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Effects of Weight on Adolescent Educational Attainment

Robert Kaestner, Michael Grossman, and Benjamin Yarnoff

10.1 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 (National Heart, Lung and Blood Institute 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 policies 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

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

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.

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 chapter, we investigate the effect of obesity on educational attainment of adolescents. We study a nationally representative sample of children aged fourteen to eighteen, 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 large, systematically positive or negative effects on grade progression and the probability of dropping out.

10.2 Previous Literature

There are relatively few studies of the effects of obesity on educational achievement.[2] Studies of adolescents often find negative associations

2. This section draws heavily on Kaestner and Grossman (2008). 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, Edwards, and Grossman 1981; Blau and Grossberg 1992; and Korenman, Miller, and Sjaastad 1995; Rosenzweig and Wolpin 1994; Kaestner and Corman 1995). However, all but Shakotko, Edwards, and Grossman (1981) and Edwards and Grossman (1979) focused on underweight as a measure of health.

between obesity and educational achievement. Shakotko, Edwards, and Grossman (1981) investigated the effect of being overweight in childhood (aged six to eleven) on scores from the Wechsler Intelligence Scale for Children (WISC) and the Wide Range Achievement Test (WRAT) in adolescence (aged twelve to seventeen) 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 tenth, eleventh, and twelfth 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. (2006) studied the grade point average (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 fourteen to seventeen 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 (2009) use data from the National Longitudinal Survey of Adolescent Health and find no effect of obesity on Peabody Individual Achievement Test (PIAT) scores after controlling for confounding factors with fixed effects and instrumental variables. Finally, Sigfusdotir, Kristjansson, and Allegrante (2006) found that among Icelandic youth aged fourteen to fifteen, a high Body Mass Index (BMI) (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.[3]

3. Canning and Mayer (1967) compared obese and nonobese high school students 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 sixteen and twenty-three who were overweight had 0.3 years less education than normal weight females eight years later.

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 United States (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 fourteen to eighteen 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 chapter, the cumulative nature of educational achievement is a central focus and we provide an arguably more theoretically consistent analysis than prior studies.

10.3 Empirical Framework

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, 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.[4] Here, we incorporate this idea into our analysis using the following model:

$$\begin{aligned} \text{GRADE}_{it} &= \alpha_i + \gamma_t + \sum_{k=0}^{t} (\tau_k\, \text{OWN}_{ik} + \beta_k\, \text{HEALTH}_{ik} + \delta_k\, \text{PAR}_{ik}) \\ &\quad + \sum_{k=0}^{t} (\lambda_k\, \text{TEACH}_{ik} + \pi_k\, \text{PEER}_{ik} + Z_{ik}\Gamma_k) + u_{it} \qquad (1) \\ t &= 14,15,16,17. \end{aligned}$$

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

4. This section draws heavily on Kaestner and Grossman (2008).

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 fourteen than at age seventeen because at age fourteen 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 of education capital. This specification was chosen to facilitate estimation, which we discuss in more detail later, 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, Patterson, and Tubbs 1992; NEA 1994; Neumark-Sztainer, Story, and Faibisch 1998; Jalongo 1999; Solovay 2000; Puhl and Brownell 2003; Schwartz and Puhl 2003; Eisenberg, Neumark-Sztainer, and Story 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).[5] 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; von Mutius et al. 2001; Gilliland et al. 2003; Beuther, Weiss, and Sutherland 2006; Geier et al. 2007).[6]

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 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

5. 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; Bjorntorp and Rosmond 2000; Rosmond 2001).

6. 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).

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:

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

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:

$$(3) \qquad \text{GRADE}_{it} - \text{GRADE}_{i(t-1)} = (\gamma_t - \gamma_{t-1}) + \rho_t \text{WEIGHT}_{it} + Z_{it}\Gamma_t + (u_{it} - u_{i(t-1)}).$$

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 ($\gamma_t - \gamma_{t-1}$) and resources used between these ages. Notably, endowed intelligence (α_i) is eliminated from the model.[7] 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

7. 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.

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 matters, 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 misspecified (Todd and Wolpin 2003). For example, Sabia (2007) used fixed effects methods that regress differences in educational achievement (e.g., GPA) on differences in children's weight, which is incorrect given the specification of equation (1).[8]

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

8. 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.

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 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, Power, and Cole 1997; McTigue, Garrett, and Popkin 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).

10.4 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 aged twelve to sixteen 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 United States between 1980 and 1984. Black and Hispanic persons are overrepresented in the data. We focused on children between the ages of fourteen and eighteen (grades eight through twelve) 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.[9] 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.[10] In most cases, the interval between ages $t - 1$ and t is between ten and twenty-one months with a median of thirteen months, but the median time

9. 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.

10. 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.

between surveys was larger for younger age groups. For example, for those aged fourteen at time $t - 1$, the median time to the next interview (t) was eighteen 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 General Equivalency Diploma (GED) was classified as a drop out. We grouped respondents by age (rounded to the nearest year) and conducted all analyses separately for persons aged fourteen, fifteen, sixteen, and seventeen at time $t - 1$.[11]

The weight and height of children was self-reported, and we used these self-reported measures to calculate body mass index (BMI).[12] We then categorize children's weight status according to where their BMI falls in the distribution of children's weight in the NLSY97 sample.[13] Separate weight distributions were calculated for males and females and by age. We use the following percentile categories: 0 to 10, 11 to 25, 26 to 75, 76 to 90, 91 to 100.[14] As described earlier, 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 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

11. 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.

12. 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.

13. 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 10A.1, which shows the distribution of the NLSY97 sample in terms of the National Health and Nutrition Examination Survey (NHANES) 2000 sample. For example, 15 percent of sixteen-year-old females in the NLSY97 are in the 91 to 100 percentiles of the NHANES distribution.

14. We performed the same analysis with the more traditional categories: 0 to 5, 6 to 15, 16 to 84, 85 to 94, 95 to 100. Results from this analysis was similar to those presented here.

for mother's educational attainment (less than high school [LTHS], high school [HS], some college, bachelor of arts [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 thirty days at baseline, number of cigarettes respondent smoked per day in last thirty days at baseline, number of days respondent drank in last thirty days at baseline, number of drinks respondent drank per day in last thirty days at baseline, dummy variables for residence in metropolitan statistical area (MSA) (MSA-central city, MSA-non-central city, non-MSA), continuous unemployment rate in local labor market, and county per capita income.

10.5 Results

10.5.1 Descriptive Analysis

Tables 10.1 and 10.2 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 10.1 suggest that there is little difference in grade attainment and drop out status by weight for male adolescents. At younger ages (fourteen and fifteen), there is some evidence that underweight (0 to 10 percentiles) males have made less progress in school than average (26 to 75 percentiles) weight males. At older ages (sixteen and seventeen), drop out rates of overweight (91 to 100 percentiles) males tend to be higher. Overall, however, the figures in table 10.1 do not indicate large or systematic differences in grade progression and drop out status by weight among male adolescents. Table 10.2 provides sample means for females. For this group, we observe slower progress in school among overweight (91 to 100 percentiles) females ages sixteen and seventeen. Otherwise, there are few statistically significant, or large, differences in educational attainment among female adolescents.[15]

Table 10.3 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 10.1 and 10.2. Figures in table 10.3 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

15. In appendix table 10A.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, aged sixteen and seventeen, 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.

Table 10.1 **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	1,822	564	332

Notes: Data drawn from survey years 1997 to 2003.

*Indicates that the estimate is statistically different ($p < 0.05$) from the estimate for adolescents in 26 to 75 percentiles.

in central cities, and their mothers tend to be less educated and younger at the time of birth of the child. Figures in table 10.3 provide some evidence that children in the upper tails of the weight distribution may differ in measured and 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

17. In appendix table 10A.2, we present means of the Armed Services Vocational Aptitude Battery (ASVAB) test percentile score and other characteristics by weight status for children aged fourteen to seventeen. We do not present separate means by age because the ASVAB test was only administered in 1997. In appendix table 10A.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 to 100 percentiles) category. These results are consistent with those presented in the text on grade progression.

Table 10.2 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	1,780	495	322

Notes: Data drawn from survey years 1997 to 2003.

*Indicates that the estimate is statistically different ($p < 0.05$) from the estimate for adolescents in 26 to 27 percentiles.

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 tenth grade were administered the test in 1997, and only those who were twelve 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 aged fourteen and fifteen in 1997 because this is part of the age range used in later analyses.

Table 10.4 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 10.4 for details). Estimates in table 10.4 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 10.1 through 10.2. Among males, the only statistically significant estimates are for those in the lowest weight category; those in the

Table 10.3 **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: Data drawn from survey years 1997 to 2003. Sample sizes are same as in table 10.1.
*Indicates that the estimate is statistically different ($p < 0.05$) from the estimate for adolescents in 26 to 75 percentiles.

lowest weight category have test scores that are 3.24 points 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 overweight category (91 to 100 percentiles), controlling for observed characteristics greatly reduces the magnitude of the estimates. Finally, we reestimated the models in table 10.4 including controls for the highest grade attended and estimates from this model were quite similar to those presented in table 10.4. This is not surprising given the weak association between weight status and highest grade attended in tables 10.1 and 10.2. 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

Table 10.4 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.	1,404		1,264	

Notes: The basic model includes the following: dummy variables for weight status (26 to 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. 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.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

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.

10.5.2 Analyses of Grade Progression, Grade Completion, and Dropping Out

We begin the discussion with an analysis of the effect of weight status on the level of educational achievement. As we described previously, this model is inconsistent with a human capital production function in which current level of educational achievement is a function of all past inputs. Nevertheless, we present results of this specification in table 10.5, which is limited to those aged sixteen (other results are available from the authors). 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

Table 10.5 **Estimates of the effect of relative weight status on the level of educational attainment at age 16**

	Highest grade attended		Highest grade completed		Dropped out	
Males	(1)	(2)	(1)	(2)	(1)	(2)
Weight 0–10%	–0.07	–0.04	–0.07	–0.08*	0.01	0.01
	(0.05)	(0.05)	(0.05)	(0.05)	(0.02)	(0.02)
Weight 11–25%	–0.06	0.07*	–0.04	–0.02	0.00	–0.01
	(0.05)	(0.04)	(0.04)	(0.04)	(0.02)	(0.02)
Weight 76–90%	0.09*	–0.03	0.09**	0.06	–0.02	–0.02
	(0.05)	(0.04)	(0.05)	(0.04)	(0.02)	(0.02)
Weight 91–100%	0.07	0.03	0.09*	0.10*	–0.03	–0.04*
	(0.06)	(0.05)	(0.05)	(0.05)	(0.02)	(0.02)
Basic model	Yes		Yes		Yes	
Extended model		Yes		Yes		Yes
Mean dep. var.	11.00	11.00	10.07	10.07	0.08	0.08
Num. obs.	2,612	2,176	2,612	2,258	2,608	2,254
Females	(1)	(2)	(1)	(2)	(1)	(2)
Weight 0–10%	–0.04	–0.04	–0.05	–0.04	0.03*	0.03*
	(0.05)	(0.05)	(0.05)	(0.05)	(0.02)	(0.02)
Weight 11–25%	0.07*	0.07*	0.05	0.06	–0.01	–0.00
	(0.04)	(0.04)	(0.04)	(0.04)	(0.01)	(0.01)
Weight 76–90%	–0.07	–0.03	–0.08**	–0.04	0.03**	0.02
	(0.04)	(0.04)	(0.04)	(0.04)	(0.02)	(0.02)
Weight 91–100%	–0.10*	0.03	–0.10**	–0.00	0.00	0.00
	(0.05)	(0.05)	(0.05)	(0.05)	(0.02)	(0.02)
Basic model	Yes		Yes		Yes	
Extended model		Yes		Yes		Yes
Mean dep. var.	11.20	11.20	10.27	10.27	0.07	0.07
Num. obs.	2,461	2,176	2,461	2,176	2,452	2,168

Notes: See notes to table 10.4.

extended model that includes additional controls (column [2]). We will focus our discussion on estimates obtained from the extended model.

For males there are few statistically significant estimates. The exceptions are for those in the highest weight category; being in this category is associated with approximately a 10 percentage point increase in being in a higher grade, and 4 percentage point lower probability of being a drop out. For females, there are no statistically significant estimates. More importantly, the inclusion of an extended set of controls greatly reduces the magnitudes and significance of almost all estimates. The sensitivity of estimates to the addition of more control variables demonstrates that weight is correlated with observable characteristics. Much of this problem is addressed in the first-difference specification. We now turn to the presentation of these results.

Equation (3) is the basis of the estimates we now discuss. 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 10.1), 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 thirty days at baseline, number of cigarettes respondent smoked per day in last thirty days at baseline, number of days respondent drank in last thirty days at baseline, number of drinks respondent drank per day in last thirty 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 10.6 presents estimates of the association between weight status and change in educational attainment between time $t - 1$ and t for children aged fourteen 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 10.6 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 to 90 and 91 to 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 to 100 percentiles have a probability of dropping out that is 1.6 percentage points higher than average (26 to 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 six through twelve are retained

Table 10.6 **Estimates of the effect of relative weight status on change in educational attainment from age 14**

	Higher grade attended		Higher grade completed		Dropped out	
Males	(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.	1,182	1,040	1,180	1,040	1,184	1,042
Females	(1)	(2)	(1)	(2)	(1)	(2)
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.	1,079	968	1,080	969	1,079	968

Notes: 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. The basic model includes the following: dummy variables for weight status (26 to 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. 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.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

in grade each year and between 5 and 6 percent of students in grade ten to twelve 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 reinterviewed approximately one year later (ten to thirteen 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 10.6 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 to 10) and highest (91 to 100) weight categories are more 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 to 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 fifteen-year-old persons are presented in table 10.7. For the male sample (top panel), there are few statistically significant estimates. Overweight (91 to 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 fourteen-year-olds, overweight males were less likely to progress in grade. For underweight (0 to 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 fifteen-year-old females, estimates indicate that those in the lower weight classes (0 to 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 6 percent-

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

Table 10.7 **Estimates of the effect of relative weight status on change in educational attainment from age 15**

	Higher grade attended		Higher grade completed		Dropped out	
Males	(1)	(2)	(1)	(2)	(1)	(2)
Weight 0–10%	–0.011	–0.024	–0.003	–0.015	0.021	0.028
	(0.038)	(0.041)	(0.030)	(0.031)	(0.018)	(0.019)
Weight 11–25%	0.022	0.017	–0.020	–0.027	0.018	0.027
	(0.030)	(0.032)	(0.024)	(0.024)	(0.014)	(0.015)
Weight 76–90%	–0.028	0.008	–0.007	0.019	0.016	0.008
	(0.031)	(0.033)	(0.025)	(0.025)	(0.015)	(0.015)
Weight 91–100%	0.044	0.089**	–0.008	0.012	0.033*	0.033*
	(0.037)	(0.040)	(0.030)	(0.030)	(0.018)	(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.	1,999	1,720	2,001	1,720	2,003	1,723
Females	(1)	(2)	(1)	(2)	(1)	(2)
Weight 0–10%	0.017	0.017	0.062**	0.059**	–0.037**	–0.030
	(0.034)	(0.034)	(0.027)	(0.028)	(0.018)	(0.018)
Weight 11–25%	0.067**	0.057**	0.047**	0.064**	–0.014	–0.009
	(0.028)	(0.029)	(0.023)	(0.023)	(0.015)	(0.015)
Weight 76–90%	0.007	0.028	0.020	0.026	0.013	0.008
	(0.029)	(0.029)	(0.024)	(0.024)	(0.015)	(0.016)
Weight 91–100%	–0.089**	–0.011	–0.061**	–0.007	0.016	0.009
	(0.035)	(0.036)	(0.028)	(0.029)	(0.018)	(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.	1,778	1,584	1,782	1,586	1,784	1,587

Notes: See notes to table 10.6.

age point (5 percent) higher rate of grade completion than average weight females.

Table 10.8 presents estimates of the association between weight status and educational attainment for sixteen-year-old persons. Again, there are very few statistically significant estimates observed in table 10.8. 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 2 to 3 percentage point range. Nevertheless, standard errors of this magnitude still result in relatively imprecisely estimated parameters.

For males aged sixteen, there is evidence that those in the lowest weight category (0 to 10 percentiles) have lower rates of grade progression and

Table 10.8 **Estimates of the effect of relative weight status on change in educational attainment from age 16**

	Higher grade attended		Higher grade completed		Dropped out	
Males	(1)	(2)	(1)	(2)	(1)	(2)
Weight 0–10%	–0.052*	–0.056*	–0.035	–0.041	0.003	0.007
	(0.029)	(0.031)	(0.027)	(0.028)	(0.018)	(0.018)
Weight 11–25%	–0.041	–0.025	–0.029	–0.0001	–0.002	–0.012
	(0.025)	(0.026)	(0.024)	(0.024)	(0.015)	(0.016)
Weight 76–90%	0.018	0.002	0.030	0.029	–0.012	–0.013
	(0.026)	(0.028)	(0.025)	(0.025)	(0.016)	(0.016)
Weight 91–100%	–0.007	0.035	0.010	0.039	–0.010	–0.031
	(0.031)	(0.033)	(0.029)	(0.030)	(0.019)	(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.	2,597	2,245	2,601	2,249	2,606	2,252
Females	(1)	(2)	(1)	(2)	(1)	(2)
Weight 0–10%	0.025	–0.024	0.007	0.011	0.034*	0.029
	(0.034)	(0.033)	(0.027)	(0.028)	(0.018)	(0.018)
Weight 11–25%	0.024	0.020	0.028	0.004	–0.008	0.001
	(0.028)	(0.026)	(0.021)	(0.022)	(0.014)	(0.015)
Weight 76–90%	–0.010	–0.024	–0.021	–0.031	0.036**	0.022
	(0.029)	(0.028)	(0.022)	(0.023)	(0.015)	(0.015)
Weight 91–100%	–0.015	0.012	–0.058**	–0.060**	0.009	–0.0001
	(0.035)	(0.033)	(0.027)	(0.028)	(0.018)	(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.	2,450	2,166	2,455	2,169	2,450	2,165

Notes: See notes to table 10.6.

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 to 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 decrease from the mean drop out rate. Among sixteen-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 seventeen years of age and these are presented in table 10.9. Similar to previous findings, there are few statistically significant estimates in table 10.8. 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.

10.5.3 IV Estimates

The final set of estimates we present are 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 10.10, 10.11, and 10.12 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 fifteen-year-old females in table 10.10 (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.

Table 10.9 Estimates of the effect of relative weight status on change in educational attainment from age 17

	Higher grade attended		Higher grade completed		Dropped out	
Males	(1)	(2)	(1)	(2)	(1)	(2)
Weight 0–10%	0.016	–0.034	0.019	0.023	0.017	0.006
	(0.035)	(0.033)	(0.028)	(0.029)	(0.019)	(0.019)
Weight 11–25%	0.006	–0.005	–0.010	–0.010	–0.006	–0.011
	(0.028)	(0.026)	(0.022)	(0.023)	(0.016)	(0.015)
Weight 76–90%	–0.027	0.001	–0.008	0.009	0.004	–0.001
	(0.029)	(0.027)	(0.023)	(0.024)	(0.016)	(0.015)
Weight 91–100%	–0.018	0.046	–0.025	0.004	0.001	–0.009
	(0.036)	(0.034)	(0.028)	(0.030)	(0.020)	(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.	2,937	2,577	2,939	2,580	2,931	2,570
Females	(1)	(2)	(1)	(2)	(1)	(2)
Weight 0–10%	0.018	0.014	0.018	0.023	0.002	0.006
	(0.035)	(0.032)	(0.028)	(0.029)	(0.017)	(0.016)
Weight 11–25%	0.057**	0.037	0.008	0.005	–0.001	0.003
	(0.029)	(0.027)	(0.023)	(0.025)	(0.014)	(0.013)
Weight 76–90%	–0.064**	–0.047*	–0.023	–0.002	0.044**	0.021
	(0.030)	(0.027)	(0.024)	(0.025)	(0.014)	(0.014)
Weight 91–100%	–0.051	–0.019	0.018	0.048	0.027	–0.009
	(0.036)	(0.033)	(0.029)	(0.031)	(0.017)	(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.	2,773	2,505	2,779	2,508	2,771	2,499

Notes: See notes to table 10.6.

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.

10.6 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 policymakers and researchers. In

Table 10.10 **IV estimates of the effect of relative weight status on change in educational attainment from age 15**

	Higher grade attended		Higher grade completed		Dropped out	
Males	(1)	(2)	(1)	(2)	(1)	(2)
Weight 0–10%	0.03	0.07	0.03	0.02	–0.00	0.02
	(0.09)	(0.08)	(0.08)	(0.07)	(0.05)	(0.05)
Weight 11–25%	0.06	0.10	–0.11	–0.03	0.00	–0.00
	(0.13)	(0.12)	(0.11)	(0.09)	(0.07)	(0.07)
Weight 76–90%	0.03	0.10	–0.11	–0.05	0.03	0.02
	(0.09)	(0.09)	(0.08)	(0.07)	(0.05)	(0.05)
Weight 91–100%	–0.03	–0.03	–0.00	0.01	–0.01	0.00
	(0.07)	(0.07)	(0.06)	(0.05)	(0.04)	(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.	1,027	933	1,032	936	1,030	935
Females	(1)	(2)	(1)	(2)	(1)	(2)
Weight 0–10%	–0.26**	–0.37**	0.03	–0.01	0.04	0.02
	(0.11)	(0.12)	(0.08)	(0.07)	(0.05)	(0.05)
Weight 11–25%	0.36*	0.69**	–0.05	0.01	–0.12	–0.07
	(0.20)	(0.24)	(0.13)	(0.14)	(0.09)	(0.09)
Weight 76–90%	0.04	0.16	–0.03	–0.05	0.01	0.01
	(0.12)	(0.14)	(0.08)	(0.08)	(0.05)	(0.05)
Weight 91–100%	–0.04	0.01	–0.03	–0.04	–0.07**	–0.05
	(0.07)	(0.08)	(0.05)	(0.05)	(0.03)	(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 10.6.

this chapter 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

Table 10.11 IV estimates of the effect of relative weight status on change in educational attainment from age 16

	Higher grade attended		Higher grade completed		Dropped out	
Males	(1)	(2)	(1)	(2)	(1)	(2)
Weight 0–10%	–0.15*	–0.07	–0.15**	–0.04	0.08	0.03
	(0.08)	(0.07)	(0.07)	(0.06)	(0.06)	(0.05)
Weight 11–25%	0.07	0.10	0.09	–0.06	–0.14	–0.02
	(0.13)	(0.11)	(0.12)	(0.10)	(0.09)	(0.08)
Weight 76–90%	0.01	–0.04	–0.02	–0.10	–0.02	0.01
	(0.08)	(0.07)	(0.07)	(0.06)	(0.05)	(0.05)
Weight 91–100%	–0.04	0.03	0.02	0.05	–0.00	–0.02
	(0.05)	(0.05)	(0.05)	(0.04)	(0.04)	(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.	1,589	1,442	1,593	1,447	1,597	1,449
Females	(1)	(2)	(1)	(2)	(1)	(2)
Weight 0–10%	0.02	–0.21**	0.01	–0.11*	0.01	0.02
	(0.08)	(0.07)	(0.07)	(0.06)	(0.05)	(0.04)
Weight 11–25%	0.10	0.24**	0.04	0.05	–0.03	–0.03
	(0.10)	(0.09)	(0.08)	(0.07)	(0.06)	(0.05)
Weight 76–90%	–0.02	–0.02	–0.04	–0.04	0.03	0.01
	(0.07)	(0.07)	(0.06)	(0.05)	(0.04)	(0.04)
Weight 91–100%	0.05	0.04	–0.09**	–0.12**	–0.03	–0.03
	(0.05)	(0.05)	(0.04)	(0.04)	(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.	1,464	1,359	1,471	1,365	1,462	1,357

Notes: See notes to table 10.6.

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 fourteen to eighteen 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

Table 10.12 IV estimates of the effect of relative weight status on change in educational attainment from age 17

	Higher grade attended		Higher grade completed		Dropped out	
Males	(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.	2,119	1,919	2,125	1,922	2,122	1,920
Females	(1)	(2)	(1)	(2)	(1)	(2)
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.	1,979	1,842	1,983	1,844	1,975	1,836

Notes: See notes to table 10.6.

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 fourteen to seventeen. 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 5 to 10 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 chapter, 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 10.1 and 10.2 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 10A.2 presents differences in the Armed Services Vocational Aptitude Battery (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 nonobese 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.

Appendix

Table 10A.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	1,752	639	521

Notes: Data drawn from survey years 1997 to 2003.

*Indicates that the estimate is statistically different ($p < 0.05$) from the estimate for adolescents in 26 to 75 percentiles.

Table 10A.2 **Educational achievement (ASVAB) of adolescents age 14 to 17 by gender and relative weight status**

	Relative weight status				
	0–10%	11–25%	26–75%	76–90%	91–100%
Males age 14 to 17					
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	1,359	399	251

Notes: Data drawn from 1997 survey year, as this is the year that ASVAB test was administered.

*Indicates that the estimate is statistically different from the estimate for adolescents in 26 to 75 percentiles.

References

Averett, S., and S. Korenman. 1996. The economic reality of the beauty myth. *The Journal of Human Resources* 31 (2): 304–30.

Beuther, D. A., S. T. Weiss, and E. R. Sutherland. 2006. Obesity and asthma. *American Journal of Respiratory and Critical Care Medicine* 174 (2): 112–9.

Bjorntorp, P., and R. Rosmond. 2000. Neuroendocrine abnormalities in visceral obesity. *International Journal of Obesity and Related Metabolic Disorders* 24: S80–5.

Blau, F., and A. J. Grossberg. 1992. Maternal labor supply and children's cognitive development. *Review of Economics and Statistics* 74 (3): 474–81.

Canning, H., and J. Mayer. 1967. Obesity: An influence on high school performance. *The American Journal of Clinical Nutrition* 20 (4): 352–54.

Cawley, J. 2004. The impact of obesity on wages. *Journal of Human Resources* 39 (2): 451–74.

Cawley, J., J. Heckman, L. Lochner, and E. Vytlacil. 1996. Ability, education and job training and earnings. University of Chicago. Working Paper.

Crandall, C. S. 1995. Do parents discriminate against their heavyweight daughters? *Personality and Social Psychology Bulletin* 21 (7): 724–35.

Crosnoe, R., and C. Muller. 2004. Body mass index, academic achievement, and school context: Examining the educational experiences of adolescents at risk of obesity. *Journal of Health and Social Behavior* 45 (4): 393–407.

Dietz, W. H. 1998. Health consequences of obesity in youth: Childhood predictors of adult disease. *Pediatrics* 101 (3): 518–25.
Ding, W., S. Lehrer, N. Rosenquist, and J. Audrain-McGovern. 2006. The impact of poor health on education: New evidence using genetic markers. NBER Working Paper no. 12304. Cambridge, MA: National Bureau of Economic Research, June.
Edwards, L. N., and M. Grossman. 1979. Adolescent health, family background, and preventive medical care. In *Health: What is it worth?* ed. S. J. Mushkin, and D. W. Dunlop, 273–314. Elmsford, New York: Pergamon Press.
Eisenberg, M. E., D. Neumark-Sztainer, and M. Story. 2003. Associations of weight-based teasing and emotional well-being among adolescents. *Archives of Pediatrics and Adolescent Medicine* 157:733–8.
Falkner, N. F., D. Neumark-Sztainer, M. Story, R. W. Jeffery, T. Beuhring, and M. D. Resnick. 2001. Social, educational, and psychological correlates of weight status in adolescents. *Obesity Research* 9 (1): 33–42.
Fletcher, J., and S. Lehrer. 2009. Using genetic lotteries within families to examine the causal impact of poor health on academic achievement. NBER Working Paper no. 15148. Cambridge, MA: National Bureau of Economic Research, July.
Fu, H., and N. Goldman. 1996. Incorporating health into models of marriage choice: Demographic and sociological perspectives. *Journal of Marriage and the Family* 58 (3): 740–58.
Geier, A., G. Foster, L. Womble, J. McLaughlin, K. Borradaile, J. Nachman, S. Sherman, S. Kumanyika, and J. Shults. 2007. The relationship between relative weight and school attendance among elementary schoolchildren. *Obesity* 15:2157–61.
Gilliland, F. D., K. Berhane, T. Islam, R. McConnell, W. J. Gauderman, S. S. Gilliland, E. Avol, and J. M. Peters. 2003. Obesity and the risk of newly diagnosed asthma in school-age children. *American Journal of Epidemiology* 158:406–15.
Goodman, E., and R. C. Whitaker. 2002. A prospective study of role of depression in the development and persistence of adolescent obesity. *Pediatrics* 109 (3): 497–504.
Gortmaker, S. L., A. Must, J. M. Perrin, A. M. Sobol, and W. H. Dietz. 1993. Social and economic consequences of overweight in adolescence and young adulthood. *The New England Journal of Medicine* 329:1008–12.
Gozal, D. 1998. Sleep-disordered breathing and school performance in children. *Pediatrics* 102 (3): 616–20.
Grossman, M. 2006. Education and nonmarket outcomes. In *Handbook of the economics of education* vol. 1, ed. E. Hanushek and F. Welch, 577–633. Amsterdam: North-Holland, Elsevier Science.
Hanushek, E. 1986. The economics of schooling: Production and efficiency in public schools. *Journal of Economic Literature* 24 (3): 1141–77.
Hoebel, B. G., P. V. Rada, G. P. Mark, and E. N. Pothos. 1999. Neural systems for reinforcement and inhibition of behavior: Relevance to eating, addiction, and depression. In *Well-being: The foundations of hedonic psychology,* ed. D. Kahneman, E. Diener, and N. Schwarz, 558–72. New York: Russell Sage Foundation.
Jalongo, M. R. 1999. Matters of size: Obesity as a diversity issue in the field of early childhood. *Early Childhood Education Journal* 27 (2): 95–103.
Janssen, I., W. Craig, W. Boyce, and W. Pickett. 2004. Association between overweight and obesity with bully behaviors in school-aged children. *Pediatrics* 113 (5): 1187–94.
Kaestner, R. and H. Corman. 1995. The impact of child health and family inputs on child cognitive development. NBER Working Paper no. 5257. Cambridge, MA: National Bureau of Economic Research, September.

Kaestner, R. and M. Grossman. 2008. Effects of weight on children's educational achievement. NBER Working Paper no. 13764. Cambridge, MA: National Bureau of Economic Research, January.

Korenman, S., J. Miller, and J. Sjaastad. 1995. Long-term poverty and child development in the United States: Results from the NLSY. *Children and Youth Services Review* 17:127–55.

Lake, J. K., C. Power, and T. J. Cole. 1997. Body mass index and height from childhood to adulthood in the 1958 British born cohort. *American Journal of Clinical Nutrition* 66 (5): 1094–101.

McTigue, K., J. Garrett, and B. Popkin. 2002. The natural history of the development of obesity in a cohort of young U.S. adults between 1981 and 1998. *Annals of Internal Medicine* 136 (12): 857–64.

Must, A., and R. S. Strauss. 1999. Risks and consequences of childhood and adolescent obesity. *International Journal of Obesity* 23 (s2): s2–s11.

Mustillo, S., C. Worthman, A. Erkanli, G. Keeler, A. Angold, and E. J. Costello. 2003. Obesity and psychiatric disorder: Developmental trajectories. *Pediatrics* 111 (4): 851–9.

National Center for Education Statistics. 2006. *The condition of education: Grade Retention.* Washington, DC: U.S. Department of Education.

National Education Association, 1994. *Report on size discrimination.* Washington, DC: National Education Association.

National Heart, Lung and Blood Institute (NHLBI). 1998. Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults. Available at: http://www.nhlbi.nih.gov/guidelines/obesity/ob_home.htm.

Neumark-Sztainer, D., M. Story, and L. Faibisch. 1998. Perceived stigmatization among overweight African American and Caucasian adolescent girls. *Journal of Adolescent Health* 23 (5): 264–70.

Puhl, R. M., and K. D. Brownell. 2003. Psychosocial origins of obesity stigma: Toward changing a powerful and pervasive bias. *Obesity Reviews* 4 (4): 213–27.

Puhl, R. M., and J. D. Latner. 2007. Stigma, obesity and the health of the nation's children. *Psychological Bulletin* 133 (4): 557–80.

Redline, S., P. V. Tishler, M. Schluchter, J. Aylor, K. Clark, and G. Graham. 1999. Risk factors for sleep-disordered breathing in children: Association with obesity, race and respiratory problems. *American Journal of Respiratory and Critical Care Medicine* 159 (5): 1527–32.

Ritts, V., M. L. Patterson, and M. Tubbs. 1992. Expectations, impressions and judgments of physically attractive students: A review. *Review of Educational Research* 62 (4): 413–26.

Rosenzweig, M. R., and K. I. Wolpin. 1994. Are there increasing returns to the intergenerational production of human capital? Maternal schooling and child intellectual achievement. *Journal of Human Resources* 29 (2): 670–93.

Rosmond, R. 2001. Visceral obesity and the metabolic syndrome. In *International textbook of obesity,* ed. P. Björntorp, 337–50. West Sussex, UK: John Wiley and Sons.

Sabia, J. 2007. The effect of body weight on adolescent academic performance. *Southern Economic Journal* 73 (4): 871–900.

Schwartz, M. B., and R. Puhl. 2003. Childhood obesity: A social problem to solve. *Obesity Reviews* 4:57–70.

Sekine, M., T. Yamagami, K. Handa, T. Saito, S. Nanri, K. Kawaminami, N. Tokui, K. Toshida, and S. Kagamimori. 2002. A dose-response relationship between short sleeping hours and childhood obesity: Results of Toyama birth cohort study. *Child: Care, Health and Development* 28 (2): 163–70.

Serdula, M. K., D. Ivery, R. J. Coates, D. S. Freedman, D. F. Williamson, and T. Byers. 1993. Do obese children become obese adults? A review of the literature. *Preventative Medicine* 22 (2): 167–77.

Shakotko, R. A., L. N. Edwards, and M. Grossman. 1981. An exploration of the dynamic relationship between health and cognitive development in adolescent. In *Contributions to economic analysis: Health, economics, and health economics,* ed. J. van der Gaag and M. Perlman, 305–25. Amsterdam: North Holland Publishing Company.

Sigfusdotir, I. D., A. L. Kristjansson, and J. P. Allegrante. 2006. Health behavior and academic achievement in Icelandic school children. *Health Education Research* 22 (1): 70–80.

Smith, D. E., M. D. Marcus, C. E. Lewis, M. Fitzgibbon, and P. Schreiner. 1998. Prevalence of binge eating disorder, obesity, and depression in a biracial cohort of young adults. *Annals of Behavioral Medicine* 20:227–332.

Sobal, J., B. S. Rauschenbach, and E. A. Frongillo. 1992. Marital status, fatness and obesity. *Social Science and Medicine* 35 (7): 915–23.

Solovay, S. 2000. *Tipping the scales of injustice: Fighting weight-based discrimination.* Amherst, NY: Prometheus Books.

Todd, P. E., and K. I. Wolpin. 2003. On the specification and estimation of the production function for cognitive achievement. *Economic Journal* 113 (485): F3–F33.

———. 2007. The production of cognitive achievement in children: Home, school, and racial test score gaps. *Journal of Human Capital* 1:91–136.

von Mutius, E., J. Schwartz, L. M. Neas, D. Dockery, and S. T. Weiss. 2001. Relation of body mass index to asthma and atopy in children: The National Health and Nutrition Examination Study III. *Thorax* 56:835–8.

Whitaker, R., M. Pepe, J. Wright, K. Seidel, and W. Dietz. 1998. Early adiposity rebound and the risk of adult obesity. *Pediatrics* 101 (3): e5.

Wurtman, J. J. 1993. Depression and weight gain: The serotonin connection. *Journal of Affective Disorders* 29 (2-3): 183–92.