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ABSTRACT

In this paper, we investigate the association between weight and adolescent's educational attainment, as measured by highest grade attended, highest grade completed, and drop out status. Data for the study came from the 1997 cohort of the National Longitudinal Survey of Youth (NLSY), which contains a large, national sample of teens between the ages of 14 and 18. We obtained estimates of the association between weight and educational attainment using several regression model specifications that controlled for a variety of observed characteristics. Our results suggest that, in general, teens that are overweight or obese have levels of attainment that are about the same as teens with average weight.

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Introduction

The documented growth in obesity over the last thirty years has resulted in widespread public and private concern over the consequences associated with this significant change in the human body. Most of this concern is focused on health, as obesity has been linked to poor health, particularly diabetes and cardiovascular disease (NHLBI 1998). The perceived seriousness of the health consequences of obesity has resulted in an explosion of research seeking to identify the causes of obesity and polices that may reduce obesity.

While the health consequences of obesity are clearly important, researchers and others have recognized that obesity may adversely affect other determinants of well being such as earnings and marriage.[1] Obesity may also affect educational attainment, which is arguably the most important determinant of well being. Surprisingly, there is little research on this issue despite widespread belief that obesity has a negative impact on children's, and thus adult, educational achievement (National Education Association 1994).

Obesity may affect educational achievement in several ways. First, peers and teachers may discriminate against overweight and obese children and this will adversely affect educational achievement (National Education Association 1994). Second, obesity may affect health in ways that lower achievement. Obesity is associated with sleeping disorders (e.g., sleep apnea) and depression and these illnesses may result in poor cognitive functioning and more missed days of school. Third, obesity may affect how children spend their time and specifically how much time they spend studying. Overweight and obese children may spend less time in physical activity and engaged in social activities, and as a result, spend more time studying, which suggests that obesity may positively affect educational achievement.

[1] See Averett and Korenman (1996), Cawley (2004), Cawley et al. (1996), Fu and Goldman (1996), Sobal et al. (1992), and Gortmaker et al. (1993).

The possibility that obesity may affect education is more than a private issue of concern only to families. While it is true that families will make decisions about food consumption and children's education that incorporates any effects of obesity on education, these decisions will, in part, reflect government policy. For example, farm subsidies affect the price of food, and transportation policy and land regulation affect the price of physical activity (e.g., walking). These government interventions will partly determine obesity, and therefore possibly determine education. Thus, analyses of the effect of obesity on children's educational achievement are particularly relevant for public policy. Moreover, if obesity lowers educational attainment, this will worsen the already significant health problems of obese persons given the protective effects of education on health (Grossman 2006).

In this paper, we investigate the effect of obesity on educational attainment of adolescents. We study a nationally representative sample of children ages 14 to 18 drawn from the 1997 cohort of the National Longitudinal Survey of Youth. Our results indicate that weight status (under- and overweight) does not have large effects on educational attainment, as measured by grade progression and drop out status. While we cannot rule out the possibility that weight may have small effects on educational attainment, there is little evidence that being under or overweight has systematically positive or negative effects on grade progression and the probability of dropping out.

Previous Literature[2]

There are relatively few studies of the effects of obesity on educational achievement.[3] Studies of adolescents often find negative associations between obesity and educational

[2] This section draws heavily on Kaestner and Grossman (2008).

[3] There is a somewhat larger, although still relatively small, literature on the effects of child health on educational achievement and some of these papers use weight as an indicator of child health (e.g., Edwards and Grossman 1979; Shakotko et al. 1981; Blau and Grossberg 1992; and Korenman, Miller and Sjaastad 1994; Rosenzweig and Wolpin

achievement. Shakotko, Edwards, and Grossman (1981) investigated the effect of being overweight in childhood (ages 6-11) on scores from the Wechsler Intelligence Scale for Children (WISC) and the Wide Range Achievement Test (WRAT) in adolescence (ages 12-17) using children who were examined in two consecutive National Health Examination Surveys (II and III). Estimates were obtained in the context of a Granger-causality model. Coefficients of overweight were positive, but not significant. Falkner et al. (2001) studied grade progression among 10th, 11th, and 12th grade students in Connecticut. Results from multivariate regression analyses indicated that obese females were 1.51 times more likely to be held back a grade than normal weight females. A similar association was not found for males. Ding et al. (2008) studied the GPA of high school students in northern Virginia. They performed an instrumental variables estimation using a genetic obesity marker as an instrument for obesity and found that obese females had GPAs 0.45 points lower than normal weight females. This association was not found for males. Sabia (2007) studied a geographically broader sample of adolescents aged 14 to 17 drawn from the National Longitudinal Survey of Adolescent Health, and he used a variety of statistical methods (e.g., fixed effects and instrumental variables) to account for potential confounding from omitted variables. In general, he found that obesity was negatively correlated with grade point average (GPA), although the most robust and consistent evidence of this association was limited to white, female adolescents. For this group, the GPA of obese females was approximately 10 percent lower than that of normal weight females. However, Crosnoe and Muller (2004), who also used data from the National Longitudinal Survey of Adolescent Health, found no effect of obesity on GPA after controlling for prior achievement. Additionally, Fletcher and Lehrer (2008) use data from the National Longitudinal Survey of Adolescent Health and find no effect of obesity on

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1994; Kaestner and Corman 1995). However, all but Shakotko et al. (1981) and Edwards and Grossman (1979) focused on underweight as a measure of health.

PIAT scores after controlling for confounding factors with fixed effects and instrumental variables. Finally, Sigfusdotir et al. (2006) found that among Icelandic youth aged 14 to 15, a high Body Mass Index (1 or 2 standard deviations above mean) was associated with lower grades after adjusting for personal and family characteristics. While not an exhaustive review, these studies are the largest and most sophisticated and their findings suggest that obesity is associated with lower educational achievement of adolescents.[4]

While the findings from previous studies suggest that obesity has an adverse effect on adolescent educational achievement, more study is warranted. First, there are relatively few studies and only three that use nationally representative data from the US (Sabia 2007; Crosnoe and Muller 2004; Fletcher and Lehrer 2008). These three studies use the same data (National Longitudinal Study of Adolescent Health) and surprisingly reached different conclusions. The paucity of research in this area is significant given the importance of education to lifetime well being. Here we begin to address this shortfall by providing an analysis of the effect of weight on adolescent educational achievement using a large, national sample of children aged 14 to 18 that have not been previously used to study this question. Second, more research is needed that recognizes that current educational achievement is a function of a lifetime of influences (Todd and Wolpin 2003, 2007). Past research has not paid appropriate attention to this issue and as a result has proceeded in an ad hoc basis that may explain some of the inconsistent findings of past research. In this paper, the cumulative nature of educational achievement is a central focus and we provide an arguably more theoretically consistent analysis than prior studies.

[4] Canning and Mayer (1967) compared obese and non-obese high school student in suburban Boston and found no difference in test (SAT) scores or educational aspirations. Gortmaker et al. (1993) studied adolescents and young adults from the 1979 cohort of the National Longitudinal Survey of Youth and found that females between the ages of 16 and 23 who were overweight had 0.3 years less education than normal weight females eight years later.

Empirical Framework[5]

Our empirical analysis is based on the educational production function approach that is widely used to identify the effects of family and school resources on educational achievement (Hanushek 1986; Todd and Wolpin 2003; Todd and Wolpin 2007). As Todd and Wolpin (2003, 2007) emphasize, an important aspect of these models is that current educational achievement is a function of all past family and school resources devoted to children's education. Here, we incorporate this idea into our analysis using the following model:

$$\begin{aligned} GRADE_{it} &= \alpha_i + \gamma_t + \sum_{k=0}^{t}(\tau_k OWN_{ik} + \beta_k HEALTH_{ik} + \delta_k PAR_{ik}) + \\ (1) \qquad & \sum_{k=0}^{t}(\lambda_k TEACH_{ik} + \pi_k PEER_{ik} + Z_{ik}\Gamma_k) + u_{it} \\ t &= 14,15,16,17 \end{aligned}$$

Equation (1) indicates that the grade level (*GRADE*) of child i at age t depends on a child-specific endowment (α_i), developmental age at time t (γ_t), the time the child spends in educational activities (*OWN*) at each age from birth to age t, child health (*HEALTH*) at each age from birth to age t, time spent by family members (e.g., mother) producing education (*PAR*) from birth to age t, the quantity and quality of school and teacher inputs (*TEACH*) from birth to age t, the quantity and quality of peer inputs (*PEER*) from birth to age t, and other market goods (*Z*) from birth to age t that are used to produce educational achievement.

Equation (1) allows determinants of educational achievement to have different effects depending on age, for example, the parental time input (*PAR*) may have a different effect at age 14 than at age 17 because at age 14 children may spend more time at home with the parent studying. However, equation (1) assumes that effects of educational inputs do not depend on time since investments were made, which is equivalent to assuming that there is no depreciation

[5] This section draws heavily on Kaestner and Grossman (2008).

of education capital. This specification was chosen to facilitate estimation, which we discuss in more detail below including ways to test the restrictions embodied in equation (1).

Our interest is to obtain estimates of the effect of weight on educational achievement. As noted, there are several ways that weight (overweight) may affect educational achievement. One of the most cited potential causes is size (weight) discrimination. Overweight and obese children face a variety of discrimination from peers and teachers that may adversely affect educational achievement (Ritts et al. 1992; NEA 1994; Neumark-Sztainer et al. 1998; Jalongo 1999; Solovay 2000; Puhl and Brownell 2003; Schwartz and Puhl 2003; Eisenberg et al. 2003; Janssen et al. 2004). In terms of equation (1), size (weight) discrimination would affect the quantity and quality of school and teacher inputs and the quantity and quality of peer inputs. Weight may even affect the quantity and quality of parental inputs if households allocate resources in response to size discrimination (Crandall 1995; Puhl and Latner 2007).

Discrimination against overweight and obese children may also lead to depression (*HEALTH* in equation 1) that can adversely affect educational achievement (Wurtman 1993; Smith et al. 1998; Hoebel et al. 1999; Goodman and Whitaker 2002).[6] Childhood obesity is also associated with other aspects of health such as asthma, sleep apnea and sleeping disorders, which may adversely affect cognitive functioning and school attendance, and thus educational achievement (Gozal 1998; Dietz 1998; Must and Strauss 1999; Redline et al. 1999; Mutius et al. 2001; Gilliland et al. 2003; Beuther et al. 2006; Geier et al. 2007).[7]

Size (weight) discrimination could also affect the child's time use. Ostracism may lead a child to have fewer social relationships and engage in fewer social activities. This may result in

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[6] However, the causal relationship between obesity and depression is unresolved and some have argued that depression causes obesity, for example, because of affective disorders such as binge eating. Others argue that there is a common genetic component linking depression and obesity (Mustillo et al. 2003; Bjontorp and Rosmond 2000; Rosmond et al. 2001).

[7] In the case of sleeping disorders, the direction of causality is uncertain, as some have argued that inadequate sleep is a cause of obesity (Sekine et al. 2002).

greater time spent in educational activities and higher educational achievement (all else equal). A child's weight may also affect their physical fitness and prevent children from engaging in recreational activities, which again may provide more time for educational activities.

In sum, past study from a variety of disciplines (e.g., psychology and medicine) suggests that overweight and obese children may have lower educational achievement than normal weight children, although the alternative, that obesity is associated with higher achievement, is plausible. One way to incorporate these causal pathways in the conceptual model is to replace the proximate causes of educational achievement (e.g., child health) with determinants of those causes, most notably child weight. Making these substitutions results in the following:

$$(2)\quad E_{it} = \tilde{\alpha}_i + \tilde{\gamma}_t + \sum_{k=0}^{t}(\rho_k WEIGHT_{ik} + Z_{ik}\tilde{\Gamma}_k) + \tilde{u}_{it}$$

Equation (2) is a quasi-reduced form model because we have substituted for the determinants of educational achievement, but weight (*WEIGHT*) remains endogenous. We discuss the source of this endogeneity below. We have used the symbol ~ to indicate a reduced form parameter. The coefficient on weight will measure the effect of weight that operates through changes in the quantity or quality of educational inputs (e.g., child's use of time, child health, and school resources).

The quasi-reduced form production function represented by equation (2) is the basis of our empirical model. The main problem associated with obtaining estimates of an empirical analog to equation (2) is that weight (*WEIGHT*) may be correlated with the error, which includes unmeasured exogenous determinants of the inputs in the production function (equation 1). Further, the data requirements necessary to obtain unbiased estimates of equation (2) are daunting, as the entire history of the exogenous determinants of production function inputs enter the model.

One way to reduce the data necessary to estimate equation (2) is to examine changes in educational achievement between two ages. Such a model is given by:

(3) $GRADE_{it} - GRADE_{i(t-1)} = (\gamma_t - \gamma_{t-1}) + \rho_t WEIGHT_{it} + Z_{it}\Gamma_t + (u_{it} - u_{i(t-1)})$

As is made clear by equation (3), the difference in educational achievement between ages t-1 and t depends on the difference in developmental age (γ_t - γ_{t-1}) and resources used between these ages. Notably, endowed intelligence (α_i) is eliminated from the model.[8] However, one consequence of this approach is that estimates of the effects of educational inputs are specific to age t (Todd and Wolpin 2003, 2007).

Three aspects of equation (3) merit discussion. The first point relates to the fact that the left hand side of equation (3) is the change in educational achievement, but the right hand side variables are the levels of inputs between ages t-1 and t, or the change in stock (i.e., investment) of what may be referred to as educational capital. For example, it is the weight of the child between ages t-1 and t that enters and not the change in weight between ages t-1 and t. This specification results from the assumption of equation (1) that the effects of educational inputs are cumulative. Consider child weight and the hypothesis that there is size (weight) discrimination. The change in grade attainment between ages t-1 and t depends on the child's weight at (during) age t. This is reasonable. It is not the change in weight that matters, but the weight itself that brings forth discrimination that adversely affects achievement. Analogously, it is not the change in family resources that matter, but the actual amount of time and money spent during the period producing child education. This point has not been well understood by previous researchers and as a result, their models have been arguably mis-specified (Todd and Wolpin 2003). For example, Sabia (2007) used fixed effects methods that regress differences in educational

[8] This is not necessarily the case, as the endowment could have different age-specific effects. If so, there would be an age subscript on the endowment in equation (1) and differencing would not eliminate the endowment effect.

achievement (e.g., GPA) on differences in children's weight, which is incorrect given the specification of equation (1).[9]

Second, because most educational inputs are not measured, proxy variables (i.e., reduced form determinants) are often used. For example, mother's educational achievement is used as a measure of the quality of parental time input. This "quality" input enters the production function each period and therefore is included in equation (3) even if it is time-invariant. Similarly, a time-invariant demographic characteristic such as race, which may be a proxy for unmeasured inputs, also enters the model because of the age-specific effects of inputs. The age-specific estimates of equation (3) merit further discussion. The coefficient on weight (e.g., obesity) measures the effect of obesity on the growth in educational attainment between time t-1 and t. Obesity (and other inputs) may have a different effect at each age. For example, discrimination associated with obesity may be more important at older than younger ages.

While equation (3) reduces the data necessary to estimate the model considerably, it remains unlikely that all relevant variables will be measured and estimates of the effect of weight (obesity) may still be biased. Given the common set of underlying factors that affect resource allocation decisions, the quantities of measured inputs (weight) are likely to be correlated with the error, which includes time-varying, unmeasured exogenous (e.g., preferences) determinants of educational inputs. One solution is instrumental variables and the structure of equation (3) suggests many potential instruments. Specifically, inputs in periods prior to t-1 may be used as instruments because only time t inputs are included in equation (3) (Todd and Wolpin 2003). The assumption underlying this approach is that the future does not cause the past and so, for

[9] There may be a measurement error problem given the nature of most available data. In our case, weight is measured at time t-1 and t and may not be constant during the period. However, most interviews in the NLSY97 occurred between October and March and our dependent variable is grade progression. So weight during the academic year is a reasonably good empirical measure. Using the difference in weight between periods, however, is not justified.

example, weight in period t-2 will be uncorrelated with the error $(u_{it} - u_{i(t-1)})$ in equation (3). Therefore, weight (and all other inputs) in period t-2 can be used as an instrument for weight in period t. Past weight is likely to be a particularly good instrument in that it is likely to be strongly correlated with current weight given the documented persistence of weight (Serdula et al. 1993; Lake et al. 1997; McTigue et al. 2002; Whitaker et al. 1998).

The fact that past period inputs, or their determinants, do not enter equation (3) provides a basis for a specification test. If included, past period inputs should have no statistically significant effect on educational attainment. We implemented this test by including lagged values of respondent's weight, drinking and smoking behavior, and health. In all cases, we could not reject the null hypothesis that these lagged variables were jointly insignificant (at the 0.05 level of significance). These results provide some evidence to support the specification of equation (3).

Data

The data for the analysis are drawn from the National Longitudinal Survey of Youth-1997 Cohort (NLSY97). The NLSY97 is a national sample of individuals ages 12 to 16 as of December 31, 1996, who were interviewed in 1997 and each subsequent year. The NLSY97 was designed to be representative of persons born in the U.S. between 1980 and 1984. Black and Hispanic persons are over represented in the data. We focused on children between the ages of 14 and 18 (grades 8th through 12th) drawn from survey years 1997 to 2002.

Educational attainment was measured by grade progression and drop out status. As indicated by equation (3), we examined changes in grade, or grade progression, between two survey dates: when a person is age t-1 and age t.[10] We define grade progression in two ways: as the change in highest grade attended, or the change in highest grade completed, from age t-1 to age t.[11] In most cases, the interval between ages t-1 and t is between 10 and 21 months with a median of 13 months, but the median time between surveys was larger for younger age groups. For example, for those age 14 at time t-1 the median time to the next interview (t) was 18 months. We classified someone as a drop out if they were not enrolled in school and they did not have a high school degree. Someone who was not enrolled and had a GED was classified as a drop out. We grouped respondents by age (rounded to the nearest year) and conducted all analyses separately for persons age 14, 15, 16 and 17 at time t-1.[12]

The weight and height of children was self-reported and we used these self-reported measures to calculate body mass index (BMI).[13] We then categorize children's weight status according to where their BMI falls in the distribution of children's weight in the NLSY97 sample. Separate weight distributions were calculated for males and females and by age. We use the following percentile categories: 0-10, 11-25, 26-75, 76-90, 91-100.[14] As described above, ideally we would be able to measure weight (and all educational inputs) during the interval between time t-1 and t. Here we have opted to use values of weight and other inputs (determinants) at time t-1. This is reasonable given that most interviews occurred during the

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[10] The NLSY97 also collected data from school transcripts from which there is information on the number and types of credits taken in high school and grade point average. However, this information is missing for a large portion of the sample.

[11] If grade progression, grade completion or drop out was negative we dropped the observation. Similarly, if grade progression or grade completion appeared unreasonably large (e.g., >3), we dropped the observation. Observations dropped for these reasons were 1.3 percent of the total.

[12] Some individuals will be the same age at two consecutive interviews and in these cases we used the first interview we observed a person to be of a particular age.

[13] We acknowledge that self-reported weight and height has considerable measurement error. In the best case, this will result in attenuation bias, but if measurement error is systematic, estimates may be upward or downward biased.

[14] The distribution of weight in the NLSY97 is shifted to the right relative to a national sample from the National Health and Nutritional Survey. See Appendix Table 1, which shows the distribution of the NLSY97 sample in terms of the NHANES 2000 sample (CDC 2000). For example, 15% of 16 year old females in the NLSY97 are in the 91-100 percentiles of the NAHNES distribution.

academic year between October and March and it is the performance during the academic year that determines whether a person will progress (drop out) in grade.

To control for other unmeasured determinants of educational attainment we used a variety of proxy variables. As is common in similar analyses, we are missing information on most inputs that are likely to enter the educational production function. Therefore, we use variables that proxy for these inputs such as mother's education and family structure (e.g., two biological parents), which are likely to be correlated with the quantity and quality of the inputs used to produce educational achievement. Specifically, we use the following variables: the number of months between surveys, dummy variables for respondent's age in months at baseline grade, dummy variables for month of interview at baseline grade, dummy variables for year of interview at baseline grade, dummy variables for highest grade attended at baseline, dummy variables for race/ethnicity (white, black, Hispanic, Asian, other), mother's age at birth of respondent (continuous), dummy variables for mother's educational attainment (LTHS, HS, some college, BA plus), dummy variables for family structure (two biological parents, two parents, one biological parent, other, on own), dummy variables for respondent health (excellent, poor, other), number of days respondent smoked in last 30 days at baseline, number of cigarettes respondent smoked per day in last 30 days at baseline, number of days respondent drank in last 30 days at baseline, number of drinks respondent drank per day in last 30 days at baseline, dummy variables for residence in MSA (MSA-central city, MSA-non-central city, non-MSA), continuous unemployment rate in local labor market, and county per-capita income

Results

Descriptive Analysis

Tables 1 and 2 present (unweighted) means for highest grade attended, highest grade completed and drop out status by gender and weight status. Figures are presented separately by age. Figures in Table 1 suggest that there is little difference in grade attainment and drop out status by weight for male adolescents. At younger ages (14 and 15), there is some evidence that underweight (0-10 percentiles) males have made less progress in school than average (26 to 75 percentiles) weight males. At older ages (16 and 17), drop out rates of overweight (91-100 percentiles) males tend to be higher. Overall, however, the figures in Table 1 do not indicate large or systematic differences in grade progression and drop out status by weight among male adolescents. Table 2 provides sample means for females. For this group, we observe slower progress in school among overweight (91-100 percentiles) females ages 16 and 17. Otherwise there are few statistically significant, or large, differences in educational attainment among female adolescents.[15]

Table 3 presents (unweighted) sample means of other characteristics by weight for females.[16] The purpose of this table is to investigate whether there are significant differences in observed characteristics by weight that may confound the relationship between weight and educational attainment observed in Tables 1 and 2. Figures in Table 3 show some systematic differences. Children in the upper tail of the weight distribution are more likely to be Black, be in poorer health, live in single parent families, and live in central cities, and their mothers tend to be less educated and younger at the time of birth of the child. Figures in Table 3 provide some evidence that children in the upper tails of the weight distribution may differ in measured and

[15] In Appendix Table 1, we show sample means for females by weight status when weight status is classified using NHANES distribution. Conclusions are similar as those stated in the text. Among older females, ages 16 and 17, there is some evidence that overweight females have progressed in school more slowly than average weight females.
[16] An analogous table for males provides similar evidence of some selection on observed characteristics.

unmeasured ways and that these differences may confound the relationship between weight and educational attainment.[17]

To further explore the extent of selection on observable variables, we present estimates of the association between weight and the respondent's score on the Peabody Individual Achievement Test (PIAT) in mathematics. The PIAT mathematics test is a widely used, validated assessment of a person's achievement in mathematics as taught in mainstream education. Estimates of the association between weight and PIAT scores are obtained from a simple cross sectional regression model because the PIAT test was administered most widely in 1997 (Round 1), and in a limited way in later interviews. Specifically, all respondents not yet enrolled in 10th grade were administered the test in 1997 and only those who were 12 as of December 1996 were administered the test in later rounds. Therefore, we are unable to exploit the longitudinal nature of the NLSY97 for this measure of achievement. Here we limit the sample to those ages 14 and 15 in 1997 because this is part of the age range used in later analyses.

Table 4 presents the estimates. We obtain estimates for two regression model specifications: a basic specification that includes only a limited number of covariates and a model with additional controls for individual and family characteristics (See notes to Table 4 for details). Estimates in Table 4 suggest small differences in PIAT test scores by weight status, which is consistent with the small differences in educational attainment by weight observed in Tables 1 through 2. Among males, the only statistically significant estimates are for those in the lowest weight category; those in the lowest weight category have test scores that are 3.24 points

[17] In Appendix Table 2, we present means of the ASVAB test percentile score and other characteristics by weight status for children ages 14 to 17. We do not present separate means by age because the ASVAB test was only administered in 1997. In Appendix Table 2, we observe significantly lower test scores for males and females in the upper right tail of the weight distribution. However, we also observe significant differences in other characteristics (females only presented) for those in the overweight (91-100 percentiles) category. These results are consistent with those presented in the text on grade progression.

lower than those of average weight (reference group is 26 to 75 percentile). The magnitude of this estimate represents approximately 0.2 standard deviations or 4 percent of the mean PIAT score. Other estimates for males are smaller. In the case of females, there are no statistically significant estimates once controls for observed characteristics are included. Moreover, among those in the over weight category (91-100 percentiles), controlling for observed characteristics greatly reduces the magnitude of the estimates. Finally, we re-estimated the models in Table 4 including controls for the highest grade attended and estimates from this model were quite similar to those presented in Table 4. This is not surprising given the weak association between weight status and highest grade attended in Tables 1 and 2. In sum, there are small differences in PIAT test scores by weight status that are similar to the small differences in grade attainment and drop out status by weight status. While these descriptive statistics and simple regression estimates are not definitive, they suggest that if there is a causal effect of weight status on educational achievement, it is likely to be quite small. We now turn to analyses of grade progression, grade completion and drop out status that exploit the longitudinal nature of the NLSY97 data.

Analyses of Grade Progression, Grade Completion and Dropping Out

In this section, we present estimates of equation (3). We obtain estimates for two specifications of this model. A basic specification that includes only a limited number of covariates: dummy variables for weight status (see Table 1), dummy variables for number of months between surveys, dummy variables for respondent's age in months at baseline (t-1) grade, dummy variables for month of interview at baseline grade, and dummy variables for year of interview at baseline grade. We also estimated a model with additional controls for individual and family characteristics: dummy variables for race/ethnicity (white, black, Hispanic, Asian, other), mother's age at birth of respondent (continuous), dummy variables for mother's educational attainment (LTHS, HS, some college, BA plus), dummy variables for family structure (two biological parents, two parents, one biological parent, other, on own), dummy variables for respondent health (excellent, poor, other), number of days respondent smoked in last 30 days at baseline, number of cigarettes respondent smoked per day in last 30 days at baseline, number of days respondent drank in last 30 days at baseline, number of drinks respondent drank per day in last 30 days at baseline, dummy variables for residence in MSA (MSA-central city, MSA-non-central city, non-MSA), unemployment rate in local labor market, and county per-capita income.

Table 5 presents estimates of the association between weight status and change in educational attainment between time t-1 and t for children age 14 at time t-1. Estimates for the male sample are presented in the top panel and estimates for the female sample are presented in the bottom panel. For each dependent variable, two specifications of the model are estimated: a basic model (column 1) and an extended model that includes additional controls (column 2). We will focus our discussion on estimates obtained from the extended model. The sample size and mean of the dependent variable are presented in the bottom rows of each panel. Note that the mean change in grade attended and grade completed is significantly greater than one because the interval between surveys, particularly for the younger age groups, is on average over a year and in some cases as much as two years.

The first point to note about Table 5 is that there are few statistically significant estimates. For males, there are no statistically significant estimates. However, there is some consistent evidence that overweight (76-90 and 91-100 percentiles) males are less likely to progress in grade or complete an additional grade, and more likely to drop out. Effect sizes are relatively large. Consider estimates associated with dropping out. Males in the 91-100 percentiles have a probability of dropping out that is 1.6 percentage points higher than average (26-75 percentiles) weight males. Given a mean drop out rate of 4 percent, these are large estimates in relative terms.

These estimates illustrate that the power to detect small effects may be limited. According to the National Center for Education Statistics (2006), between 5 and 7 percent of students in grades 6 through 12 are retained in grade each year and between 5 and 6 percent of students in grade 10 to 12 drop out. Data from the NLSY97 indicate somewhat higher retention rates. Among those interviewed during the school year (November to March) at time t and re-interviewed approximately one year later (10 to 13 months), retention rates, specifically failing to attend a higher grade (which would encompass dropping out), are between 5 and 17 percent; retention rates increase with age and are somewhat larger for males than females.[18] Standard errors of estimates of the association between weight status and change in grade attended (completed) are in the 3 to 4 percentage point range indicating that we are unable to reject effect sizes smaller than 6 to 8 percentage points. These minimum effect sizes necessary to reject the null hypothesis of no effect are relatively large given an expected mean of the dependent variable of between 5 and 15 percent (on an annual basis, larger for longer intervals between interviews). So only if weight status had particularly large effects, for example 33 percent or more of the mean, would we be able to detect reliably such an effect.

Estimates in the bottom panel of Table 5 pertain to adolescent females. Again there are few statistically significant estimates, and standard errors are relatively large. For this group, estimates indicate that those in the lowest (0-10) and highest (91-100) weight categories are more

[18] By age 16, 20 percent of males and 11 percent of females in the NLSY97 reported being held back a grade. However, approximately 20 percent of sample is missing this information.

likely to progress in grade and less likely to drop out than those in the average weight category. Again, effect sizes are relatively large; females in the 91-100 percentiles have a drop out probability that is 4.1 percentage points lower than average weight females. Other than these associations, there do not appear to be any further evidence of a systematic effect of weight status.

Estimates of the associations between weight status and educational attainment of 15 year old persons are presented in Table 6. For the male sample (top panel), there are few statistically significant estimates. Overweight (91-100 percentiles) males are more likely to progress in grade and more likely to drop out. These are inconsistent findings; faster grade progression should be associated with lower rates of dropping out. These results also contrast with the finding that among 14 year olds, overweight males were less likely to progress in grade. For underweight (0-10 percentiles) males, there is consistent evidence of reduced achievement—slower grade progression and higher rate of dropping out—but these estimates are not statistically significant. Among 15 year old females, estimates indicate that those in the lower weight classes (0-25 percentiles) have significantly higher rates of grade progression and grade completion and lower rates of dropping out than average weight females. Estimates indicate that low-weight females have approximately a six percentage point (five percent) higher rate of grade completion than average weight females.

Table 7 present estimates of the association between weight status and educational attainment for 16 year old persons. Again, there are very few statistically significant estimates observed in Table 7. The standard errors are somewhat smaller too for these moderately larger samples; standard errors associated with estimates of the effect of weight status on grade progression and grade completion are in the two to three percentage point range. Nevertheless, standard errors of this magnitude still result in relatively imprecisely estimated parameters.

For males age 16, there is evidence that those in the lowest weight category (0-10 percentiles) have lower rates of grade progression and grade completion than average weight males; estimates suggest that these low-weight males are 5.6 percentage points (4.8 percent) less likely to progress in grade and 4.1 percentage points (3.6 percent) less likely to complete an additional grade. The estimate pertaining to grade progression is significant at the 0.10 level. In contrast, overweight (91-100 percentiles) males have higher rates of grade progression and grade completion and lower rates of dropping out than average weight males. However, none of these estimates are statistically significant even though they are relatively large, for example, the estimate for dropping out is -0.031, which represents a 39 percent increase above the mean drop out rate. Among 16 year old females, there is little evidence that weight is systematically related to educational attainment. There are few statistically significant estimates and there are few consistent indications that weight status positively or negatively affects the three educational outcomes.

The final set of estimates is for persons 17 years of age and these are presented in Table 8. Similar to previous findings, there are few statistically significant estimates in Table 7. Perhaps more importantly, there is little systematic evidence that weight status is associated with educational attainment.

We estimated several alternative specifications, all of which produced similar results to those presented here. We estimated a model using the four traditional relative weight categories (underweight, normal weight, overweight, and obese). Results from this specification were comparable to those from the models using five relative weight categories presented here.

Additionally, we attempted to unpack the reduced form estimates and control for potential offsetting effects that would result in the reduced form estimate being zero. To this end, we estimated a model that included measures of physical health and depression. The results from this specification were similar to those from the models presented here, finding no evidence of a systematic relationship between weight status and educational attainment.

IV Estimates

The final set of estimates we present are the instrumental variables (IV) estimates of equation (3) for both the basic and extended models. Theoretically, IV estimation will control for correlation between weight and the error term. Correlation is possible given that the error may include time-varying, unmeasured exogenous determinants of educational inputs such as preferences that are most likely determinants of weight as well. If we assume a myopic model of weight determination, unmeasured determinants of education and weight in the present do not cause weight in the past. This means that weight in period t-2 will be uncorrelated with the error $(u_{it} - u_{i(t-1)})$ in equation (3) and we can thus use it as an instrument for weight between periods t-1 and t. In order to increase efficiency, we also include two period lags of the other explanatory variables in the extended model as instruments.

Tables 9, 10 and 11 present the IV estimates. In general, IV estimates are imprecisely estimated and the pattern of estimates fails to indicate a consistent relationship between weight status and educational achievement. Because our data set is an unbalanced panel, IV estimates obtained using two period lags reduced the sample size that was used and further exacerbated the limited statistical power of the analysis. While some IV estimates are statistically significant, for example, estimates for 15 year females in Table 9 (e.g., a 37 percent point reduction in the probability of attending a higher grade for those in the lowest weight category), the large standard errors and absence of a consistent pattern to the results makes us cautious about drawing inferences. Overall, IV estimates provide little new information.

If individuals do not behave myopically, then past weight status will be a poor instrument for current weight status. Because of this potential problem, we also estimated an alternative IV specification, using county level weight category prevalence as an instrument for weight status. However, this alternative specification produces similar estimates, finding no evidence of a systematic relationship between weight status and educational attainment.

Conclusion

Obesity is an important health issue and the health consequences of obesity have received much attention because of the rapid growth in obesity over the last thirty years. But obesity may have other important consequences that have received less attention from policy makers and researchers. In this paper we investigated whether obesity, and more generally weight status (over- or underweight), was associated with educational attainment of adolescents. This research was motivated by plausible causal mechanisms that link obesity to (lower) educational attainment and the potential importance of the issue in light of the central role that education plays in determining lifetime well being. Moreover, the question of whether obesity affects educational attainment is interesting from a policy perspective because government intervention in several markets may significantly affect obesity and possibly education as a result. Therefore, policies that reduce obesity may have large long term benefits if reductions in obesity increase educational attainment, as some prior research suggests. Finally, although we do not study the issue here, if obesity is associated with lower educational attainment and one of the causes of this is discrimination in the school context, government action to eliminate such discrimination may be justified.

To investigate the issue of whether weight status is associated with educational attainment, we used data from the NLSY97 cohort, which is a large, national sample of adolescents. We focused on adolescents 14 to 18 years of age. Educational attainment was measured by highest grade attended, highest grade completed and whether a person had dropped out of school. We obtained age- and gender-specific estimates of the effect of weight status on changes in the educational attainment measures.

Our results suggest that the association between weight status and the measures of educational attainment we use are not large, and that there is little systematic evidence that weight status either adversely or positively affects educational attainment. While there was some limited evidence of large associations between weight status and educational attainment for certain weight groups at certain ages for either males and females, overall estimates were sufficiently mixed (sign and magnitude) to conclude that weight status does not seem to have a significant effect on grade progression and dropping out among teens aged 14 to 18. However, a caveat of our analysis is that we lacked statistical power to detect reliably small effects. The explanation for this is that the outcomes we studied are relatively infrequent events with approximately five to ten percent of the population likely to fail to progress in grade or drop out, and relatively small samples of teens that were in the upper or lower tails of the weight distribution.

The findings from our analysis raise questions as to whether obesity is associated with lower educational attainment, as suggested by some previous research and some professional groups such as the National Education Association (1994). In earlier research, we also found that obesity was not associated with young children's cognitive achievement as measured by scores on achievement tests (Kaestner and Grossman 2008). Indeed, simple descriptive statistics presented in this paper, in the earlier paper by Kaestner and Grossman (2008) on younger children, and in Crosnoe and Muller (2004) suggest that the association between obesity and educational attainment is unlikely to be large, as there are relatively small differences in means between obese and average weight children. For example, Tables 1 and 2 reported typical differences in highest grade attended between obese and average weight teens of 0.1, which is approximately 0.2 of a standard deviation. Appendix Table 2 presents differences in the ASVAB percentile score by gender and weight status. Overweight females have an ASVAB score that is 11 percentage points lower than average weight females, but this 11 percentage point difference is 0.4 of a standard deviation. For males, the difference in ASVAB scores between overweight and average weight persons is only 0.17 of a standard deviation. Crosnoe and Muller (2004) reported that the difference in GPA between obese and non-obese teens was approximately 0.2 of a standard deviation. While not trivial, these simple differences in mean educational achievement suggest relatively small effects that are likely to be much smaller once the significant amount of selection on observed characteristics is eliminated.

In sum, we do not find much evidence that obesity, and more generally weight status, is significantly related to educational attainment. The potential importance of this issue and the limited amount of prior study make this a topic for further research. Additional research can also address several of the limitations of our study. Most importantly, we lacked statistical power to detect small effects. Second, we were unable to effectively address the likely endogeneity of weight status. While instrumental variables is a plausible solution in our context (i.e., first difference model), we did not have samples of sufficient size to draw reliable inference from this approach. Third, while our measures of educational attainment were of significant practical importance given the centrality to well being of obtaining a high school degree, they are relatively limited in their ability to reflect differences in achievement by weight status. Finally, our measures of weight and height were self reported and the measurement error associated with these variables may have biased estimates.

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Table 1
Educational Attainment of Male Adolescents by Age and Relative Weight Status

	Relative Weight Status				
	0-10%	11-25%	26-75%	76-90%	91-100%
Age 14					
Highest Grade Attended	7.6*	7.8	7.8	7.9	7.9
Highest Grade Completed	6.8*	7.0	7.0	7.0	7.1
Dropout	0.00	0.02	0.01	0.03	0.04*
Number of Observations	128	192	654	196	128
Age 15					
Highest Grade Attended	8.7*	8.8	8.9	8.9	9.0*
Highest Grade Completed	7.8*	7.9	8.0	8.0	8.1*
Dropout	0.00*	0.02	0.03	0.04	0.04
Number of Observations	203	365	1122	341	223
Age 16					
Highest Grade Attended	9.8	9.8	9.8	9.9*	9.9
Highest Grade Completed	8.9	8.9	8.9	9.0	8.9
Dropout	0.03	0.03	0.05	0.05	0.08*
Number of Observations	313	454	1513	421	288
Age 17					
Highest Grade Attended	10.7	10.7	10.7	10.8*	10.7
Highest Grade Completed	9.8	9.8	9.8	9.9*	9.8
Dropout	0.08	0.09	0.09	0.09	0.11
Number of Observations	359	618	1822	564	332

Notes:
1. Data drawn from survey years 1997 to 2003.
2. * indicates that the estimate is statistically different ($p<0.05$) from the estimate for adolescents in 26-75 percentiles.

Table 2
Educational Attainment of Female Adolescents by Age and Relative Weight Status

	Relative Weight Status 0-10%	11-25%	26-75%	76-90%	91-100%
Age 14					
Highest Grade Attended	7.9	8.0	8.0	7.9	8.0
Highest Grade Completed	7.1	7.2	7.2	7.1	7.1
Dropout	0.01	0.01	0.02	0.03	0.03
Number of Observations	118	182	605	175	120
Age 15					
Highest Grade Attended	8.9	8.9*	9.0	9.0	9.0
Highest Grade Completed	8.0	8.1	8.1	8.1	8.1
Dropout	0.04	0.02	0.03	0.04	0.03
Number of Observations	204	311	1011	296	211
Age 16					
Highest Grade Attended	9.9*	10.0	10.0	9.9	9.8*
Highest Grade Completed	9.0*	9.1	9.1	9.0	9.0*
Dropout	0.04	0.03	0.05	0.04	0.02
Number of Observations	264	451	1391	419	284
Age 17					
Highest Grade Attended	10.9	10.9	10.9	10.8*	10.7*
Highest Grade Completed	10.0	10.1	10.0	9.9*	9.8*
Dropout	0.09	0.06	0.08	0.11*	0.11
Number of Observations	340	488	1780	495	322

Notes:
1. Data drawn from survey years 1997 to 2003.
2. * indicates that the estimate is statistically different (p<0.05) from the estimate for adolescents in 26-75 percentiles.

Table 3
Individual and Family Characteristics of Female Adolescents by Age and Relative Weight Status

	Relative Weight Status				
	0-10%	11-25%	26-75%	76-90%	91-100%
Age 14					
Black	0.14*	0.19	0.25	0.42*	0.48*
Hispanic	0.19	0.19	0.20	0.21	0.22
Excellent Health	0.75	0.77	0.76	0.62*	0.53*
Smoke	0.25	0.29	0.34	0.37	0.27
Age in Months	168.7	169.1	169.1	168.9	169.9*
Mom Age at Birth	26.1	25.7	26.0	24.2*	24.7*
Mom LTHS	0.18	0.19	0.20	0.24	0.23
Mom BA	0.22	0.21	0.19	0.07*	0.09*
Two Biological Parents	0.58*	0.55	0.48	0.44	0.38*
Central City Resident	0.32	0.27	0.28	0.38*	0.47*
Age 16					
Black	0.20*	0.20*	0.24	0.33*	0.46*
Hispanic	0.13*	0.21	0.20	0.25	0.19
Excellent Health	0.69	0.75	0.73	0.62*	0.50*
Smoke	0.47	0.42	0.46	0.42	0.44
Age in Months	191.8*	192.5	192.5	192.8	192.5
Mom Age at Birth	25.5	25.8	25.9	25.0*	24.5*
Mom LTHS	0.19	0.21	0.20	0.25*	0.25*
Mom BA	0.14	0.21	0.17	0.11*	0.10*
Two Biological Parents	0.53	0.53	0.48	0.45	0.35*
Central City Resident	0.26	0.29	0.32	0.34	0.40*

Notes:
1. Data drawn from survey years 1997 to 2003.
2. Sample sizes are same as in Table 1b.
3. * indicates that the estimate is statistically different ($p<0.05$) from the estimate for adolescents in 26-75 percentiles.

Table 4
Estimates of the Effect of Relative Weight Status
on PIAT Math Score: Adolescents Ages 14 and 15 in Round 1 (1997)

	Males PIAT Math Score		Females PIAT Math Score	
	(1)	(2)	(1)	(2)
Weight 0-10%	-2.78*	-3.24**	2.09	0.70
	(1.62)	(1.46)	(1.60)	(1.48)
Weight 11-25%	-0.23	-0.69	0.71	-0.16
	(1.32)	(1.19)	(1.41)	(1.31)
Weight 76-90%	-2.01	-0.87	-2.43	0.48
	(1.37)	(1.23)	(1.36)	(1.29)
Weight 91-100%	-1.97	0.93	-4.68**	-1.46
	(1.63)	(1.49)	(1.67)	(1.58)
Basic Model	Yes		Yes	
Extended Model		Yes		Yes
Mean Dep. Var.	73		73	
Num. Obs.	1404		1264	

Notes:
1. The basic model includes the following: dummy variables for weight status (see table, 26-75 percentiles are reference category), dummy variables for respondent's age in months at time of survey, dummy variables for month of interview, and dummy variables for year of interview.
2. Extended model includes all variables in basic model and the following: dummy variables for race/ethnicity (white, black, Hispanic, Asian, other), mother's age at birth of respondent (continuous), dummy variables for mother's educational attainment (lths, HS, some college, BA plus), dummy variables for family structure (two biological parents, two parents, one biological parent, other, on own), dummy variables for respondent health (excellent, poor, other), number of days respondent smoked in last 30 days at baseline, number of cigarettes respondent smoked per day in last 30 days at baseline, number of days respondent drank in last 30 days at baseline, number of drinks respondent drank per day in last 30 days at baseline, dummy variables for residence in MSA (MSA-central city, MSA-non-central city, non-MSA), continuous unemployment rate in local labor market, and county per-capita income.

   * indicates (0.05 < p-value ≤ 0.10), ** indicates (p-value ≤ 0.05)

Table 5
Estimates of the Effect of Relative Weight Status
on Change in Educational Attainment from Age 14

Males	Higher Grade Attended		Higher Grade Completed		Dropped Out	
	(1)	(2)	(1)	(2)	(1)	(2)
Weight 0-10%	0.031	-0.045	0.041	-0.022	-0.023	-0.015
	(0.037)	(0.037)	(0.035)	(0.037)	(0.020)	(0.022)
Weight 11-25%	-0.011	-0.046	0.007	0.009	-0.014	-0.001
	(0.032)	(0.031)	(0.030)	(0.031)	(0.017)	(0.019)
Weight 76-90%	-0.010	-0.022	0.015	-0.004	0.010	0.015
	(0.031)	(0.031)	(0.029)	(0.030)	(0.017)	(0.018)
Weight 91-100%	-0.049	-0.026	-0.036	-0.038	0.033	0.016
	(0.038)	(0.038)	(0.036)	(0.037)	(0.021)	(0.022)
Basic Model	Yes		Yes		Yes	
Extended Model		Yes		Yes		Yes
Mean Dep. Var.	1.60	1.60	1.47	1.48	0.04	0.04
Num. Obs.	1182	1040	1180	1040	1184	1042
Females	Higher Grade Attended		Higher Grade Completed		Dropped Out	
	(1)	(2)	(1)	(1)	(2)	(1)
Weight 0-10%	0.087**	0.081**	0.040	0.034	-0.014	-0.010
	(0.038)	(0.037)	(0.038)	(0.038)	(0.021)	(0.022)
Weight 11-25%	-0.003	0.015	-0.010	0.003	-0.022	-0.027
	(0.031)	(0.031)	(0.031)	(0.032)	(0.017)	(0.018)
Weight 76-90%	-0.041	-0.025	-0.017	-0.006	-0.025	-0.035*
	(0.033)	(0.033)	(0.033)	(0.034)	(0.018)	(0.019)
Weight 91-100%	-0.001	0.026	-0.005	0.044	-0.039*	-0.041*
	(0.039)	(0.039)	(0.039)	(0.041)	(0.021)	(0.023)
Basic Model	Yes		Yes		Yes	
Extended Model		Yes		Yes		Yes
Mean Dep. Var.	1.54	1.52	1.43	1.42	0.04	0.04
Num. Obs.	1079	968	1080	969	1079	968

Notes:
1. The mean for "Higher Grade Attended (Completed)" is greater than 1 because some respondents may have skipped a grade or the interval between interviews was long enough to include more than one grade.
2. The basic model includes the following: dummy variables for weight status (see table, 26-75 percentiles are reference category), dummy variables for each number of months between surveys, dummy variables for respondent's age in months at baseline grade, dummy variables for month of interview at baseline grade, and dummy variables for year of interview at baseline grade.
3. Extended model includes all variables in basic model and the following: dummy variables for race/ethnicity (white, black, Hispanic, Asian, other), mother's age at birth of respondent (continuous), dummy variables for mother's educational attainment (lths, HS, some college, BA plus), dummy variables for family structure (two biological parents, two parents, one biological parent, other, on own), dummy variables for respondent health (excellent, poor, other), number of days respondent smoked in last 30 days at baseline, number of cigarettes respondent smoked per day in last 30 days at baseline, number of days respondent drank in last 30 days at baseline, number of drinks respondent drank per day in last 30 days at baseline, dummy variables for residence in MSA (MSA-central city, MSA-non-central city, non-MSA), continuous unemployment rate in local labor market, county per-capita income, and dummy variables for highest grade attended at baseline survey.
4. * indicates ($0.05 < \text{p-value} \leq 0.10$), ** indicates ($\text{p-value} \leq 0.05$)

Table 6
Estimates of the Effect of Relative Weight Status
on Change in Educational Attainment from Age 15

Males	Higher Grade Attended (1)	(2)	Higher Grade Completed (1)	(2)	Dropped Out (1)	(2)
Weight 0-10%	-0.011 (0.038)	-0.024 (0.041)	-0.003 (0.030)	-0.015 (0.031)	0.021 (0.018)	0.028 (0.019)
Weight 11-25%	0.022 (0.030)	0.017 (0.032)	-0.020 (0.024)	-0.027 (0.024)	0.018 (0.014)	0.027 (0.015)
Weight 76-90%	-0.028 (0.031)	0.008 (0.033)	-0.007 (0.025)	0.019 (0.025)	0.016 (0.015)	0.008 (0.015)
Weight 91-100%	0.044 (0.037)	0.089** (0.040)	-0.008 (0.030)	0.012 (0.030)	0.033* (0.018)	0.033* (0.018)
Basic Model	Yes		Yes		Yes	
Extended Model		Yes		Yes		Yes
Mean Dep. Var.	1.33	1.32	1.28	1.27	0.05	0.05
Num. Obs.	1999	1720	2001	1720	2003	1723
Females	Higher Grade Attended (1)	(2)	Higher Grade Completed (1)	(1)	Dropped Out (2)	(1)
Weight 0-10%	0.017 (0.034)	0.017 (0.034)	0.062** (0.027)	0.059** (0.028)	-0.037** (0.018)	-0.030 (0.018)
Weight 11-25%	0.067** (0.028)	0.057** (0.029)	0.047** (0.023)	0.064** (0.023)	-0.014 (0.015)	-0.009 (0.015)
Weight 76-90%	0.007 (0.029)	0.028 (0.029)	0.020 (0.024)	0.026 (0.024)	0.013 (0.015)	0.008 (0.016)
Weight 91-100%	-0.089** (0.035)	-0.011 (0.036)	-0.061** (0.028)	-0.007 (0.029)	0.016 (0.018)	0.009 (0.019)
Basic Model	Yes		Yes		Yes	
Extended Model		Yes		Yes		Yes
Mean Dep. Var.	1.33	1.31	1.29	1.28	0.05	0.05
Num. Obs.	1778	1584	1782	1586	1784	1587

Notes: See notes to Table 4.

Table 7
Estimates of the Effect of Relative Weight Status
on Change in Educational Attainment from Age 16

Males	Higher Grade Attended (1)	(2)	Higher Grade Completed (1)	(2)	Dropped Out (1)	(2)
Weight 0-10%	-0.052* (0.029)	-0.056* (0.031)	-0.035 (0.027)	-0.041 (0.028)	0.003 (0.018)	0.007 (0.018)
Weight 11-25%	-0.041 (0.025)	-0.025 (0.026)	-0.029 (0.024)	-0.0001 (0.024)	-0.002 (0.015)	-0.012 (0.016)
Weight 76-90%	0.018 (0.026)	0.002 (0.028)	0.030 (0.025)	0.029 (0.025)	-0.012 (0.016)	-0.013 (0.016)
Weight 91-100%	-0.007 (0.031)	0.035 (0.033)	0.010 (0.029)	0.039 (0.030)	-0.010 (0.019)	-0.031 (0.019)
Basic Model	Yes		Yes		Yes	
Extended Model		Yes		Yes		Yes
Mean Dep. Var.	1.19	1.17	1.16	1.15	0.08	0.08
Num. Obs.	2597	2245	2601	2249	2606	2252
Females	Higher Grade Attended (1)	(2)	Higher Grade Completed (1)	(1)	Dropped Out (2)	(1)
Weight 0-10%	0.025 (0.034)	-0.024 (0.033)	0.007 (0.027)	0.011 (0.028)	0.034* (0.018)	0.029 (0.018)
Weight 11-25%	0.024 (0.028)	0.020 (0.026)	0.028 (0.021)	0.004 (0.022)	-0.008 (0.014)	0.001 (0.015)
Weight 76-90%	-0.010 (0.029)	-0.024 (0.028)	-0.021 (0.022)	-0.031 (0.023)	0.036** (0.015)	0.022 (0.015)
Weight 91-100%	-0.015 (0.035)	0.012 (0.033)	-0.058** (0.027)	-0.060** (0.028)	0.009 (0.018)	-0.0001 (0.018)
Basic Model	Yes		Yes		Yes	
Extended Model		Yes		Yes		Yes
Mean Dep. Var.	1.23	1.21	1.20	1.18	0.07	0.07
Num. Obs.	2450	2166	2455	2169	2450	2165

Notes: See notes to Table 4.

Table 8
Estimates of the Effect of Relative Weight Status
on Change in Educational Attainment from Age 17

Males	Higher Grade Attended (1)	(2)	Higher Grade Completed (1)	(2)	Dropped Out (1)	(2)
Weight 0-10%	0.016 (0.035)	-0.034 (0.033)	0.019 (0.028)	0.023 (0.029)	0.017 (0.019)	0.006 (0.019)
Weight 11-25%	0.006 (0.028)	-0.005 (0.026)	-0.010 (0.022)	-0.010 (0.023)	-0.006 (0.016)	-0.011 (0.015)
Weight 76-90%	-0.027 (0.029)	0.001 (0.027)	-0.008 (0.023)	0.009 (0.024)	0.004 (0.016)	-0.001 (0.015)
Weight 91-100%	-0.018 (0.036)	0.046 (0.034)	-0.025 (0.028)	0.004 (0.030)	0.001 (0.020)	-0.009 (0.019)
Basic Model	Yes		Yes		Yes	
Extended Model		Yes		Yes		Yes
Mean Dep. Var.	0.97	0.95	1.05	1.04	0.10	0.09
Num. Obs.	2937	2577	2939	2580	2931	2570
Females	Higher Grade Attended (1)	(2)	Higher Grade Completed (1)	(1)	Dropped Out (2)	(1)
Weight 0-10%	0.018 (0.035)	0.014 (0.032)	0.018 (0.028)	0.023 (0.029)	0.002 (0.017)	0.006 (0.016)
Weight 11-25%	0.057** (0.029)	0.037 (0.027)	0.008 (0.023)	0.005 (0.025)	-0.001 (0.014)	0.003 (0.013)
Weight 76-90%	-0.064** (0.030)	-0.047* (0.027)	-0.023 (0.024)	-0.002 (0.025)	0.044** (0.014)	0.021 (0.014)
Weight 91-100%	-0.051 (0.036)	-0.019 (0.033)	0.018 (0.029)	0.048 (0.031)	0.027 (0.017)	-0.009 (0.017)
Basic Model	Yes		Yes		Yes	
Extended Model		Yes		Yes		Yes
Mean Dep. Var.	1.00	0.99	1.09	1.08	0.06	0.06
Num. Obs.	2773	2505	2779	2508	2771	2499

Notes: See notes to Table 4.

Table 9
IV Estimates of the Effect of Relative Weight Status
on Change in Educational Attainment from Age 15

Males	Higher Grade Attended		Higher Grade Completed		Dropped Out	
	(1)	(2)	(1)	(2)	(1)	(2)
Weight 0-10%	0.03 (0.09)	0.07 (0.08)	0.03 (0.08)	0.02 (0.07)	-0.00 (0.05)	0.02 (0.05)
Weight 11-25%	0.06 (0.13)	0.10 (0.12)	-0.11 (0.11)	-0.03 (0.09)	0.00 (0.07)	-0.00 (0.07)
Weight 76-90%	0.03 (0.09)	0.10 (0.09)	-0.11 (0.08)	-0.05 (0.07)	0.03 (0.05)	0.02 (0.05)
Weight 91-100%	-0.03 (0.07)	-0.03 (0.07)	-0.00 (0.06)	0.01 (0.05)	-0.01 (0.04)	0.00 (0.04)
Basic Model	Yes		Yes		Yes	
Extended Model		Yes		Yes		Yes
Mean Dep. Var.	1.33	1.32	1.28	1.27	0.05	0.05
Num. Obs.	1027	933	1032	936	1030	935
Females	Higher Grade Attended		Higher Grade Completed		Dropped Out	
	(1)	(2)	(1)	(1)	(2)	(1)
Weight 0-10%	-0.26** (0.11)	-0.37** (0.12)	0.03 (0.08)	-0.01 (0.07)	0.04 (0.05)	0.02 (0.05)
Weight 11-25%	0.36* (0.20)	0.69** (0.24)	-0.05 (0.13)	0.01 (0.14)	-0.12 (0.09)	-0.07 (0.09)
Weight 76-90%	0.04 (0.12)	0.16 (0.14)	-0.03 (0.08)	-0.05 (0.08)	0.01 (0.05)	0.01 (0.05)
Weight 91-100%	-0.04 (0.07)	0.01 (0.08)	-0.03 (0.05)	-0.04 (0.05)	-0.07** (0.03)	-0.05 (0.03)
Basic Model	Yes		Yes		Yes	
Extended Model		Yes		Yes		Yes
Mean Dep. Var.	1.33	1.31	1.29	1.28	0.05	0.05
Num. Obs.	919	861	924	865	924	864

Notes: See notes to Table 4.

Table 10
IV Estimates of the Effect of Relative Weight Status
on Change in Educational Attainment from Age 16

Males	Higher Grade Attended (1)	(2)	Higher Grade Completed (1)	(2)	Dropped Out (1)	(2)
Weight 0-10%	-0.15* (0.08)	-0.07 (0.07)	-0.15** (0.07)	-0.04 (0.06)	0.08 (0.06)	0.03 (0.05)
Weight 11-25%	0.07 (0.13)	0.10 (0.11)	0.09 (0.12)	-0.06 (0.10)	-0.14 (0.09)	-0.02 (0.08)
Weight 76-90%	0.01 (0.08)	-0.04 (0.07)	-0.02 (0.07)	-0.10 (0.06)	-0.02 (0.05)	0.01 (0.05)
Weight 91-100%	-0.04 (0.05)	0.03 (0.05)	0.02 (0.05)	0.05 (0.04)	-0.00 (0.04)	-0.02 (0.03)
Basic Model	Yes		Yes		Yes	
Extended Model		Yes		Yes		Yes
Mean Dep. Var.	1.19	1.17	1.16	1.15	0.08	0.08
Num. Obs.	1589	1442	1593	1447	1597	1449
Females	Higher Grade Attended (1)	(2)	Higher Grade Completed (1)	(1)	Dropped Out (2)	(1)
Weight 0-10%	0.02 (0.08)	-0.21** (0.07)	0.01 (0.07)	-0.11* (0.06)	0.01 (0.05)	0.02 (0.04)
Weight 11-25%	0.10 (0.10)	0.24** (0.09)	0.04 (0.08)	0.05 (0.07)	-0.03 (0.06)	-0.03 (0.05)
Weight 76-90%	-0.02 (0.07)	-0.02 (0.07)	-0.04 (0.06)	-0.04 (0.05)	0.03 (0.04)	0.01 (0.04)
Weight 91-100%	0.05 (0.05)	0.04 (0.05)	-0.09** (0.04)	-0.12** (0.04)	-0.03 (0.03)	-0.03 (0.03)
Basic Model	Yes		Yes		Yes	
Extended Model		Yes		Yes		Yes
Mean Dep. Var.	1.23	1.21	1.20	1.18	0.07	0.07
Num. Obs.	1464	1359	1471	1365	1462	1357

Notes: See notes to Table 4.

Table 11
IV Estimates of the Effect of Relative Weight Status
on Change in Educational Attainment from Age 17

Males	Higher Grade Attended		Higher Grade Completed		Dropped Out	
	(1)	(2)	(1)	(2)	(1)	(2)
Weight 0-10%	-0.26**	-0.27**	-0.42**	-0.35**	0.18**	-0.06
	(0.13)	(0.12)	(0.12)	(0.11)	(0.08)	(0.07)
Weight 11-25%	0.35**	0.37**	0.54**	0.51**	-0.13	0.08
	(0.14)	(0.13)	(0.13)	(0.13)	(0.09)	(0.08)
Weight 76-90%	-0.05	-0.05	-0.01	-0.00	0.05	0.04
	(0.08)	(0.07)	(0.07)	(0.07)	(0.05)	(0.04)
Weight 91-100%	0.06	0.05	0.10*	0.10*	-0.01	0.04
	(0.06)	(0.05)	(0.05)	(0.05)	(0.04)	(0.03)
Basic Model	Yes		Yes		Yes	
Extended Model		Yes		Yes		Yes
Mean Dep. Var.	0.97	0.95	1.05	1.04	0.10	0.09
Num. Obs.	2119	1919	2125	1922	2122	1920
Females	Higher Grade Attended		Higher Grade Completed		Dropped Out	
	(1)	(2)	(1)	(1)	(2)	(1)
Weight 0-10%	0.04	0.08	0.02	0.02	0.02	0.03
	(0.06)	(0.06)	(0.04)	(0.04)	(0.03)	(0.03)
Weight 11-25%	0.07	-0.03	-0.01	-0.08	-0.07	-0.02
	(0.10)	(0.09)	(0.07)	(0.07)	(0.05)	(0.04)
Weight 76-90%	-0.01	0.01	-0.02	-0.04	-0.06	-0.05
	(0.09)	(0.08)	(0.07)	(0.06)	(0.05)	(0.04)
Weight 91-100%	-0.10*	-0.06	-0.03	0.04	0.02	0.01
	(0.06)	(0.06)	(0.05)	(0.05)	(0.03)	(0.03)
Basic Model	Yes		Yes		Yes	
Extended Model		Yes		Yes		Yes
Mean Dep. Var.	1.00	0.99	1.09	1.08	0.06	0.06
Num. Obs.	1979	1842	1983	1844	1975	1836

Notes: See notes to Table 4.

Appendix Table 1
Educational Attainment of Female Adolescents by Age and NHANES 2000 Weight Status

	NHANES 2000 Relative Weight Status				
	0-10%	11-25%	26-75%	76-90%	91-100%
Age 14					
Highest Grade Attended	8.1	7.9	8.0	8.0	8.0
Highest Grade Completed	7.2	7.0	7.2	7.1	7.1
Dropout	0.00	0.01	0.02	0.02	0.03
Number of Observations	35	83	642	231	209
Age 15					
Highest Grade Attended	8.9	9.0	9.0	9.0	9.0
Highest Grade Completed	8.0	8.1	8.1	8.1	8.1
Dropout	0.06*	0.02	0.02	0.03*	0.03
Number of Observations	83	180	1037	414	319
Age 16					
Highest Grade Attended	9.9	9.9*	10.0	9.9*	9.9*
Highest Grade Completed	9.0	9.0	9.1	9.0*	9.0
Dropout	0.04	0.03	0.04	0.05	0.04
Number of Observations	118	238	1487	538	428
Age 17					
Highest Grade Attended	10.9	10.9	10.9	10.8*	10.8*
Highest Grade Completed	10.0	10.0	10.1	9.9*	9.8*
Dropout	0.07	0.08	0.07	0.11*	0.11*
Number of Observations	187	326	1752	639	521

Notes:
1. Data drawn from survey years 1997 to 2003.
2. * indicates that the estimate is statistically different ($p<0.05$) from the estimate for adolescents in 26-75 percentiles.

Appendix Table 2
Educational Achievement (ASVAB) of Adolescents Age 14 to 17 by Gender and Relative Weight Status

	Relative Weight Status				
Males Age 14 to 17	0-10%	11-25%	26-75%	76-90%	91-100%
ASVAB Percentile	42.5	46.1	45.5	44.2	40.3*
Number of Observations	282	432	1441	397	244
Females Age 14 to 17					
ASVAB Percentile	46.9	51.5	49.2	41.9*	36.5*
Black	0.18*	0.20	0.24	0.33*	0.43*
Hispanic	0.17	0.15	0.18	0.22	0.22
Excellent Health	0.72	0.78*	0.73	0.63*	0.55*
Smoke	0.43	0.37*	0.46	0.44	0.43
Age in Months	182.1	183.3	182.8	181.6	181.8
Mom Age at Birth	25.9	25.9	25.6	24.5*	25.1
Mom LTHS	0.18	0.16	0.18	0.25*	0.24*
Mom BA	0.21	0.23	0.18	0.12*	0.07*
Two Biological Parents	0.54	0.51	0.50	0.47	0.34*
Central City Resident	0.30	0.30	0.31	0.36	0.39*
Number of Observations	247	398	1359	399	251

Notes:
1. Data drawn from 1997 survey year, as this is the year that ASVAB test was administered.
2. * indicates that the estimate is statistically different from the estimate for adolescents in 26-75 percentiles.