Adolescent Obesity and Academic Attainment in Young Adulthood

Abstract

Using nationally-representative data from the National Longitudinal Study of Adolescent to Adult Health (Add Health), this study examines the impact of adolescent obesity on young adult educational attainment. In this analysis, we estimate multilevel logistic models in order to specifically examine whether race/ethnicity, immigrant generation and peer networks mediate the effects of obesity on later attainment. Results suggest that individuals who were obese in adolescence are less likely to transition from high school to college, and even less likely to obtain a baccalaureate degree than their healthy-weight counterparts., even after controlling for other individual, family SES and school-level factors associated with attainment. Further, the effects of obesity were consistent throughout the analysis, indicating that adolescent obesity exerts an independent influence on young adult academic outcomes. In addition, having overweight and obese friends in adolescence also drives down the odds of educational success.

Keywords: educational attainment, obesity, race-ethnicity, immigrant generational status, weight status.

Introduction

Adolescent obesity has tripled over the last three decades, and has become a major public health concern in the United States. It is estimated that approximately 17% of our nation's children and adolescents are now obese (Ogden et al., 2010; Ogden et al., 2014). Apart from being a major antecedent of adult obesity, adolescent obesity has long-term consequences through the

accumulation of various health risk factors over the life course (Biro & Wien, 2010; Blazer et al., 2002; Reilly et al., 2005). Adolescent obesity incurs not only health risks in adulthood, but also high societal costs (McCormick & Stone, 2007; Reilly & Kelly, 2011; Trasande et al., 2009). Limited evidence suggests that the social burden of adolescent obesity includes lasting effects on economic mobility (Chung et al., 2014; Sabia & Rees, 2012). Yet, only a handful of studies have directly addressed whether and how adolescent obesity affects academic attainment in young adulthood (e.g., Crosnoe & Muller, 2004; Crosnoe 2007; Fowler-Brown et al., 2010).

The present study is intended to contribute to this strand of research and to estimate the impact of adolescent weight status on educational outcomes in young adulthood. Specifically, we use the National Longitudinal Study of Adolescent to Adult Health (Add Health), to examine the following questions:

(1) Is adolescent obesity associated with educational outcomes in young adulthood, specifically, high school graduation, college enrollment, and college graduation?

(2) Does race/ethnicity mediate the relationship between obesity and educational attainment, and, if so, how?

(3) Does immigrant generational status mediate the association between adolescent obesity and young adult educational outcomes, and if so how?

(4) How do peer networks, specifically having a high proportion of obese or overweight peers, influence young adult educational outcomes?

This paper adds to the literature by using longitudinal data from Add Health to examine the effects of adolescent obesity on young adult educational outcomes. Our study bridges several literatures (racial disparities, migration studies, social networks) to explore different scenarios that could potentially cause spurious associations between adolescent weight and later educational

attainment. Specifically, we investigate whether and to what extent the relationship between weight status in adolescence and academic attainment in young adulthood is explained by the following factors: (1) race/ethnicity; (2) immigrant generations status; or (3) peer networks. Concerning the former, this study is unique in considering both: (1) a school's student body composition that provides an opportunity for the formation of social ties, and (2) the actual composition of a school's social networks.

Other strengths of the present study include the use of a nationally representative sample—the National Longitudinal Study of Adolescent Health (the Add Health)—and the longitudinal nature of the Add Health data. Many prior studies examining obesity's effects have been cross-sectional in nature, whereas Add Health enables us to follow youth through young adulthood to examine the effects of characteristics in childhood and adolescence on later outcomes. Moreover, Add Health contains a wealth of information on youth friendship networks, enabling us to explore social influences on the relationship between obesity and attainment and the social costs of adolescent obesity on later outcomes. Finally, these data are hierarchical in nature which allows the use of multilevel modeling, a practice that has not been fully employed in prior research on peer networks.

Obesity and Educational Attainment

Existing research clearly indicates that adolescent obesity has important health, social, and economic consequences and is a major antecedent of adult obesity (e.g., McCormick & Stone, 2007; Reilly & Kelly, 2011; Sabia & Rees, 2012). While the association between adolescent obesity and physical health problems is well known (Ferraro & Kelley-Moore, 2003; Reilly & Kelly, 2011), the existing empirical evidence linking adolescent obesity and academic performance is weak (Caird et al., 2011). Although literature tends to suggest that overweight and

obese youth perform worse in school that their healthy-weight counterparts, the number of studies is limited, their individual power is low (i.e., small sample sizes), and they lack extensive controls (Caird et al., 2011). Most importantly, this research is almost exclusively cross-national in nature, which means that a long-term impact of adolescent obesity on adult educational attainment remains underexamined.

So far, only a handful of studies have examined the relationship between adolescent obesity and adult educational outcomes. Using the 1979 and 1997 National Longitudinal Survey of Youth, Fowler-Brown et al. (2010) examined the relationship between adolescent obesity and college degree attainment and found mixed results across cohorts. Specifically, adolescent weight was not associated with degree attainment for the earlier (1979) cohort, but there was a negative association between adolescent obesity and graduating from college in the later (1997) cohort.

In an attempt to underscore school context in determining an individual's weight status, Crosnoe (2007) and Crosnoe & Muller (2004) used the average BMI of a school as to capture the prevalence of obesity as a norm in the educational setting. Using data from Add Health, Crosnoe (2007) used this measure to test a social psychological model of the gendered link between obesity and education. He found that in schools where the average BMI of the student body was lower than the sample's average, obese women were half as likely to attend college than healthy-weight women. However, in schools where female obesity was more prevalent, obese women had the same chance of attending college as non-obese women. Crosnoe & Muller (2004) achieved similar results in an earlier study. Specifically, obese individuals from schools with lower average BMI had higher academic achievement compared to obese individuals from schools with higher average BMI demonstrating an inverse relationship between average body size among students and

academic achievement. Both Crosnoe (2007) and Crosnoe & Muller (2004) emphasized how school context may influence the association between weight status and academic outcomes.

Present Study

Collectively, the existing body of knowledge indicates that being obese as adolescent puts one at an elevated risk of lower academic attainment and suggests at least one potential mechanism—school context—that may explain the relationship between obesity and attainment. That said, earlier research suffers from several limitations. First, it overlooks potential mediators of the relationships between adolescent obesity and adult attainment, such as generational status. Indeed, little is known about how immigrant generational (nativity) status intersects with the obesity-education relationship. Despite the fact that first- and second-generation immigrants comprise the fastest growing segment of the child population, there is a paucity of data available about the epidemiology of obesity among immigrants (Harris, Perreira, & Lee, 2009). The existing evidence suggests that, at least for some immigrant groups, the native population tends to be heavier than first generation immigrants (Harris, Perreira, & Lee, 2009; Gordon-Larsen et al., 2003).

Scholars agree that generational status is an important predictor of educational outcomes (e.g., Baum & Flores, 2011; Portes & Rivas, 2011). Sociological theories of immigrant adaptation sketch out different paths of academic advancement across immigrant generations. According to the immigrant optimism hypothesis (Feliciano & Lanuza, 2015; Kao & Tienda, 1995; Waldinger & Feliciano, 2004), immigrant parents transmit their values to succeed and desires for social mobility to their children. This parental optimism leads to higher educational achievement among immigrants relative to their nonimmigrant peers (Feliciano & Lanuza, 2015; Kao & Tienda, 1995). The opposite view, represented by the second-generation decline hypothesis (Gans, 1992),

maintains that today's children of immigrants will not follow the pattern of upward mobility experienced by their immigrant parents. In this view, immigrant optimism will subside across generations for more recent waves of immigrants, particularly those who are racial minorities and/or of lower socio-economic status (Alba, 2005; Gans, 1992; Waters, 1994).

Second and most important, earlier research has not paid adequate attention to social networks. Although Crosnoe (2007) and Crosnoe & Muller (2004) consider school context and acknowledge the role of social networks in contributing to the spread of obesity in school environment, they fail to make the distinction between contextual effects and social network effects. Yet, this distinction is central to social network theory (Blau, 1977. 1994, Christakis & Fowler, 2007). One can think of contextual influences as those arising from the shared environment that could lead to similar outcomes. In contrast, social network effects refer to the propensity to engage in similar behavior because of the direct interaction with another individual.

Thus, drawing from social network theory (Christakis & Fowler, 2007; Cohen-Cole & Fletcher, 2008), we argue that it is essential to maintain the conceptual and empirical clarity when treating: (1) the composition of social setting (i.e., average BMI of a school) that provide an opportunity for the formation of social ties, and (2) the composition of social networks that are formed and operate in this social setting (i.e., BMI of a friendship network). Individuals are expected to have friendship networks that reflect school composition. However, the compositional effect on peer networks can be offset by a behavioral influence on patterns of friendship formation (Dufur, Parcel, & Troutman, 2013). Put differently, adolescents tend to form friendships with similar others, thus displaying behavior known as homophily (Ryabov, 2009; Titzmann, 2014). Therefore, overweight students are likely to choose one another as friends and become connected regardless of the average weight status of the school they attend. Peers can become influential to

individual's behaviors, particularly when conformity helps individuals gain social status among their peers. Having obese peers may alter a person's views on obesity and impact health-related behaviors such as diet and exercise (Cohen-Cole & Fletcher, 2008; Crosnoe & Muller, 2004; Trogdon, Nonnemaker, & Pais, 2008).

In practical terms, it means that average BMI of school may not be the perfect approximation of the influence of the school context on individual weight-related behaviors. The novelty of the present study is that it introduces the obesity saliency index (OSI), which estimated preferences for friends based on weight status conditional on the average weight status of peers in the school. We believe that this measure is useful for future empirical analyses of obesity in different social settings and to test social network theory (Christakis & Fowler, 2007; Cohen-Cole & Fletcher, 2008).

Data

Data came from the National Longitudinal Study of Adolescent to Adult Health (hereafter, Add Health), a national longitudinal survey of adolescents and young adults conducted by the Carolina Population Center at the University of North Carolina at Chapel Hill. The first round of Add Health data among adolescents in grades 7 through 12 was collected in 1995 (Wave 1). Four later waves were conducted in 1996 (Wave 2); 2001-2002 (Wave 3); and 2007-2008 (Wave 4)., At Wave 4, the Add Health respondents were young adults, with ages ranging from 24 to 32 years. Add Health used a school-based stratified sample design (Harris et al., 2009), that is, respondents were drawn from a random sample of high schools along with their feeder schools (i.e., middle schools whose students matriculate at the selected high school). Overall, 79% of the schools that were contacted agreed to participate in the study. All participating schools were stratified by sex and grade, with students randomly chosen within each stratum. During Wave 1 all students in the

participating schools were surveyed (N=90,118). A subset of students (N=20,745) was randomly selected for in-home interviews conducted approximately one year after the in-school survey. In-home interviews were collected along the subset of students selected at Wave 1 in all subsequent waves.

In the present study, all information on independent variables was obtained from Wave 1 in-home interview data when the respondents were 11 to 18 years old, while outcomes—educational attainment—were measured at Wave 4 when the respondents were 24 to 32 years old. Wave 4 interviews were completed with 15,701 of the Add Health respondents. Cases with missing values on anthropometric measurements (weight and height) used to compute the weight status as well as at least one educational outcome of the interest were excluded (N=3,610). Applying this selection criterion reduced the final sample size to 12,091 students from 129 schools. Missing values for all independent variables, except weight status, were handled using the Markov Chain Monte Carlo (MCMC) technique for multiple imputation, with the efficiency of the resulting estimates within 95% confidence interval (for more information see Rubin 1996, 2009).[1]

Methods

In this analysis, our primary interest is in understanding how weight status in adolescence affects educational attainment of young adults after most of their school-to-work transitions have been completed. Our dependent variables include three educational outcomes for young adults in our analytic sample: (1) having a high school diploma or less; (2) having some college education,

[1] The MCMC procedure assumes data are missing and random and iteratively replaces missing values with predictions based on the variance-covariance matrix of the study variables. Empirical results are averaged across the five imputation samples and we appropriately account for the variation across imputation samples to calculate standard errors (Acock, 2005; Royston, 2005). Data were imputed using the Stata 10.0 software.

but no degree; or (2) holding a bachelor's degree or higher. We measure these outcomes at Wave 4, when respondents are 24 to 32 years of age and, therefore, likely to have completed college if they had attended.

Measuring Adolescent Obesity

Currently, the most widely used indicator to determine weight status is the Body Mass Index (BMI) (Cole et al., 2007; Janssen et al., 2005). The BMI is calculated by dividing weight in kilograms by height squared in meters. To estimate weight status in adolescence, we used the standard endorsed by the Centers for Disease Control and Prevention for overweight using BMI cut-off points for age and sex (for more information see Cole et al., 2007). Overweight and obesity were defined as having a BMI at or above the 85th and 95th percentiles, respectively, for age and gender. In Wave I, anthropometric measurements were obtained as self-reports of the respondents. Although it is entirely possible that some students did not know how their exact height and weight, previous research indicates a very high correlation between self-reported and measured BMI among young people (Elgar et al., 2005). Indeed, interviewer measures of height and weight were included Add Health at Wave 2, and they were found to be highly correlated (Pearson's correlation coefficient=0.95) with the adolescent self-reports for Wave 2 (Goodman & Strauss, 2003).

In this analysis, our predictor of interest is weight status in adolescence measured as a categorical variable distinguishing healthy weight (BMI<85^{th} percentile for sex and gender), overweight (BMI at 85^{th} to 94^{th} percentile for sex and gender) and obese (BMI at 95^{th} percentile or above for sex and gender). Weight status is the key variable in our study, and concerning its effect on academic outcomes we propose the following hypothesis. *Hypothesis 1*: On the basis of prior research (e.g., Clarke et., 2009; Cohen et al., 2013; Crosnoe & Muller, 2004; Fowler-Brown et al., 2010; Gavin et al., 2010), we believe that different weight status groups experience different

academic trajectories. Particularly, after controlling for socio-economic background and other predictors, educational outcomes of adults who were overweight and obese as children are expected to be worse than those of adults who were healthy-weight as children. The support for this hypothesis draws from recent findings that overweight and obese youth tend to perform worse in school that their healthy-weight peers (Booth et al., 2014; Caird et al., 2011).

Other Key Independent Variables

In this analysis, we are also interested in how race/ethnicity, immigrant generation and peer networks shape the relationship between adolescent obesity and later attainment. Race-ethnicity, one of our key variables, is represented by four dichotomous variables representing African-American, Asian, Hispanic and non-Hispanic white. These categories are mutually exclusive, and non-Hispanic whites were the reference category for the purpose of this analysis. It has been documented that African-Americans and Hispanics tend to be more vulnerable to the adverse effects of childhood obesity that non-Hispanic whites (Griffith et al., 2011; Ogden et al., 2014; Romero et al., 2012; Sabia & Rees, 2012). *Hypothesis 2*: Following this line of research, we expect that educational attainment will be lower for African-American and Hispanic participants than for non-Hispanic whites, and race-ethnicity will mediate the relationship between weight status and educational attainment.

We are also interested in the interplay between adolescent obesity, immigrant generational status and educational attainment. We measure immigrant generation using three dichotomous variables representing first-, second- and higher generation immigrants. We define first generation immigrants as any respondent born outside the United States; we define second generation immigrants as any respondent with at least one foreign-born parent; and, we define third (or higher) generation immigrants as respondents whose parent(s) were native born. This latter category was

the reference category in our analyses. Evidence abounds that adolescent educational outcomes are associated with immigrant generational status (e.g., Baum & Flores, 2011; Gordon-Larsen et al., 2003; Portes & Rivas, 2011; Ryabov, 2009). Faced with racial discrimination, prejudice, isolation, and declining economic opportunities, contemporary second and third generation immigrants are likely to less successful than first-generation immigrants (Alba, 2005; Goel et al., 2004; Waldinger & Feliciano, 2004). *Hypothesis 3*: Therefore, we hypothesize that, first-generation immigrants will have higher academic attainment than the native-parentage group, and immigrant generational status will partially explain the association between adolescent obesity and young adult educational outcomes.

An important variable in this study is the obesity saliency index (OSI) which measures the likelihood having a friendship with an overweight or obese student conditional on the share of overweight and obese students in the school. This index was calculated as follows:

$$Obesity\ Saliency\ Index\ =\ \frac{Percentage\ of\ Friends\ Who\ Are\ Overweight/Obese}{Percentage\ of\ Overweight\ and\ Obese\ Students\ in\ School}$$

This measure was derived from friendship nominations reported by respondents at Wave 1. For each participating school, the Add Health obtained a roster of its students and assigned them identification numbers. These rosters enabled students to identify five friends of each gender (and, by implication, their weight status). We use this information to calculate the OSI, that is the relative preference for overweight and obese friends based conditional on the average weight status of peers in the school. First, we identified all overweight and obese students among the friends at the school nominated by the respondent. Then we divided this number by the number of all friends identified by the respondent. In order to calculate the percentage of overweight and obese students in each study school, we identified all overweight and obese students in the school and then divided this number by the total number of students in the school.

OSI was included in the analysis as a social network measure because the literature suggests that obesity is a social disease and social networks facilitate its epidemic (Christakis & Fowler, 2007). Having obese peers may alter a person's views on obesity and impact health-related behaviors such as diet and exercise (Cohen-Cole & Fletcher, 2008; Lakon & Valente, 2012; Trogdon et al., 2008). It is also known that adolescents tend to form friendships with similar others, thus displaying behavior known as homophily (Ryabov, 2009; Titzmann, 2014). In other words, overweight students are likely to choose one another as friends and become connected. *Hypothesis 4*: We expect: (1) to find a negative association between the friendship preference for overweight or obese students in one's school and their academic attainment in young adulthood; and (2) that OSI will mediate the relationship between weight status and educational attainment.

Control Variables

In order to avoid spurious correlation between weight status and later educational attainment, this study controls for individual- and school-level factors associated with both obesity and educational outcomes. We include individual-level controls for respondents' age and gender, parental education, parents' income, and whether respondent resided with both parents at Wave 1. Additionally, in order to account for the status of the community were the school is located, we incorporate two measures at the school-level: the percentage of minority students and average SES. The percentage of minority students was computed as the percentage of African-American and Hispanic students and was aggregated from person-level cases within each school.[2] School SES composite was constructed as the sum of the standardized scores of parent's income and education across all person-level cases within each school. This is appropriate as these two variables are

[2] We did not count Asians as minorities in this case because prior research shows that African-American and Latinos attend schools with far higher minority student enrollment than whites, while Asians attend the most integrated schools (Logan et al., 2012).

strongly intercorrelated at the school level (Pearson's r = 0.90), but not at the individual level (Pearson's r = 0.67). With the exception of age, each of these controls was measured at Wave 1.

Analytic Strategy

Given the multilevel, hierarchical structure of the Add Health dataset and the fact that the dependent variables are dichotomous outcomes, multilevel logistic regression was used as an appropriate technique.[3] Individuals were defined as level-1 units, while schools were defined as level-2 units. To account for the stratified and clustered nature of the Add Health data, we weighted all analyses and adjust standard errors for school-level clustering.

Our multivariate regression models consist of three sets of analyses (Tables 2-4) designed to predict three levels of educational attainment in young adulthood. Parallel analyses are estimated for all three educational outcomes. Model 1 documents the effects of weight status only. Model 1 is nested in models 2, 3 and 4 which add, respectively, race/ethnicity, generational status and OSI. Model 5 adds all individual-level variables, including family effects and other controls (age and gender). The final Model (6) incorporates school-level factors, percentage of minority students and school SES..

Results

Descriptive Characteristics by Weight Status

Table 1 reports sample characteristics across weight status categories. As shown in Table 1, more than 1 in 3 (37%) of young adults who were obese as adolescence held a high school degree, Moreover, Table 1 also revealed an adolescent obesity gradient with respect to college completion. For example, only 28% of obese adolescents held bachelor's degree by young adulthood, compared to 33% of overweight adolescents, and 40% of healthy weight adolescents.

[3] All analyses were performed using the STATA software. Regression coefficients were obtained using maximum likelihood estimation.

Table 1 also shows important differences in adolescent weight status by race/ethnicity. For example, although African-Americans and Hispanics comprise about 29% of young adults, they accounted for 45% of the obese and 38% of the overweight in adolescence.

[Table 1 is about here]

Further, there were noticeable differences in adolescent weight status by immigrant generation. Specifically, first generation immigrants account for just 2% of the obese and 4% of the overweight, despite comprising 6% of the young adult sample. Second-generation young adults were also underrepresented among the obese, while third (or higher) generation young adults constitute 85% of the obese and overweight as adolescents, but only 80 percent of the young adult population.

With respect to the OSI, which reflects peer network effects, Table 1 reveals a gradient such that young adults who were overweight and obese as adolescence were also more likely to have obese friends. In terms of other controls, Table 1 also shows differences in family socioeconomic characteristics by adolescent weight status. For example, parental educational attainment for obese adolescents compared to healthy-weight adolescents differed by 1.8 years. The distribution of parents' income follows a parallel pattern across weight status categories. Further, a lower proportion of obese (44%) and overweight (53%) adolescents were raised in a two-parent family compared to those who were healthy weight (60%). Thus, there is a consistent gradient for all measures of family SES by adolescent weight status, which suggests an association, and potential mediating effect between obesity and SES. The sample's sex ratio was relatively balanced with females slightly outnumbering males (by 1-4% across weight status categories). The average age of the Add Health respondents as of Wave IV was approximately 28 years. In terms of school-level measures, as shown in Table 1, obese and overweight adolescents attended lower

SES schools, as well as schools with a higher proportion of minority students than their healthy-weight counterparts.

Multivariate Analyses

Table 2 shows multilevel logistic models predicting the odds of having the lowest level of educational attainment – high school diploma or less. As shown in Table 2, the baseline model, including no other covariates, shows that young adults who were obese or overweight in adolescence are significantly more likely to hold a terminal high-school diploma. Model 2 incorporates race/ethnicity as a potential mediating factor in the relationship between adolescent obesity and young adult educational attainment. As expected, minority status (being African-American or Hispanic) was positively associated holding a terminal high school diploma, yet differences in educational attainment by adolescent weight status remain robust even after taking into account race-ethnicity.[4] Indeed, including race/ethnicity in model 2 does not significantly alter the reported effects of weight status. Notably, the associations between race/ethnicity effects and low educational attainment remain robust to the inclusion of other controls in the subsequent models.

Model 3 includes measures of immigrant generation. As shown, 1st and 2nd generation immigrants are significantly less likely to terminate their education after high school than their third+ generation counterparts, and this result remains robust for foreign-born young adults even in the full model. However, as in Model 2, the addition of immigrant generation as a predictor in Model 3, did not alter the independent effects of obesity on educational attainment.

[Table 2 is about here]

[4] In Model 2, Asians are significantly less likely to have terminated their education with a high school diploma than non-Hispanic whites. However, this association is no longer significant in Models including additional controls.

We gauge the relationship between friendship networks, adolescent obesity and later attainment using the OSI in Model 4. As shown in Model 4, preference for overweight and obese friends results in higher odds of young adults having terminated their education after high school. But again, including this variable does not significantly alter the relationship between obesity and later attainment. Thus, this result is only partially consistent with our Hypothesis 4 which predicted that OSI has a negative impact on one's educational attainment and mediates the relationship between weight status and attainment.

In Model 5, we control for family characteristics shown to be associated with young adult educational attainment in previous studies as well as for age and sex. As expected from literature (Feliciano & Lanuza, 2016; Pong & Landale, 2012), higher parental education and income was negatively associated with low educational attainment. Similarly, young adults who grew up in a two-parent household also had lower odds of terminating their education at the high school level. Strikingly, the relationship between adolescent obesity and educational attainment remains robust, and the inclusion of these controls does not significantly alter the predicted effects of obesity on educational attainment.

Finally, in Model 6, we incorporate school-level SES and race/ethnic composition. As shown, attending a school with a higher proportion of minorities increases the odds of having lower educational attainment, whereas higher school SES reduces these odds. Still, even in the full model (model 6) which controls for all individual- and school-level factors, the odds of holding a high school diploma is 13 and 20% higher for overweight and obese respondents, correspondingly, than for the healthy-weight. This finding lends significant support to *Hypothesis 1*.

Table 3 shows results from models predicting the odds of having some college education. In the baseline model, we see some evidence of reversal of the weight status effects on attainment

observed in Table 2. Specifically, the odds of having some college education are lower for young adults who were obese as adolescents than for those who were healthy weight. Further, this result remains robust across all models, even after controlling for race/ethnicity, immigrant generation, friendship networks (OSI) and other factors influencing attainment. In contrast, in the baseline model, young adults who were overweight in adolescence were more likely to have some college experience (with no degree) by age 28. However, this association does not hold across the models. Once controls are added, there is no difference between the odds of some college attendance for those who were overweight and those who were healthy-weight in adolescence.

Incorporating race/ethnicity in Model 2 reveals that African-Americans and Hispanics are less are less likely to have some college education than non-Hispanic whites (the reference category), a result consistent with prior research (Bae, Wickrama, & O'Neal, 2014; Kao & Thompson, 2003). Yet, as in Table 2, race/ethnicity does not mediate the association between adolescent obesity and young educational attainment, which is contrary to our expectations (see *Hypothesis 2*). In Model 3, 1st generation immigrants have higher odds of enrolling in (but not completing) college than their third-generation counterparts, yet the odds of attending college are not significantly different for second- and third-generation young adults. In the full model, the odds of having some college education for generation 1 are approximately 15% higher than for third generation. Further, the remaining key covariate, the OSI, was not significantly associated with some college attainment.

Parental SES, as measured by parental education and income, and school SES were also positively associated with attending (but not graduating from) college by age 28, as expected from prior research (Bankston & Zhou, 2002; Crosnoe et al., 2002; Crosnoe, 2004; Carneiro et al., 2013;

Kao & Thompson, 2003). Even after including these controls, however, the effects of obesity on some college remained strong and significant, a result consistent with *Hypothesis 1*.

[Table 3 is about here]

In Table 4 we repeat the above analyses for our final outcome, the odds of holding a baccalaureate or higher degree. As shown in Table 4, Model 1 reveals that, compared to young adults who were healthy-weight as adolescents, those who were overweight or obese individuals were less likely to hold a Bachelor's degree or higher. When race/ethnicity is included in Model 2, African Americans and Hispanics appear to be at a disadvantage vis-a-vis non-Hispanic whites in terms of college education, a finding that holds across all models. In contrast, Asian Americans have higher odds of holding a baccalaureate or higher. However, this latter result is no longer robust when additional controls are included in Models 5 and 6.

Model 3 shows that 1st generation immigrants tend to consistently outperform the native-parentage adults (generation 3) on the likelihood of getting a baccalaureate or higher degree. The effect for children of immigrants (generation 2) is less consistent across models. After controlling for family background, the probability of obtaining a college degree does not differ significantly for the second and third+ generations. As in Table 2, the OSI is significantly associated with educational attainment. Specifically, having overweight and obese friends (conditional on their availability) significantly lowers the odds of becoming a baccalaureate-holder by the age of 28. Consistent with results reported previously, parental education and income, as well as school SES, are positively associated with the odds of completing college. Nevertheless, the effect of weight status on likelihood of getting a baccalaureate or higher degree remains robust to the inclusion of controls for SES.

[Table 4 is about here]

Discussion

Considered together, the evidence presented in this article shows that obesity in and of itself drives down the odds of educational success. Together with socio-demographic predictors of educational attainment that have received abundant attention in the literature (e.g., race-ethnicity, immigrant generational status) and those that have not (e.g., socio-economic and race-ethnic composition of the school), weight status in adolescence appears to have a profound effect on one's chances of pursuing and completing post-secondary education. Specifically, we found that the odds of having some college education and of holding a baccalaureate or more advanced degree are noticeably lower for respondents who were obese as children than for those who were healthy-weight. The odds of having a bachelor's degree are also significantly lower for those who were overweight as children. At the same time, the odds of holding a terminal high school diploma in young adulthood are significantly higher for respondents falling into the top two weight status categories than for the healthy-weight. All in all, higher weight status in adolescence is associated with lower academic attainment in young adulthood.

While the results for weight status are the most substantively important, other results are worth noting. First, in line with early studies (Bae, Wickrama, & O'Neal, 2014; Kao & Thompson, 2003), we find that both African-Americans and Hispanics are less likely to be college educated and be awarded a bachelor's or higher degree. Still, these differences do not attenuate the strong association between obesity and attainment. Second, as expected, we found that first-generation immigrants tend to outperform non-immigrants in terms of attainment. We did not find, however, significant differences in the odds of being a high school graduate, having some college education or holding a bachelor's degree between second and third generations, that is between children of immigrants and U.S.-born respondents of native parentage. This finding is consistent with the

prediction of the second-generation decline hypothesis (Gans, 1992) that purports that second generation will be worse off academically and otherwise that their parents – first-generation immigrants. Third, our results indicate that having overweight or obese friends in adolescence drives down the odds of educational success. This finding lends significant support to the social network hypothesis that suggests that social networks facilitate the spread and adverse social consequences of the obesity epidemic (Christakis & Fowler, 2007). Strikingly, however, neither race/ethnicity, immigrant generation, nor the OSI (which reflects obesity within peer networks) mediated the relationship between adolescent obesity and attainment.

The ongoing obesity epidemic presents a unique challenge for the U.S. health care system. Although the precipitous pace of the epidemic is certainly a public health issue, it also has larger social implications that go beyond physical health (Anderson & Butcher, 2006; Ferraro & Kelley-Moore, 2003). We found a strong, independent relationship between adolescent obesity later and attainment, even after including additional controls. These findings point to the high social costs of obesity in terms of educational outcomes for young adults, and have implications for their later economic mobility and well-being. Adolescent obesity is indeed an academic risk factor. Academic outcomes are of high importance to individuals and to society, as a whole, given the link between educational attainment and employment opportunities in young adulthood. Academic underperformance due to obesity adds to the latent costs of the obesity epidemic, the costs which have the potential to become unaffordable unless adolescent obesity prevention is taken seriously and acted upon responsibly.

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Table 1. Descriptive Statistics of Add Health Wave 4 Respondents by Adolescent Weight Status.

		All Sample (N=12,091)	Obese (n=1,451)	Overweight (n=2,056)	Healthy Weight (n=8,584)
1	***Dependent Variables***				
2	High School or Less	20.7%	36.9%	25.4%	16.4%
3	Some College	42.8%	34.8%	40.3%	43.5%
4	Bachelor's degree of higher	36.5%	28.3%	34.3%	40.1%
5	***Race/Ethnicity***				
6	African-American	16.3%	26.1%	21.7%	12.8%
7	Asian	6.0%	0.9%	3.1%	7.3%
8	Latino	12.8%	19.4%	16.2%	11.4%
9	Non-Hispanic whites	64.9%	53.6%	59.0%	68.5%
10	***Immigrant Generation***				
11	Generation 1	6.8%	2.8%	4.3%	7.4%
12	Generation 2	12.7%	8.1%	9.4%	11.8%
13	Generation 3	80.5%	89.1%	86.3%	80.8%
14	***Network Factor***				
15	Overweight Saliency	0.39	0.46	0.41	0.37
16	***Family Socioeconomic Characteristics***				
17	Parents' Education	14.8	13.5	14.3	15.3
18	Parents' Income (in $1000)	4.9	4.2	4.5	5.2
19	Two-Parent Household	56.8%	43.6%	53.1%	59.8%
20	***Other Controls***				
21	Age	28.2	28.3	28.2	28.2
22	Gender (Male)	48.1%	46.4%	47.1%	48.7%
23	**School-Level Variables**				
24	Average SES	2.9	2.4	2.6	3.1
25	Percentage of Minority Students	25.4%	31.5%	28.6%	23.7%

Note: All variables are from Wave 1 except for age and the dependent variables, which are from Wave 4. Because the table presents weighted averages, the column totals do not necessarily add up to 100%.

Source: National Longitudinal Survey of Adolescent to Adult Health, Waves 1 and 4 (age and educational attainment)

Table 2. Odds ratios from Multilevel Logistic Regression Models Predicting Educational Attainment (Holding a High School Diploma, but No College Experience) Among Young Adults, *Standard Errors in Parentheses*.

	Models					
	1	**2**	**3**	**4**	**5**	**6**
Weight Status						
Overweight [a]	1.16 ** (0.30)	1.14 ** (0.30)	1.15 ** (0.29)	1.14 ** (0.30)	1.18 *** (0.30)	1.13 ** (0.31)
Obese [a]	1.24 *** (0.27)	1.24 *** (0.26)	1.24 *** (0.26)	1.25 *** (0.26)	1.19 *** (0.28)	1.20 *** (0.27)
Race/Ethnicity						
African-American [b]		1.15 *** (0.25)			1.16 *** (0.27)	1.12 * (0.26)
Asian [b]		0.83 *** (0.32)			0.97 (0.34)	0.96 (0.34)
Latino [b]		1.21 *** (0.30)			1.14 ** (0.30)	1.15 *** (0.29)
Immigrant Generational Status						
Immigrant Generation 1 [c]			0.71 *** (0.30)		0.82 *** (0.32)	0.82 *** (0.32)
Immigrant Generation 2 [c]			0.82 ** (0.26)		0.96 (0.27)	0.94 (0.27)
Network Factor						
Overweight Saliency				1.23 *** (0.34)	1.19 *** (0.36)	1.16 ** (0.35)
Family Effects and Other Controls						
Parents' Education					0.82 *** (0.27)	0.84 *** (0.27)
Parents' Income					0.80 *** (0.23)	0.85 *** (0.24)
Two-Parent Household					0.85 *** (0.24)	0.90 * (0.23)
Age					0.90 (0.27)	0.93 (0.27)
Male [d]					1.05 (0.24)	1.04 (0.24)
School-Level Factors						
Percentage of Minority Students						1.13 * (0.44)
Average SES						0.77 *** (0.41)
Model Comparison Test[5]		739 ***	725	743 ***	812 **	405 ***
Models Compared		1 and 2	1 and 3	1 and 4	4 and 5	5 and 6

*p<0.05; **p<0.01; ***p<0.001.

Note: Reference Categories: a – healthy weight; b – non-Hispanic white; c – generation 3; d – female.

Source: National Longitudinal Survey of Adolescent to Adult Health

[5] The test is analogous to the nested F-test for OLS regression models. It is based on the difference between the deviance statistics (defined as -2 ln likelihood function value at convergence) of the models contrasted. The model comparison test is not applicable for models that differ only in the number of level-2 factors or cross-level interactions.

Table 3. Odds ratios from Multilevel Logistic Regression Models Predicting Educational Attainment (Some College but No Degree) Among Young Adults, *Standard Errors in Parentheses*.

	Models					
	1	**2**	**3**	**4**	**5**	**6**
Weight Status						
Overweight [a]	1.11 *	1.09	1.10	1.10	1.09	1.06
	(0.33)	(0.33)	(0.32)	(0.33)	(0.34)	(0.34)
Obese [a]	0.83 ***	0.87 **	0.85 ***	0.86 **	0.89 *	0.88 *
	(0.27)	(0.26)	(0.26)	(0.27)	(0.26)	(0.26)
Race/Ethnicity						
African-American [b]		0.87 ***			0.88 **	0.86 ***
		(0.27)			(0.25)	(0.25)
Asian [b]		1.08			1.05	1.03
		(0.33)			(0.33)	(0.32)
Latino [b]		0.85 ***			0.89 *	0.90 *
		(0.27)			(0.27)	(0.27)
Immigrant Generational Status						
Immigrant Generation 1 [c]			1.24 ***		1.14 ***	1.15 ***
			(0.30)		(0.32)	(0.32)
Immigrant Generation 2 [c]			0.94		1.06	1.05
			(0.25)		(0.28)	(0.27)
Network Factor						
Overweight Saliency				1.06	0.92	0.94
				(0.33)	(0.33)	(0.32)
Family Effects and Other Controls						
Parents' Education					1.17 ***	1.14 ***
					(0.26)	(0.26)
Parents' Income					1.31 ***	1.27 ***
					(0.23)	(0.24)
Two-Parent Household					1.08	1.06
					(0.24)	(0.24)
Age					1.04	1.05
					(0.28)	(0.27)
Male [d]					0.93	0.95
					(0.23)	(0.23)
School-Level Factors						
Percentage of Minority Students						0.89
						(0.45)
Average SES						1.17 *
						(0.43)
Model Comparison Test[6]		688 ***	660 ***	187	723 ***	213
Models Compared		1 and 2	1 and 3	1 and 4	4 and 5	5 and 6

*p<0.05; **p<0.01; ***p<0.001.

Note: Reference Categories: a – healthy weight; b – non-Hispanic white; c – generation 3; d – female.

Source: National Longitudinal Survey of Adolescent to Adult Health

[6] The test is analogous to the nested F-test for OLS regression models. It is based on the difference between the deviance statistics (defined as -2 ln likelihood function value at convergence) of the models contrasted. The model comparison test is not applicable for models that differ only in the number of level-2 factors or cross-level interactions.

Table 4. Odds ratios from Multilevel Logistic Regression Models Predicting Educational Attainment (Having a Bachelors' Degree or Higher) Among Young Adults *Standard Errors in Parentheses.*

	Models					
	1	**2**	**3**	**4**	**5**	**6**
Weight Status						
Overweight [a]	0.86 *** (0.30)	0.84 *** (0.33)	0.80 *** (0.32)	1.09 (0.34)	1.09 (0.34)	0.87 ** (0.34)
Obese [a]	0.79 *** (0.26)	0.85 *** (0.25)	0.81 *** (0.25)	0.80 *** (0.25)	0.82 *** (0.25)	0.82 *** (0.26)
Race/Ethnicity						
African-American [b]		0.77 *** (0.24)		0.81 *** (0.24)	0.83 ** (0.25)	0.86 *** (0.25)
Asian [b]		1.21 *** (0.30)		1.13 ** (0.30)	1.08 (0.30)	1.02 (0.31)
Latino [b]		0.82 *** (0.25)		0.83 *** (0.25)	0.85 *** (0.25)	0.88 ** (0.26)
Immigrant Generational Status						
Immigrant Generation 1 [c]			1.26 *** (0.30)	1.25 *** (0.32)	1.24 *** (0.32)	1.20 *** (0.32)
Immigrant Generation 2 [c]			1.20 *** (0.23)	1.13 * (0.25)	1.09 (0.28)	1.06 (0.27)
Network Factor						
Overweight Saliency				0.81 *** (0.36)	0.81 *** (0.36)	0.85 ** (0.37)
Family Effects and Other Controls						
Parents' Education					1.36 *** (0.24)	1.31 *** (0.24)
Parents' Income					1.26 *** (0.23)	1.22 *** (0.24)
Two-Parent Household					1.19 *** (0.23)	1.11 * (0.24)
Age					1.10 (0.28)	1.08 (0.28)
Male [d]					0.97 (0.21)	0.97 (0.23)
School-Level Factors						
Percentage of Minority Students						0.79 *** (0.45)
Average SES						1.35 *** (0.43)
Model Comparison Test[7]		771 ***	415 ***	458 ***	323 ***	427 ***
Models Compared		1 and 2	2 and 3	4 and 3	5 and 4	6 and 5

*p<0.05; **p<0.01; ***p<0.001.

Note: Reference Categories: a – healthy weight; b – non-Hispanic white; c – generation 3; d – female.

Source: National Longitudinal Survey of Adolescent to Adult Health

[7] The test is analogous to the nested F-test for OLS regression models. It is based on the difference between the deviance statistics (defined as -2 ln likelihood function value at convergence) of the models contrasted. The model comparison test is not applicable for models that differ only in the number of level-2 factors or cross-level interactions.