] The regressions in Section 4 reflect data from 3,328 females and 3,295 males with valid data in Waves I and III.
[5] The limitations of BMI in identifying obese individuals are discussed in Cawley and Burkhauser (2008).

use of growth charts from the CDC based on nationally representative data on the distribution of BMI generated from the National Health and Nutrition Examination Surveys (NHANES) conducted since 1971. The charts provide percentile cutoffs by age and gender for the classification of adolescents as "at risk of overweight" (BMI>85th percentile) and "overweight" (BMI>95th percentile). While these terms were developed to avoid stigmatizing adolescents with the label of obese, I will refer to students with BMI above the 85th percentile as overweight and those with BMI above the 95th percentile as obese.

i) Calculation of relative BMI position within schools

The problem with using average BMI levels within a high school for the purposes of determining relative weight status for the Add Health participants is that cutoffs for indications of weight problems vary within this population by both age and gender. For 14 year old males, the 95th percentile cutoff for the indication of obesity is a BMI of 26 while obesity among 18 year old males is indicated by a BMI above 29. These cutoffs not only vary by age but gender as well with the 95th percentile for 14 year old females being roughly 27.5 with an increase to 30.5 as the cutoff value indicating obesity among 18 year old females. The CDC growth charts provide parameters for the computation of age- and gender-specific z-scores to determine the relative position of adolescents in the national distribution of BMI by age and gender. Thus, with after calculating BMI values for Add Health participants during high school, I first generate z-scores based on the national distribution of BMI (termed *national* BMI z-score). This provides a measure of an individual's weight status relative to the United States population of the same age and gender.

However, the goal is to consider a student's relative weight status within their school and its influence on education accumulation. Since the calculated *national* z-scores eliminate the problems of incompatible BMI level comparisons across age and gender differences within a high school due to non-stable cutoffs for obesity classifications, I then calculate the mean and standard deviation of *national* BMI z-scores within each high school in the Add Health sample. This allows me to compute a within-school (termed *local*) BMI z-score based on the student's relative position within the distribution of BMI z-scores in the school. To summarize, the measure of relative weight status for individual *i*, with gender *g* in school *s* at age *t* is determined by first calculating the *national* z-score for BMI by age *t* and gender *g* using the CDC growth charts:

$$(National)\ BMIZ_{igt} = \frac{BMI_{igt} - \overline{BMI}_{gt}}{\sigma_{gt}} \qquad (1)$$

and then take averages and standard deviations of *national* BMI z-scores by gender within each school to calculate the relative position locally in the distribution of BMI z-scores by gender *g* within school *s* of

$$(Local)\ BMIZ_{igst} = \frac{BMIZ_{igt} - \overline{BMIZ}_{gs}}{\sigma^{z}{}_{gs}} \qquad (2)$$

where $\sigma^{z}{}_{gs}$ is the standard deviation of *national* BMI z-scores within school *s* among students of gender *g*. Note that if *national* BMI z-scores for a given gender within a school are distributed standard normal, the *local* BMI z-score ($BMIZ_{igst}$) will coincide with the *national* BMI z-score ($BMIZ_{igt}$).

There was substantial variation in the average BMI z-scores between schools ranging from a low of -0.145 (indicating that the average child at the school had a BMI below the national mean for their age and gender) to a high of 0.906. The standard deviation of BMI z-scores within a school varied from 0.73 to 1.5 indicating a wide range of potential weight distributions across the schools.

ii) Measuring Perceived Weight Problems Relative to Actual Current and Future BMI Levels in Add Health

As already indicated, there are numerous difficulties in the use of BMI to determine actual weight problems and relative weight status among adolescents. An additional concern in the use of BMI as a measure of excess body fatness (formally known as adiposity) is that its calculation (which uses only measures of weight and height) may misclassify individuals as "obese" who have large amounts of muscle mass, rather than high levels of body fat. Evidently, the implications for measuring the effect of relative BMI on education accumulation are likely to be quite different for those with high BMI levels resulting from excess adiposity versus those with high BMI due to muscle mass. This is one potential explanation for why there appears to be such a serious asymmetric consequence on economic outcomes between genders, with obese women facing negative consequences while "obese" male adolescents are not generally found to have negative economic consequences from elevated BMI levels. Insofar as relative social status during high school influences the likelihood of attending college (as found in Crosnoe (2007) where psychosocial measures attenuated the influence of obesity on college attendance by 1/3), then classifying the football team as obese is likely to confound this issue when considering outcomes for males.

The Add Health Wave I survey included questions in both the student and parent in-home interviews that allow for the consideration of potential biases in the classification of weight status using BMI relative to the perception of weight problems from both the parent and student. As well, with height and weight data collected in Weight III it is possible to measure the correlation between BMI during high school and at the follow-up survey 7 years later.

In the parental survey in Wave I, parents were asked whether their child was obese.[6] Table 2 shows the percent of children in each weight category (based on BMI level relative to age/gender percentile cutoffs) who were classified as obese by their parents. Among females with BMI above the 95th percentile for their age, nearly 52 percent were thought to be obese by their parent. In contrast, among males with BMI above the 95th percentile for their age, only one-third were characterized as obese by their parent. This disparity is evident among students who were overweight or even had BMI in the recommended range for their age, with females more than twice as likely to be characterized as obese by their parent in both cases. The results here allow for several possible interpretations. If BMI actually does overstate the prevalence of weight problems among males with substantial muscle mass, then it may result in a higher percentage of females with BMI above the 95th percentile to be characterized as obese by their parents. However, this result could also be explained by parental bias in the willingness to characterize their sons as obese relative to their daughters.

During the Wave I in-home interview, students were asked "How do you think of yourself in terms of weight?" Obviously, the response to this question likely reflects much more than a quick calculation in the student's head of their approximate BMI relative to national percentiles for their age and gender. Insofar as there exists a social stigma of obesity resulting

[6] The parents were also asked whether the child's biological mother and father had problems with obesity. These variables are used as instrumental variables for the child's weight status in Sabia (2007). The results for parental classification of child obesity relative to actual obesity based on BMI measures provides some indication of the quality of those instruments.

in isolation or harassment from peers for perceived weight problems in high schools, these responses may reflect a self-image at variance with actual measures of BMI. And if this stigma varies significantly between genders, then responses to this question are likely to vary significantly across genders regardless of actual differences in BMI levels. Nonetheless, the summary of responses provided in Table 3 may also reflect the potential for adolescent measures of BMI to misclassify individuals (especially muscular males) as obese. Over 90 percent of females classified as obese based on calculated BMI perceive themselves as being somewhat or very overweight compared to slightly less than 80 percent of males with BMI above the 95th percentile. A sizeable disparity between genders again exists for the overweight and recommended weight categories. Among overweight females, 80 percent perceive themselves as somewhat or very overweight compared to less than half of overweight adolescent males. And for females with BMI falling in the recommended range between the 5th and 85th percentiles, nearly 28 percent perceive themselves as at least somewhat overweight compared to slightly less than 8 percent of males with BMI in the recommended range.

A final attempt to verify the quality of adolescent BMI measures in Wave I of the Add Health survey is to compare BMI levels and weight status classifications in Wave I to outcomes in the Wave III in-home survey collected seven years later. Table 4 displays the distribution of Wave III weight outcomes relative to weight status while in high school. Each row displays the distribution of weight status in Wave III based on Wave I weight status. The disparities between genders are not as evident as in Tables 2 and 3, but we do see that among males who were classified as obese in Wave I, 77 percent had BMI above 30 (the classification for adult obesity) by Wave III as opposed to 85 percent of females who were obese at Wave I. The last column of

Table 4 displays the average BMI calculated at Wave III for students in each of the four weight categories at Wave I. This shows that average BMI at Wave III among females who were obese at Wave I is more than 3 points higher than average BMI at Wave III for males who were obese in high school. It is also apparent that participants in the Add Health survey underwent substantial weight gain between Waves I and III similar to changes in national rates of obesity between 1994 and 2001. More than 50 percent of males have BMI above 25 (overweight or obese) by Wave III compared to slightly less than 27 percent of Wave I males classified as obese or overweight. Similar trends are seen among females with more than double the fraction classified as overweight or obese by Wave III compared to rates at Wave I.

III. Model of Weight Status and Human Capital Attainment

This section considers a simple model of the relationship between obesity and investments in education.

A. Model of Human Capital and Obesity Transmission

In order to demonstrate the potential relationships between obesity and human capital accumulation, consider the following version of a model similar to the classical Becker-Tomes (1986) framework, but without credit constraints and allowing wages to depend on weight status. A parent *m* with offspring *s* faces the following problem:

$$\max_{c_m, c_s, h_s, x_s} u(c_m, c_s)$$
$$s.t.\ \ c_m + h_s + x_s \leq w(a_m, b_m, h_m) + x_m$$
$$c_s \leq w(a_s, b_s, h_s) + (1+r)x_s$$

where c_m and c_s are consumption levels of the parent and child, h_m and h_s are the education levels of the parent and child, a_m and a_s are measures of ability of the parent and child, b_m and

b_s are measures of obesity of the parent and child, and x_m and x_s are assets of the parent and child that provide a rate of return *r* that is uniform across families. As discussed in Section 1, there exists evidence that $w_b(a_m, b_m, h_m) < 0$ for certain groups. Of interest in this study is the sign of $w_{hb}(a_s, b_s, h_s)$. Given the assumption of a uniform rate of return to assets across families, the determination of the education of the offspring and their assets requires that $w_h(a_s, b_s, h_s) = (1+r)$. Thus, if $w_{hb}(\bar{a}_s, b_s, h_s) < 0$ for a given ability level, we would expect parents to make lower investments in the education of obese offspring. Such an outcome is depicted in Figure 1 where b_2 indicates a weight level closer to the desirable BMI range than b_1.

Evidently, the assumption that all families are unconstrained in their access to credit markets for investments in education is difficult to reconcile with empirical realities. As the NLSY data indicate, women with less education (and lower income) are more likely to have overweight and obese offspring. Thus, the families that are most likely to face credit constraints are also the most likely to have obese children (who are more likely born to obese parents). While credit constraints limit opportunities for total investments in education among these relatively poor families,[7] such constraints will force lower-income families to invest relatively more in children with better future wage prospects.

[7] The availability of government subsidies for higher education limits these credit constraints to some extent. Carneiro and Heckman (2002) argue that less than 10 percent of U.S. households are credit constrained in making investments in higher education by the time children have reached late adolescence. They find that a more substantial credit constraint is generated from low income families' inability to invest in early education and assist in the development of cognitive and non-cognitive abilities of children.

IV. Estimates of the Influence of Weight Problems on Education Accumulation

Using the measures of relative weight status developed in Section 2 as well as indicators of obesity or overweight based on BMI relative to age- and gender-specific cutoff percentiles, this section presents results of regression models estimated to determine the influence of relative weight levels during high school on education accumulation by early adulthood. The covariates described in Section 2 and summarized in Table 1 account for other factors likely to influence the education accumulation process. Table 5 presents the distribution of education attainment across the four weight categories by gender. A substantial disparity in the likelihood of attending a 4-year college is evident between obese females and those with recommended BMI levels. Females with recommended BMI levels are nearly twice as likely to attend a 4-year college compared to their obese counterparts. While there exists a gap in the likelihood of attending a 4-year college between obese and recommended weight males, it is less than half as large as the gap among females. As well, overweight females are substantially less likely to attend a 4-year college than those with recommended weight, but there is not a significant difference in the likelihood of 4-year college attendance between overweight and recommended weight males.

Table 6 presents results of estimated marginal effects for four probit specifications of weight status and its effect on the likelihood of females attending college. Table 7 presents results for these same specifications for males. Local BMI z-scores indicate that female students higher in the local distribution of BMI are less likely to attend college (Model 1) and this effect size reflects the negative influence of relative weight size for obese and overweight students (Model 3). Indicator variables of weight status relative to national distributions of BMI indicate that obese and overweight females are 16 and 10 percent less likely, respectively, to attend college than their peers with BMI levels in the recommended range (Model 4). Table 7 indicates that only when BMI z-scores are considered separately by weight status (Model 3) is there a significant relationship between relative weight level and the likelihood of college attendance. In this case, obese males with relatively higher BMI levels within the local distribution are less likely to invest in education beyond high school. This effect also is present in Model 4 using weight status based on BMI levels relative to the national distribution of weight. This result indicates that obese males are 7 percent less likely to attend college than peers with BMI levels in the recommended range.

V. Conclusions and Directions for Further Research

This paper adds to a growing literature on the role of health in the determination of economic status. Specifically, I estimate the role of obesity and overweight in the accumulation of education via high school graduation and college enrollment. I find that females with BMI levels relatively higher in the local distribution of weight within their high school are less likely to enroll in college. Contrary to previous evidence, I find that obese males may be less likely to attend college, but the magnitude of this effect is significantly smaller than for obese females.

These results add to a growing body of evidence on the asymmetric influence of obesity on economic outcomes between genders. While there exist a plethora of possible explanations for why obese females have lower wages and obtain less education than those females with BMI levels in the recommended range, the lack of any consistent negative influence of weight status (or positive relationship in certain cases) on economic outcomes among males is puzzling. The potential for misclassification of males with relatively high levels of muscle mass as obese due to the limitations of BMI as a measure of actual obesity may explain some portion of this contrary result, but further studies to explore this paradox seem warranted.

Bibliography

Baum and Ruhm (2007)

Becker, G. and N. Tomes (1986) "Human Capital and the Rise and Fall of Families," *Journal of Labor Economics*, vol. 4, no. 3 (part 2), pp. S1-S39

Canning, H and J. Mayer (1966) "Obesity - its possible effect on college acceptance," *New England Journal of Medicine*, vol. 275, pp. 1172-1174.

Carneiro, P. and J. Heckman (2002) "The Evidence on Credit Constraints in Post-Secondary Schooling," *Economic Journal*, vol. 112, issue 482, pp. 705-734.

Cawley, J. (2004) "The Impact of Obesity on Wages," *Journal of Human Resources*, Vol. 39, no. 2, pp. 451-474

Cawley and Burkhauser (2008)

Crandall, S.C. (1995) "Do Parents Discriminate Against their Heavyweight Daughters?" *Personality and Social Psychology Bulletin*, vol. 21, no. 7, pp. 724-735

Crosnoe (2007)

Crosnoe and Muller (2004)

Dietz, W. H. (1998) "Health Consequences of Obesity in Youth: Childhood Predictors of Adult Disease," *Pediatrics*, vol. 101, no. 3, pp. 518-525

Gortmaker, S.L.; A. Must; J. M. Perrin; A. M. Sobol; W. H. Dietz (1993) "Social and Economic Consequences of Overweight in Adolescence and Young Adulthood," *New England Journal of* Medicine, vol. 329, no. 14, pp.1008-1012

Kaestner and Grossman (2008)

Karnehed, N.; F. Rasmussen; T. Hemmingsson; P. Tynelius (2006) "Obesity and Attained Education: Cohort Study or More Than 700,000 Swedish Men," *Obesity*, vol. 14, no. 8, pp. 1421-1428.

Kenkel, D., D. Lillard, A. Mathios (2006) "The Roles of High School Completion and GED Receipt in Smoking and Obesity," NBER Working Paper No. 11990

Persico N., Postlewaite, A., Silverman, D. (2004) "The Effect of Adolescent Experience on Labor Market Outcomes: The Case of Height," *Journal of Political Economy*, vol. 112, no. 5, pp. 1019-1053

Rustuccia, D. and C. Urrutia (2004) “Intergenerational Persistence of Earning: The Role of Early and College Education,” *American Economic Review*, vol. 94, no. 5, pp. 1354-1378.

Sabia (2007)

Sargent, J. and D. Blanchflower (1994) “Obesity and Stature in Adolescence and Earnings in Young Adulthood. Analysis of a British Birth Cohort,” *Archives of Pediatrics and Adolescent Medicine*, vol. 148, no. 7, pp. 681– 687

Tables and Figures

Figure 1 – Weight Problems May Reduce Investment in Education

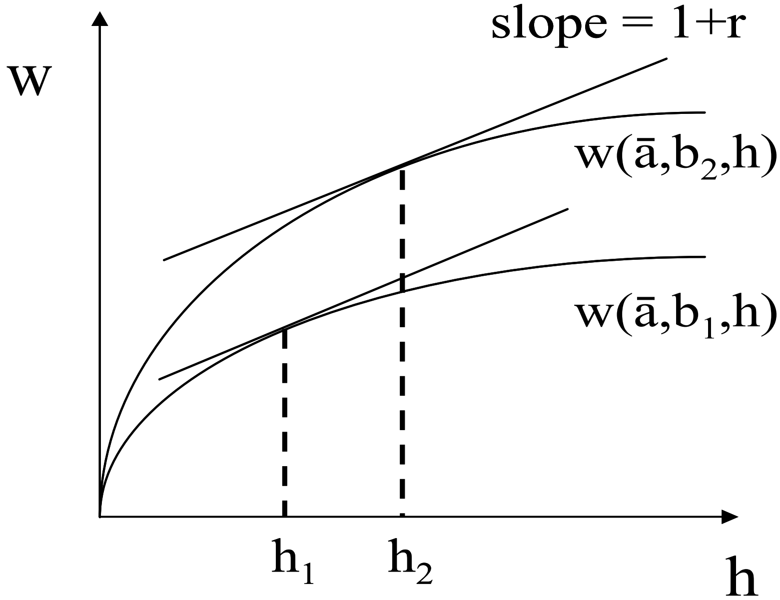

Table 1 - Sample Means of Variables

Variable	Females	Males
Any 4 Year College	41.8%	31.9%
Local BMI z-score	0.005	0.026
Obese	7.9%	12.6%
Overweight	13.0%	13.7%
Underweight	2.6%	3.3%
English GPA	2.99	2.59
Math GPA	2.60	2.48
PVT Percentile Score	101.5	102.7
Grade in School at Wave I	10.3	10.3
White	55.5%	57.4%
Latino	15.7%	17.1%
Black	21.8%	18.0%
Other Race/Ethnicity	7.0%	7.6%
Parental Characteristics		
Can't Pay Bills	18.2%	16.8%
Maternal Highest Edu		
High School	35.2%	36.4%
Any College	13.7%	12.9%
College Graduate	28.7%	29.8%
School Demographics		
West	24.8%	25.6%
Midwest	27.1%	25.9%
Northeast	13.2%	12.7%
South	34.9%	35.8%
Urban	27.6%	25.4%
Suburban	54.1%	54.9%
Rural	18.3%	19.7%
Public	92.2%	91.3%
Private	7.8%	8.7%

Table 2 - Percent of Parents in Wave I Who Classified Child as Obese by Actual Child Weight Status

Actual Weight Status	Females	Males
Obese *BMI > 95th percentile*	51.7%	33.1%
Overweight *85th < BMI < 95th*	14.3%	4.7%
Recommended *5th < BMI < 85th*	1.3%	0.5%
Underweight *BMI < 5th percentile*	0.0%	0.0%

Table 3 - Student Self-Perception of Weight Status by BMI Classification

Females

	Weight Classification by BMI Percentiles for Age			
	Underweight	Recommended	Overweight	Obese
Self-Perception of Weight	*BMI < 5th pctle*	*5th<BMI<85th*	*85th<BMI<95th*	*BMI>95th pctle*
Very Underweight	14.3%	1.3%	0.2%	2.0%
Slightly Underweight	53.8%	10.9%	2.0%	2.0%
About the right weight	29.0%	59.8%	17.7%	5.5%
Slightly Overweight	3.0%	26.8%	68.8%	59.2%
Very Overweight	0.0%	1.1%	11.3%	31.4%

Males

	Weight Classification by BMI Percentiles for Age			
	Underweight	Recommended	Overweight	Obese
Self-Perception of Weight	*BMI < 5th pctle*	*5th<BMI<85th*	*85th<BMI<95th*	*BMI>95th pctle*
Very Underweight	14.8%	2.7%	0.4%	0.8%
Slightly Underweight	52.0%	24.8%	3.8%	2.8%
About the right weight	31.8%	64.7%	46.9%	17.1%
Slightly Overweight	1.1%	7.7%	47.4%	66.4%
Very Overweight	0.3%	0.1%	1.6%	12.9%

Table 4 - Transition Probabilities of Weight Classfication Changes From Wave I to III

Females

	Wave III Weight Status					
	Underweight	Recommended	Overweight	Obese	Total	Avg. BMI
Wave I Weight Status					Wave I	by Wave III
Underweight	37.2%	60.2%	2.0%	0.5%	3.0%	19.5
Recommended	4.5%	61.7%	23.5%	10.4%	78.9%	24.2
Overweight	0.3%	13.5%	29.6%	56.6%	13.7%	31.5
Obese	0.2%	4.1%	10.6%	85.2%	8.7%	37.9
Total Wave III	4.5%	50.5%	22.6%	22.4%		

Males

	Wave III Weight Status					
	Underweight	Recommended	Overweight	Obese	Total	Avg. BMI
Wave I Weight Status					Wave I	by Wave III
Underweight	22.3%	70.6%	5.9%	1.3%	3.6%	20.6
Recommended	2.0%	57.8%	33.1%	7.2%	69.7%	24.5
Overweight	0.2%	14.8%	42.4%	42.6%	14.5%	29.4
Obese	0.0%	6.7%	16.5%	76.9%	12.2%	34.2
Total Wave III	2.2%	45.8%	31.4%	20.6%		

Table 5 - Distribution of Education Attainment by Weight Status

	Females			
Edu Accumulation	Underweight	Recommended	Overweight	Obese
Less than HS/GED	5.5%	4.5%	6.7%	10.4%
GED only	4.8%	3.7%	5.5%	6.1%
High School Grad	42.8%	34.5%	47.3%	46.2%
Any 2 yr college	12.4%	15.4%	13.8%	15.8%
Any 4 yr college	34.5%	42.0%	26.6%	21.5%

	Males			
Edu Accumulation	Underweight	Recommended	Overweight	Obese
Less than HS/GED	11.4%	8.4%	7.4%	9.2%
GED only	6.6%	6.5%	6.7%	7.2%
High School Grad	44.3%	41.0%	45.0%	50.3%
Any 2 yr college	12.0%	13.0%	12.1%	11.1%
Any 4 yr college	25.7%	31.1%	28.9%	22.1%

Note: " Any 2 yr college" and "Any 4 yr college" indicate either the individual is either currently attending a 2 or 4 year college or has graduated from a 2 or 4 year college

Table 6 - Marginal Effects Probits of Female College Attendance

Variable	**Model 1**	**Model 2**	**Model 3**	**Model 4**
Local BMI z-score	-0.0260***	-0.0328***		
	[0.00896]	[0.00930]		
(Local BMI z-score)^2		-0.0286***		
		[0.00930]		
Local BMI z*Obese			-0.111***	
			[0.0277]	
Local BMI z*Overweight			-0.0920***	
			[0.0201]	
Local BMI z*Recommended			0.0276*	
			[0.0156]	
Local BMI z*Underweight			0.0135	
			[0.0270]	
Weight Indicator Variables				
Obese				-0.160***
				[0.0415]
Overweight				-0.104***
				[0.0206]
Underweight				-0.0267
				[0.0599]
English GPA	0.140***	0.138***	0.139***	0.139***
	[0.0138]	[0.0137]	[0.0138]	[0.0136]
Math GPA	0.0651***	0.0652***	0.0652***	0.0644***
	[0.0103]	[0.0105]	[0.0105]	[0.0105]
PVT Percentile	0.00893***	0.00895***	0.00896***	0.00893***
	[0.000865]	[0.000858]	[0.000856]	[0.000866]
Grade in School (9-12)	0.0404***	0.0405***	0.0409***	0.0399***
	[0.00977]	[0.00967]	[0.00981]	[0.00957]
Latino	0.156***	0.155***	0.152***	0.154***
	[0.0453]	[0.0451]	[0.0452]	[0.0452]
Black	0.136***	0.138***	0.143***	0.149***
	[0.0375]	[0.0374]	[0.0371]	[0.0368]
Other Race	0.0693	0.0703	0.0742	0.0703
	[0.0575]	[0.0554]	[0.0549]	[0.0560]
Maternal Education				
High School	0.113***	0.111***	0.114***	0.113***
	[0.0330]	[0.0322]	[0.0323]	[0.0323]
Any College	0.229***	0.229***	0.227***	0.226***
	[0.0362]	[0.0361]	[0.0363]	[0.0361]
College Graduate	0.337***	0.337***	0.338***	0.337***
	[0.0332]	[0.0328]	[0.0325]	[0.0326]
Can't Pay Bills	-0.0487*	-0.0487*	-0.0449	-0.0470*
	[0.0274]	[0.0277]	[0.0279]	[0.0277]
West	-0.0277	-0.0291	-0.0314	-0.0319
	[0.0368]	[0.0368]	[0.0369]	[0.0365]
Midwest	0.0714	0.0702	0.0664	0.0665
	[0.0458]	[0.0462]	[0.0452]	[0.0450]
Northeast	0.153***	0.151***	0.149***	0.150***
	[0.0544]	[0.0552]	[0.0544]	[0.0536]
Urban	0.0343	0.0318	0.03	0.031
	[0.0442]	[0.0449]	[0.0439]	[0.0434]
Rural	-0.0463	-0.0465	-0.0448	-0.0439
	[0.0325]	[0.0322]	[0.0320]	[0.0315]
Public	-0.0973	-0.101*	-0.0981*	-0.0954
	[0.0597]	[0.0602]	[0.0590]	[0.0587]
Observations	3328	3328	3328	3328
Pseudo R^2	0.23	0.234	0.237	0.236

Robust standard errors in brackets
*** p<0.01, ** p<0.05, * p<0.1

Notes: South is excluded region, Less than high school is excluded Maternal Education, White is excluded racial category, Private is excluded school type, Recommended BMI is excluded weight category

Table 7 - Marginal Effects Probits of Male College Attendance

Variable	**Model 1**	**Model 2**	**Model 3**	**Model 4**
Local BMI z-score	-0.0178	-0.0191*		
	[0.0109]	[0.0109]		
(Local BMI z-score)^2		-0.00756		
		[0.00578]		
Local BMI z*Obese			-0.0416***	
			[0.0151]	
Local BMI z*Overweight			-0.000142	
			[0.0314]	
Local BMI z*Recommended			-0.0115	
			[0.0181]	
Local BMI z*Underweight			-0.0024	
			[0.0184]	
English GPA	0.105***	0.105***	0.106***	0.105***
	[0.00879]	[0.00879]	[0.00880]	[0.00879]
Math GPA	0.0613***	0.0609***	0.0605***	0.0605***
	[0.00751]	[0.00759]	[0.00759]	[0.00759]
PVT Percentile	0.00673***	0.00672***	0.00670***	0.00669***
	[0.000862]	[0.000863]	[0.000859]	[0.000857]
Grade in School (9-12)	0.0134*	0.0138*	0.0141*	0.0142*
	[0.00775]	[0.00771]	[0.00775]	[0.00774]
Latino	0.0437	0.0436	0.0451	0.0451
	[0.0336]	[0.0337]	[0.0334]	[0.0338]
Black	0.0681*	0.0661*	0.0671*	0.0660*
	[0.0383]	[0.0382]	[0.0380]	[0.0379]
Other Race	0.103**	0.104**	0.105**	0.107**
	[0.0504]	[0.0500]	[0.0501]	[0.0489]
Maternal Education				
High School	0.0451*	0.0446*	0.0452*	0.0452*
	[0.0243]	[0.0242]	[0.0242]	[0.0242]
Any College	0.0995***	0.0985***	0.0991***	0.0980***
	[0.0349]	[0.0349]	[0.0348]	[0.0349]
College Graduate	0.226***	0.225***	0.227***	0.226***
	[0.0318]	[0.0317]	[0.0319]	[0.0320]
Can't Pay Bills	-0.0466	-0.046	-0.0455	-0.0455
	[0.0381]	[0.0382]	[0.0382]	[0.0383]
West	-0.0285	-0.0287	-0.0296	-0.0305
	[0.0333]	[0.0332]	[0.0330]	[0.0328]
Midwest	0.0846**	0.0843**	0.0848**	0.0830**
	[0.0382]	[0.0383]	[0.0377]	[0.0375]
Northeast	0.0851*	0.0862*	0.0867*	0.0854*
	[0.0467]	[0.0466]	[0.0463]	[0.0462]
Urban	0.00132	0.0012	0.00151	0.000731
	[0.0332]	[0.0331]	[0.0331]	[0.0332]
Rural	-0.0467	-0.0466	-0.0461	-0.0466
	[0.0372]	[0.0372]	[0.0369]	[0.0368]
Public	-0.114**	-0.114**	-0.112**	-0.112**
	[0.0527]	[0.0526]	[0.0522]	[0.0522]
Weight Indicator Variables				
Obese				-0.0678***
				[0.0220]
Overweight				-0.00814
				[0.0358]
Underweight				0.00333
				[0.0426]
Observations	3295	3295	3295	3295
Pseudo R^2	0.2	0.2	0.201	0.201

Robust standard errors in brackets
*** p<0.01, ** p<0.05, * p<0.1

Notes: South is excluded region, Less than high school is excluded Maternal Education, White is excluded racial category, Private is excluded school type, Recommended BMI is excluded weight category