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Education and obesity at age 40 among American adults

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Abstract

Although many have studied the association between educational attainment and obesity, studies to date have not fully examined prior common causes and possible interactions by race/ethnicity or gender. It is also not clear if the relationship between actual educational attainment and obesity is independent of the role of aspired educational attainment or expected educational attainment. The authors use generalized linear log link models to examine the association between educational attainment at age 25 and obesity (BMI≥30) at age 40 in the USA's National Longitudinal Survey of Youth 1979 cohort, adjusting for demographics, confounders, and mediators. Race/ethnicity but not gender interacted with educational attainment. In a complete case analysis, after adjusting for socioeconomic covariates from childhood, adolescence, and adulthood, among whites only, college graduates were less likely than high school graduates to be obese (RR= 0.69, 95%CI: 0.57, 0.83). The risk ratio remained similar in two sensitivity analyses when the authors adjusted for educational aspirations and educational expectations and analyzed a multiply imputed dataset to address missingness. This more nuanced understanding of the role of education after controlling for a thorough set of confounders and mediators helps advance the study of social determinants of health and risk factors for obesity.

Keywords

body weight; educational status; ethnic groups; health status disparities; obesity; social class; socioeconomic factors; United States of America

Introduction

Educational attainment appears to be inversely related to obesity (e.g. McLaren, 2007), in both women and men of several races/ethnicities in developed countries and, increasingly, in

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developing countries. However, these studies vary greatly in how they measure educational attainment and for which covariates they adjust. To the best of our knowledge, no study has adjusted for a rigorous set of potential socioeconomic confounders and mediators, considered effect measure modifiers, and addressed potential other explanations when calculating the risk ratio for education and obesity in a nationally representative sample.

First, the relationship between educational attainment and obesity may be confounded by potentially important demographic factors and factors from childhood and adolescence that are not often measured and analyzed but are associated with both educational attainment and obesity and merit inclusion in the model as covariates (figure 1). These include potential confounders from childhood and adolescence such as parental educational attainment (Chevalier, 2004; Keane & Wolpin, 2001) and other measures of childhood socioeconomic position (Adler & Rehkopf, 2008; Kitagawa & Hauser, 1973), intelligence (Yu et al., 2010), where the individual grew up (Kimbro et al., 2008; McLaren, 2007; Wang & Beydoun, 2007) and level of acculturation (Ahn et al., 2008; Chandola et al., 2006; Cutler & Lleras-Muney, 2006; Gordon-Larsen et al., 2003; Mirowsky & Ross, 1998). Additionally, adult socioeconomic factors (Chandola et al., 2006; Cutler & Lleras-Muney, 2006), adult family structure (e.g., marital status, children) (Bogossian et al., 2012; Brown, 2011; Luoto et al., 2011), and geography (Lovasi et al., 2009; Wang & Beydoun, 2007) may mediate the relationship between education and obesity (figure 1). Education is often used to measure general socioeconomic status, but other components of socioeconomic status (e.g., income, wealth) may also be relevant (Chevalier, 2004; Keane & Wolpin, 2001; McLaren, 2007; Parsons et al., 1999; Sobal & Stunkard, 1989).

Second, gender and/or race/ethnicity may modify the relationship between education and obesity. (Note that this cannot be visualized in figure 1, except to say that the relations between the variables may be different by race/ethnicity and/or gender). For example, across many European countries, an inverse association between educational tercile and body mass index (BMI) was observed for women, with less consistent results among men (Molarius et al., 2000). In the United States (US), similar trends were observed by gender; among women, further differences by race/ethnicity were observed (Kahn & Williamson, 1991).

Third, the role of educational attainment may reflect educational aspirations—how much education an individual hopes to achieve—and/or educational expectations, or how much education an individual expects to achieve (figure 2 demonstrates how these variables may be related to the other measures identified in figure 1). Educational aspirations reflect internal motivation and perceived self-efficacy, influence of parents, role models, and peers, perceived value of additional years of education, school climate, neighborhood context, and social norms (Bandura et al., 2001; Jacob & Wilder, 2008; Kao & Tienda, 1998; Rumbaut, 2005). It is possible that the relationship between educational attainment and obesity observed elsewhere is an artifact of the type of people who seek higher amounts of education. Educational expectations, on the other hand, are realistic aspirations (Jacob & Wilder, 2008) shaped by structural forces that limit or extend the amount of education an individual receives, including an individual's socioeconomic and racial/ethnic background, family support, peer norms, school experiences, and neighborhood setting (Beattie, 2002; Cheng & Starks, 2002; Jacob & Wilder, 2008; Museus et al., 2010). Similarly, it is possible that the previously documented relationship between educational attainment and obesity is an artifact of the phenomenon that the same social factors that limit educational attainment may also limit the attainment of positive health outcomes. Both educational aspirations (Kao & Tienda, 1998) and educational expectations (Jacob & Wilder, 2010) are associated with educational attainment. We also note that these are disparities in educational aspirations and educational expectations by race/ethnicity and gender. For example, minority youth often have lower educational aspirations and are less likely to achieve the educational level to which they aspire (Kao & Tienda, 1998). And while men used to expect to achieve more education than women, now the reverse is true (Jacob & Wilder, 2010).

The National Longitudinal Survey of Youth (NLSY) 1979 cohort offers a unique opportunity to test three related hypotheses: 1) prior studies of the relationship between educational attainment and obesity may have been confounded because potentially important social factors were not included in their models; 2) interactions by race/ethnicity and/or gender may affect the adjusted relationship between educational attainment and obesity; and 3) the association between educational attainment and obesity is independent of any relationship between educational aspirations and/or educational expectations and obesity.

In particular, we hypothesize that: 1) there will be an inverse association between educational attainment and obesity that will be attenuated when confounders and mediators from across the life course are included in the model; 2) the association between educational attainment and obesity may be stronger among whites and/or women; and 3) the association between educational attainment and obesity will be attenuated and may be erased after controlling for educational aspirations and educational expectations.

METHODS

The 1979 National Longitudinal Survey of Youth is a nationally representative cohort study that recruited 14-21 year-old American males and females in 1979 and collected data annually until 1994 and then biennially through in-person and telephone interviews. A complex multistage sampling approach randomly sampled households in the United States, screened for eligible participants, and oversampled blacks, Hispanics, economically disadvantaged non-Hispanic non-black youth, and individuals serving in the military (CHRR, 2008). Seventy-seven percent of respondents remained alive, eligible, and participating through 2008 (7757 respondents of 9964 eligible) (CHRR, 2008). By further restricting our analytic sample to those individuals who had data for all our variables of interest (n=4527), our final sample consisted of 58.4% of those who were retained through 2008 (n=7757), or 45.4% of the original NLSY sample (n= 9964). While this participation proportion appears low, this is not uncommon for prospective cohort studies; one recent Whitehall II study included 44.1% of the original sample (Elovainio et al., 2011), and a recent National Longitudinal Survey of Adolescent Health survey analysis used 43.0% of their original sample (Gordon-Larsen et al., 2003). Furthermore, although attrition from the NLSY is nonrandom, the estimation of socioeconomic factors appears unbiased, and any attrition related to health would most likely bias results towards the null (Quesnel-Vallée & Taylor, 2012). We also looked within our specific dataset to examine the distribution of obesity at an earlier time point among attriters and non-attriters. Among non-attriters (individuals for whom obesity at age 40 was measured), the prevalence of obesity at age 25 was 40.9%; among attriters (people who were not tracked to age 40 and for whom obesity at age 40 was not measured), the prevalence of obesity at age 25% was only 36.3%. This suggests that, if anything, the attriters were slightly healthier than the participants in the sample. The Bureau of Labor Statistics created custom sampling weights to make the sample nationally representative and account for loss to follow-up. The University of California Berkeley Office for the Protection of Human Subjects waived the requirement for formal review of this research because these data are unidentifiable and publicly available.

The outcome of interest was obesity at 40 or 41 years of age. This age cut-off was chosen because it was the oldest age that all members of the cohort had achieved and for which data were available at the time the analyses were completed. Self-reported weight and height measures were regression-calibrated using data from the National Health and Nutrition

Examination Survey III that contained both self-reported and objectively measured weight and height (Cawley & Burkhauser, 2006). The calibrated weights and heights were used to calculate BMI (weight (kg)/height^2 (m^2)). Obesity was defined as BMI≥30 per World Health Organization cut-off (WHO, 1995), which was demonstrated to be meaningful for morbidity (Visscher & Seidell, 2001) and mortality (Flegal et al., 2005) outcomes, although we acknowledge that others argue that the BMI cutoff points may not be as meaningful.

The primary explanatory variable was educational attainment by age 25, which US Census reports and researchers (e.g., Barro & Lee, 2010; Bogossian et al., 2012; Brown, 2011; Luoto et al., 2011) use as the age by which formal educational attainment has typically ceased. Educational attainment was defined categorically rather than continuously because, when using multiple indicator variables for each educational attainment group, the assumption of linearity did not hold. NLSY participants reported the number of years of education attained at each interview; at the interview for which respondents were 25 years old, a categorical variable was created (e.g., Kominski & Siegel, 1993): less than a high school education (less than twelve years), high school graduates (at least 12 but fewer than 16 years), and college graduates (16 or more years). All other educational variables of interest (adolescent educational aspirations and expectations, maternal and paternal education, and the educational aspirations of the participant's best friend in adolescence) were also coded this way. Principal components analyses and Cronbach's alpha analyses found that educational aspirations and educational expectations, while substantively different, are correlated enough to map onto a single latent construct, whereas educational attainment maps onto a different construct (data available upon request).

All models adjusted for gender and race/ethnicity (Hispanic, non-Hispanic black, and non-Hispanic non-black white). Asians (n=142) were excluded from the analyses due to small sample size. Childhood and adolescent confounders were: maternal and paternal education (categorical variables), living in the southern part of the United States as a child, living in an urban setting as a child, and speaking a foreign language as a child (all binary variables). Participants' age in 1979, as a measure of birth year, was also included in the model to account for any potential birth cohort differences. The Armed Forces Qualifying Test score assessed intelligence in late adolescence (in 1981, when respondents were 16-23 years old).

Several measures from adulthood (as measured at age 40 or 41) were included as potential mediators to assess direct versus indirect associations of educational attainment on obesity. Wealth and income (equivalized household (Rehkopf et al., 2010a) and total family) were continuous variables measured in standardized year 2000 dollar increments and transformed to be on the natural log scale, as is common in past studies (e.g., Rehkopf et al., 2010a). Living in the southern part of the United States as an adult, urban residence as an adult, family size (number of household residents), and number of dependents were also included in the model. We chose to measure these variables concurrently with the outcome because we hypothesized that the effect of any measures of these variables earlier in life (e.g., at age 30) would operate via the most proximal measure of that variable (i.e., at age 40) (Rehkopf et al., 2010b).

Generalized linear modeling with the log linear link function was used to calculate adjusted risk ratios in Stata 11.2. Risk ratios are preferable to odds ratios because risk is more intuitive to interpret than odds (Schwartz et al., 1999). A Poisson distribution was specified with robust standard errors; this method does not require correctly specifying the distribution and has been demonstrated to calculate correct point estimates and standard errors and avoid non-convergence (non-convergence can sometimes occur when using a binomial distribution) (Zou, 2004). All *P*-values were two-sided and were not adjusted for multiple comparisons (Rothman, 1990). To examine how missing data may have biased

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results, multiple imputation, using Stata's "mi" package with five imputations, was done using all the covariates in the models to impute missing data for all education-related variables, confounders, and mediators; the outcome variable (obesity at age 40) was not imputed. The same analyses were then repeated on the multiply imputed dataset.

RESULTS

Table 1 presents weighted descriptive statistics of the complete case analytic sample of 4527 individuals. Almost one-third (31.2%) of the sample was obese (BMI≥30) at age 40. The majority were high school graduates (66.8%), with 23.9% having graduated from college or higher, and 9.3% having less than a high school education. Among those excluded from the analyses, the prevalences of obesity (30.5%) and high school graduates (66.1%) were similar to those included in the sample, but there was a larger proportion of individuals with less than a high school education (16.5%) and a smaller proportion of individuals with a college degree (17.4%) than in the sample. The sample was evenly divided by gender (49.7% female) and the majority of the sample (84.2%) was white; those excluded from the sample were similarly evenly divided by gender, but had higher proportions of blacks and non-black Hispanics. The sample was diverse by early life, adolescent, and adult characteristics, and these characteristics varied widely by educational attainment level.

The adjusted relationship between educational attainment and obesity differed by race (Wald test two-sided P=0.017) but not gender (two-sided P=0.91). We then measured the association between educational attainment and obesity, adjusting for potential confounders from childhood and adolescence and potential mediators from adulthood (table 2) (effect estimates for each of the covariates is available upon request). These analyses assess the extent to which each of the potentially confounding sets of variables indicated in figure 1 confound the primary association of interest between educational attainment and adult obesity. The childhood variables (birth year, paternal educational attainment, maternal educational attainment, living in the South, urban residence, speaking a foreign language) made a substantive contribution to the model as compared to a model with just gender and race (Wald test two-sided P=0.06), whereas adding the variables from adolescence (intelligence, best friend's educational aspirations) to a model with all the demographic and childhood covariates did not (Wald test two-sided P=0.76). Potential mediators from adulthood (wealth, individual income, total family income, family size, number of dependents, marital status, living in the South, urban residence) made a significant contribution to the model that already included demographic, childhood and adolescent covariates (Wald test two-sided P=0.002) (table 2). Adjusting for all covariates, white college graduates were less likely than white high school graduates to be obese (risk ratio (RR)= 0.69, 95% confidence interval (CI): 0.57, 0.83).

We then exchanged the variables for educational attainment with, first, the amount of education to which individuals aspired and, second, the amount of education individuals expected to attain (table 2). This assessed the extent to which educational aspirations and educational expectations could be empirical confounders. The only statistically significant adjusted risk ratio for either educational aspirations or educational expectations was that Blacks who aspire to a college degree were more likely to be obese than Blacks who aspire to only a high school degree (RR=1.22, 95%CI: 1.04, 1.43).

Finally, we re-examined the relationship between educational attainment and obesity by also adjusting for educational aspirations and educational expectations (table 2). This analysis is aligned with figure 2, which hypothesizes that educational aspirations and educational expectations may confound our primary association of interest between educational attainment and obesity. Our results did not change: the one statistically significant association is that white college graduates are less likely than white high school graduates to be obese (RR= 0.69, 95%CI: 0.57, 0.84).

The risk ratios calculated in the multiply imputed dataset (supplemental table 1) were similar to those calculated in the complete case dataset (table 2), and all estimates with $P<0.05$ in the complete case dataset also had $P<0.05$ in the multiply imputed dataset. However, additional risk ratios became statistically significant at the $P=0.05$ level in the multiply imputed dataset that were not statistically significant in the complete case analysis, due to narrowed confidence intervals. Among whites, college graduates were less likely to be obese than those with less than a high school education (RR=0.70, 95%CI: 0.55, 0.89), and, among blacks, high school graduates were more likely to be obese than those who had not graduated from high school (RR=1.19, 95%CI: 1.02, 1.39). Additionally, among whites, there appeared to be an association between educational expectations and obesity: those who aspired to graduate college were less likely to be obese than those who aspired to graduate high school (RR=0.83, 95%CI: 0.72, 0.95) and those who aspired to less than a high school education (RR=0.76, 95%CI: 0.59, 0.98).

DISCUSSION

In our sample of American adults, after adjusting for confounders and mediators from across the life course, we found non-monotonic relationships between educational attainment and obesity that varied by race/ethnicity. A statistically significant inverse association between college graduates versus high school graduates was observed for whites, but we found no statistically significant association among Blacks/African-Americans (although point estimates suggested a positive association) or Hispanics (where point estimates suggested an inverse association). While some (Cutler & Lleras-Muney, 2006; Ross & Mirowsky, 1999) have concluded that years of education, rather than degree attainment, has the greatest association with other health outcomes, others (e.g., Backlund et al., 1999; Montez et al., 2012) have identified a non-linear relationship. Additionally, although the potential socioeconomic mediators from adulthood made a statistically significant contribution to the model per the Wald test statistic, the estimated measure of association did not substantively change. This implies that these variables were not major mediators, although we acknowledge the limitations of the decomposition approach (Kaufman et al., 2004).

The relationship between educational attainment and obesity had different directions by race/ethnicity but not gender. Several other studies (Brown et al., 2009; Burke et al., 1990; Flegal et al., 1988a; 1988b; Himes, 1999; Himes & Reynolds, 2005; Leigh et al., 1992; Lewis et al., 2005; Sabia, 2007; Zhang & Wang, 2004) have observed that race modifies the education and obesity relationship in American populations, but none considered interaction for all three major American racial/ethnic groups. Among those studies, most found an inverse association for whites or white females (Burke et al., 1990; Flegal et al., 1988b; Himes, 1999; Himes & Reynolds, 2005; Lewis et al., 2005; Sabia, 2007; Zhang & Wang, 2004), although some studies of white men found a null association (Burke et al., 1990; Flegal et al., 1988a; Sabia, 2007) or an inverted U association (with obesity highest among high school graduates, as compared to those with less than a high school education and those with a college education) (Leigh et al., 1992). The data were mixed for blacks, with some studies reporting an inverse association (Flegal et al., 1988b; Himes & Reynolds, 2005; Lewis et al., 2005), others (Burke et al., 1990; Flegal et al., 1988a; Himes, 1999; Zhang & Wang, 2004) a null association, one (Burke et al., 1990) finding a positive association, and one (Leigh et al., 1992) finding an inverted U association for black men.

One possible explanation for this race-education interaction may be that blacks' educational experiences may be of lower quality than whites, due to de jure segregation (Garibaldi, 1997), de facto segregation (Mickelson & Heath, 1999), and disparities in school resources (Kozol, 1992), with implications for lower consequent social status and lower adult health status as compared to whites (Barnes et al., 2011; Johnson, 2010; Rohit et al., 2007). We plan to pursue this potential explanation in future research. Race/ethnicity may also affect how educational attainment shapes life chances and well-being (Walsemann et al., 2008; Williams, 1999). Educational attainment may affect social prestige (Backlund et al., 1999; Muennig, 2007), but this pathway may differ by race/ethnicity and/or gender due to other, race- and/or gender-based sources of disadvantage (see Ross & Mirowsky (2006) for an example of this, with depression as the health outcome). Immigration or acculturation may also play a role. Although results were not statistically significant at the P=0.05 level, our results suggested that Hispanics with less than a high school education may be less likely to be obese. Others have found that first-generation Hispanic/Latino immigrants are less likely to be obese than US-born Hispanic/Latinos (Barcenas et al., 2007). However, the 22.3% of Hispanics in our sample who were foreign born were evenly distributed across levels of educational attainment. Nevertheless, how acculturation relates to educational attainment merits further inquiry, since studies considering both acculturation and educational attainment in relation to obesity (e.g., Khan et al., 1997; Sundquist & Winkleby, 2000) have not explicitly examined potential interaction. Future studies could also include more nuanced measures of acculturation (e.g., individual and parental English-language proficiency).

Our data suggest that the association between educational attainment and obesity cannot be fully explained by aspirations or expectations, since an association remained after adjusting for educational aspirations and educational expectations. When we considered the relationship between educational aspirations and obesity on its own, our only statistically significant finding was that blacks who aspired to graduate from college were significantly more likely to be obese than blacks who aspired to graduate only from high school. There were no statistically significant associations between educational expectations and obesity in our complete case analysis, although our multiply imputed dataset suggested that, among whites, those who expect to graduate college were less likely to be obese than those who expect to only graduate high school or not complete high school. We encourage other researchers to study educational aspirations and expectations to see if similar or different patterns appear with other health outcomes, since these constructs have been understudied in public health. We also encourage researchers to use educational aspirations and educational expectations variables to develop measures of gaps between aspirations and attainment, for example, to determine if these life experiences have implications for health.

This study's primary strength was its large and representative sample paired with a diverse set of social confounders. The two previous educational attainment and obesity studies to control for the most categories of confounders and mediators are a study of Korean adults (Yoon et al., 2006) that controlled for age, gender, income, nutritional factors, physical activity, health behaviors, marital status, and region, and a study of California adults (Ettner & Grzywacz, 2003) that controlled for age, gender, race/ethnicity, additional measures of socioeconomic status, physical activity, health behaviors, marital status, and region. Both studies observed an inverse association between educational attainment and obesity. Our study also adjusted for intelligence, educational aspirations, and educational expectations. We did not include the most proximal mediators for obesity (e.g., diet and physical activity) in our model due to our focus on upstream risk factors and socioeconomic mediators. Although other factors may confound the relationship between educational attainment and obesity (e.g., personality traits (Hampson et al., 2007)), we hypothesize that any such associations would be relatively small and unlikely to dramatically confound estimates observed, especially since the risk ratios for educational attainment and obesity did not change substantially with the addition of several confounders.

The analyses were limited in three main ways. First, height and weight were self-reported, which may add bias in comparison to anthropometric measurements. To attempt to reduce bias, we used regression-calibrated measures of BMI (Cawley & Burkhauser, 2006). Second, this analysis focused on individuals for whom we have complete data. Although those included were relatively comparable to those excluded from the analysis on most measures, those excluded from the sample tended to have lower income and wealth in adulthood and fewer were married. To address this limitation, we used the NLSY's custom sampling weights that account for missingness and we also did multiple imputation. The risk ratios from the multiply imputed data were consistent with the risk ratios from the complete case analysis. Third, we were underpowered to test for three-way race-gender-education interaction due to the relatively small number of study participants in some of these categories (e.g., Black women who had graduated college (n=77)).

With these strengths and limitations in mind, there appears to be a moderate, non-monotonic, direct relationship between educational attainment and obesity, unmediated by adult socioeconomic factors and independent of educational aspirations and expectations, among white adults who were American adolescents in 1979. Further research should elucidate if the association is causal and how education may interact with race to affect obesity. A fundamental causes of disease framework could help identify multiple pathways by which educational attainment can affect health (Link & Phelan, 1995), including knowledge gained or social status achieved. We encourage future researchers to assess these possible mechanisms and others as we deepen our understanding of education as a social determinant of health.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Research highlights

- Previous research considering education as a social determinant of obesity may have residual confounding.
- We adjust for socioeconomic covariates from across the life course, educational aspirations, and educational expectations.
- The relationship between educational attainment and obesity differs by race/ethnicity and is non-linear.

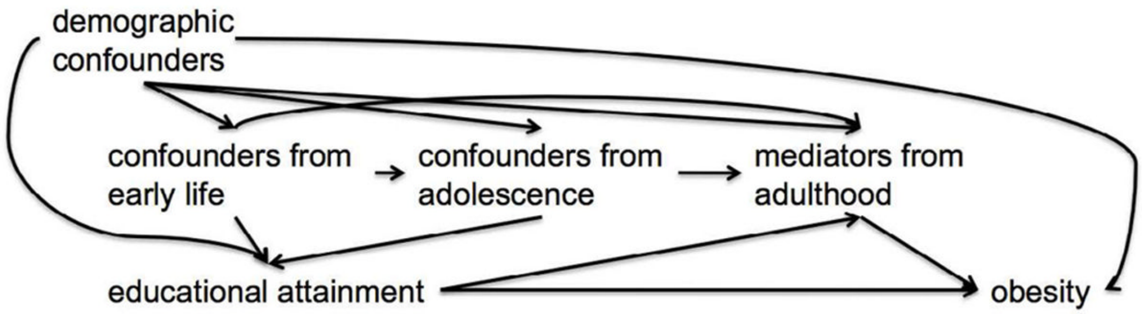

Figure 1.
The Hypothesized Relationships Between Educational Attainment, Obesity, Potential Confounding Variables, and Potential Mediating Variables.

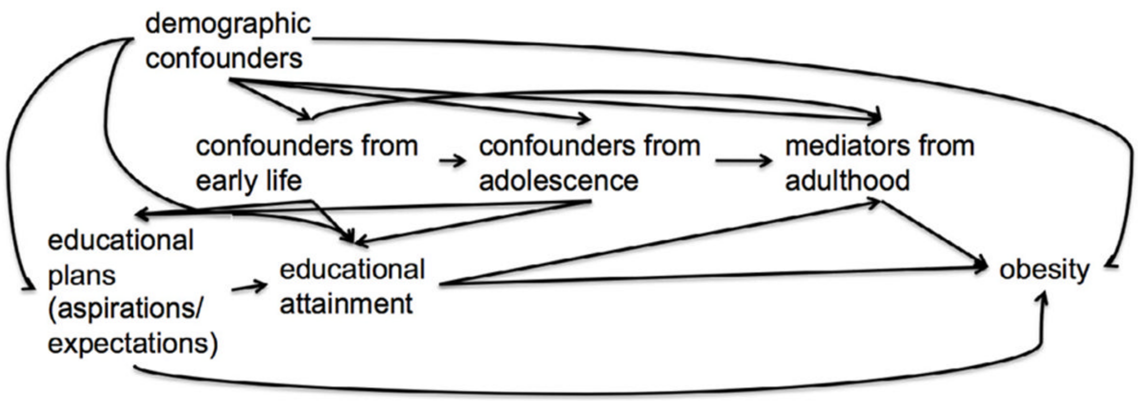

Figure 2.
The Hypothesized Relationships Between Educational Aspirations, Educational Expectations, Educational Attainment, Obesity, Potential Confounding Variables, and Potential Mediating Variables.

Table 1

Weighted Descriptive Statistics for Complete Case Analysis Sample (n=4527) and Those Excluded From Sample (n varies), National Longitudinal Survey of Youth 1979 cohort, United States of America, 1979-2006.

	Less than high school graduate at age 25 (n=564)	**High school graduate at age 25 (n=3075)**	**College graduate at age 25 (n=888)**	**Total (n=4527)**	**Excluded from analytic sample (n ranges from 2949 to 8287)**
Weighted proportion of sample	9.5%	66.4%	24.1%	100%	0%
Outcome variable of interest					
Obese (BMI≥30) at age 40	30.5%	34.3%	22.8%	31.1%	30.5%
Demographic characteristics					
White/other	72.9%	83.2%	91.5%	84.2%	74.9%
Black/African-American	15.7%	11.7%	6.0%	10.7%	15.9%
Hispanic/Latino	9.6%	4.2%	1.8%	4.1%	6.1%
Female	45.8%	51.8%	48.2%	50.4%	47.4%
Early life characteristics					
Father had less than high school education	68.0%	34.4%	10.6%	31.9%	35.6%
Father graduated high school	29.8%	53.3%	44.4%	48.9%	46.2%
Father graduated college	2.2%	12.3%	45.0%	19.2%	18.2%
Mother had less than high school education	65.5%	30.7%	7.7%	28.5%	35.0%
Mother graduated high school	33.3%	63.1%	63.8%	60.4%	56.0%
Mother graduated college	1.2%	6.2%	28.5%	11.1%	9.0%
Lived in the South as a child	38.2%	29.4%	29.0%	30.1%	32.5%
Lived in an urban (city or town) setting as a child	74.4%	75.9%	80.2%	76.8%	78.6%
Spoke a foreign language as a child	18.0%	11.7%	10.6%	12.0%	16.3%
Adolescent characteristics					
Closest friend aspired to less than high school graduation	9.5%	1.5%	0.2%	1.9%	3.1%
Closest friend aspired to high school graduation	76.0%	59.2%	21.3%	51.7%	54.0%
Closest friend aspired to college graduation	14.5%	39.3%	78.5%	46.4%	42.9%
Armed Forces Qualifying Test (intelligence) score	Mean: 22397 (SD: 18965) (range: 0-93854)	Mean: 49576 (SD: 24875) (range: 0-100000)	Mean: 79863 (SD: 18063) (range: 7515-100000)	Mean: 54285 (SD: 28153) (range: 0-100000)	Mean: 45592 (SD: 29179) (range: 0-100000)

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	Less than high school graduate at age 25 (n=564)	High school graduate at age 25 (n=3075)	College graduate at age 25 (n=888)	Total (n=4527)	Excluded from analytic sample (n ranges from 2949 to 8287)
Adult characteristics					
Equivalized household income at age 40	Mean: $24,466 (SD: $25,579) (range: $0, $273,861)	Mean: $38,301 (SD: $29,854) (range: $0, $387,483)	Mean: $68,005 (SD: $47,835) (range: $0, $319,353)	Mean: $44,138 (SD: $37,439) (range: $0, $387,483)	Mean: $31,757 (SD: $35, 024) (range: $0, $287,930)
Total family income at age 40	Mean: $37,034 (SD: $37,905) (range: $0, $422,385)	Mean: $60,665 (SD: $50,679) (range: $0, $422,385)	Mean: $113,772 (SD: $89,089) (range: $0, $422,385)	Mean: $71,206 (SD: $66,140) (range: $0, $422,385)	Mean: $55,951 (SD: $55,279) (range: $0, $422,385)
Wealth at age 40	Mean: $73,016 (SD: $230, 345) (range: $-701,240, $2,260,942)	Mean: $166,007 (SD: $336,332) (range: $-969,030, $2,415,097)	Mean: $447,042 (SD: $608,876) (range: $-421,214, $2,415,097)	Mean: $224,834 (SD: $431,062) (range: $-969,030, $2,415,097)	Mean: $140,696 (SD: $305,024) (range: $-821,956, $2,415,097)
Lived in an urban area at age 40	63.4%	65.3%	67.6%	67.6%	69.6%
Lived in the South at age 40	43.3%	33.9%	34.2%	34.8%	39.3%
Family size at age 40	Mean: 2.87 (SD: 1.58) (range: 1- 11)	Mean: 3.22 (SD: 1.51) (range: 1- 11)	Mean: 3.46 (SD: 1.51) (range: 1-10)	Mean: 3.25 (SD: 1.53) (range: 1-11)	Mean: 3.23 (SD: 1.57) (range: 1- 14)
Number of dependents at age 40	Mean: 1.13 (SD: 1.25) (range: 0-7)	Mean: 1.44 (SD: 1.24) (range: 0-8)	Mean: 1.66 (SD: 1.26) (range: 0-8)	Mean: 1.47 (SD: 1.26) (range: 0-8)	Mean: 1.34 (SD: 1.28) (range: 0- 10)
Married at age 40	49.2%	66.2%	77.7%	67.3%	30.6%

Percentages may not add up to 100% due to rounding.

Table 2

Adjusted Risk Ratio (95% Confidence Interval) of Obesity at Age 40 by Educational Attainment at Age 25 and Race/Ethnicity.

	Black/African- American	Hispanic	White
Educational attainment (adjusts only for gender)			
(Wald test P-value for gender = 0.52)			
RR of obesity for college graduates vs. high school graduates	1.02 (0.83, 1.25)	0.64 (0.37, 1.10)	0.66 *** (0.56, 0.77)
RR for college graduates vs. less than high school graduates	1.16 (0.88, 1.53)	0.66 (0.36, 1.18)	0.78 (0.59, 1.01)
RR for high school graduates vs. less than high school graduates	1.14 (0.92, 1.42)	1.03 (0.79, 1.34)	1.18 (0.94, 1.48)
Educational attainment (adjusts for child covariates)			
(Wald test P-value for child covariates = 0.06)			
RR of obesity for college graduates vs. high school graduates	1.07 (0.87, 1.33)	0.68 (0.40, 1.16)	0.69 *** (0.58, 0.83)
RR for college graduates vs. less than high school graduates	1.25 (0.94, 1.67)	0.71 (0.41, 1.25)	0.86 (0.66, 1.14)
RR for high school graduates vs. less than high school graduates	1.17 (0.94, 1.45)	1.05 (0.80, 1.36)	1.25 (0.99, 1.57)
Educational attainment (adjusts for child and adolescent covariates)			
(Wald test P-value for adolescent covariates = 0.76)			
RR of obesity for college graduates vs. high school graduates	1.04 (0.84, 1.30)	0.66 (0.39, 1.13)	0.68 *** (0.56, 0.82)
RR for college graduates vs. less than high school graduates	1.21 (0.89, 1.63)	0.68 (0.38, 1.21)	0.82 (0.61, 1.11)
RR for high school graduates vs. less than high school graduates	1.15 (0.93, 1.44)	1.02 (0.78, 1.34)	1.21 (0.96, 1.53)
Educational attainment (adjusts for child, adolescent, and adult covariates)			
(Wald test *P*-value for adult covariates = 0.002)			
RR of obesity for college graduates vs. high school graduates	1.09 (0.87, 1.36)	0.70 (0.42, 1.17)	0.69 *** (0.57, 0.83)
RR for college graduates vs. less than high school graduates	1.31 (0.96, 1.77)	0.74 (0.42, 1.30)	0.85 (0.63, 1.14)
RR for high school graduates vs. less than high school graduates	1.20 (0.96, 1.50)	1.07 (0.82, 1.40)	1.22 (0.97, 1.55)
Educational aspirations (adjusts for child, adolescent, and adult covariates)			
RR of obesity for college graduates vs. high school graduates	1.22 * (1.04, 1.43)	0.92 (0.72, 1.16)	0.93 (0.80, 1.08)
RR for college graduates vs. less than high school graduates	1.19 (0.55, 2.57)	1.07 (0.48, 2.37)	0.80 (0.46, 1.40)
RR for high school graduates vs. less than high school graduates	0.98 (0.46, 2.10)	1.17 (0.53, 2.56)	0.86 (0.50, 1.49)
Educational expectations (adjusts for child, adolescent, and adult covariates)			
RR of obesity for college graduates vs. high school graduates	1.13 (0.96, 1.33)	0.88 (0.68, 1.14)	0.86 (0.73, 1.01)
RR for college graduates vs. less than high school graduates	0.91 (0.65, 1.28)	1.16 (0.70, 1.94)	0.86 (0.62, 1.19)

	Black/African- American	Hispanic	White
RR for high school graduates vs. less than high school graduates	0.81 (0.58, 1.11)	1.32 (0.82, 2.13)	1.00 (0.75, 1.33)
Educational attainment (adjusts for child, adolescent, and adult covariates, plus educational aspirations and educational expectations)			
RR of obesity for college graduates vs. high school graduates	1.09 (0.87, 1.37)	0.70 (0.41, 1.17)	0.69*** (0.57, 0.84)
RR for college graduates vs. less than high school graduates	1.34 (0.99, 1.83)	0.77 (0.44, 1.36)	0.88 (0.65, 1.21)
RR for high school graduates vs. less than high school graduates	1.23 (0.98, 1.54)	1.11 (0.84, 1.46)	1.27 (0.99, 1.63)

* $P<0.05$,

** $P<0.01$,

*** $P<0.001$ (two-sided *P*-value)

These estimates are calculated based on race-by-education interaction terms. All models adjust for gender.

Child covariates: birth year, paternal educational attainment, maternal educational attainment, living in the South as a child, living in an urban setting as a child, and speaking a foreign language as a child.

Adolescent covariates: intelligence as an adolescent and best friend's educational aspirations as an adolescent.

Adult covariates: wealth as an adult, income as an adult, total family income as an adult, family size as an adult, number of dependents as an adult, marital status as an adult, living in the South as an adult, and living in an urban setting as an adult.