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Obesity in adolescence predicts lower educational attainment and income in adulthood: The Project EAT longitudinal study

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Abstract

Objectives—Prospective associations between obesity in adolescence and adult socioeconomic outcomes, and potential mediators, were examined in a contemporary cohort.

Methods—Longitudinal data collected in 1998–1999 (Project EAT-I) and 2015–2016 (EAT-IV) were analyzed for 1796 participants who provided data at both time points. Adolescents (mean age=14.8 years) self-reported demographic and psychosocial variables (EAT-I) and follow-up outcomes (EAT-IV). Body weight and height were directly measured. Bachelor's degree or more education, income > US \$50,000, and partnered status at follow up were examined by baseline obesity (>95th BMI percentile) using logistic regression. Self-esteem, depression and weight-related teasing were examined as mediators using multivariate probit regressions. All analyses were adjusted for race, baseline age and parent socioeconomic status.

Results—Girls with obesity were significantly less likely to have achieved a Bachelor's degree (OR 0.32, 95% CI [0.18, 0.58]; $p < .001$), earn > \$50,000 annually (OR 0.57, 95% CI [0.33, 0.99]; $p < .04$) or be partnered (OR 0.45, 95% CI [0.27, 0.75]; $p < .002$) in adulthood. No associations were observed among boys. Among girls, depression mediated 8.5% and 23.6% of the association between adolescent obesity and adult education and income, respectively.

Conclusions—Adolescent girls with obesity have lower educational attainment and income and are less likely to be partnered in later adulthood. Depression may partly mediate the associations.

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Keywords

obesity; academic attainment; income; partnered status

Introduction

Childhood obesity is a risk factor for a wide range of negative social and economic outcomes (1,2). Prospective epidemiologic cohort studies have consistently observed that children with obesity have lower adult educational attainment than children without obesity (3–5). For example, in a cohort of Swedish youth, 55% of children with obesity completed > 12 years of school compared with 76% of population-based comparison children (3). In another study, among a cohort of 9754 Finnish adults, obesity in adolescence was associated with lower educational completion at age 31 years (4). A nationally representative sample of 10,039 US adults ages 16–24 years showed that adults with obesity had lower educational attainment relative to adults without obesity at 7-year follow up (5).

Childhood obesity is also prospectively associated with lower income in adulthood (6–8). However, results are not consistent, with some sex differences observed. Lower income in adulthood was observed among women and men with obesity in childhood compared with those who did not have obesity in childhood, based on data from 12,686 participants in the National Longitudinal Survey of Youth 1979–1994 (7). Income in later adulthood was 6% and 3% lower among women and men with obesity respectively (7). Data from a large cohort of 145,193 Swedish men showed that obesity and overweight in young adulthood were associated with 18% and 6% lower income, respectively, 10–20 years later (6). In another study, at 7-year follow up, women with obesity had lower household income compared with women without obesity (5). No association was observed between obesity and later income among men (5). Among 12,537 British adolescents, women with obesity at age 16 years earned 7% less income at 7-year follow up compared with women without obesity at age 16 yrs (9). No association between adolescent obesity and adult income was observed among men (9). Another large cohort study observed no association between obesity in adolescence and later adult income among women or men (4).

Childhood obesity is also prospectively associated with adult marital status, another indicator of social “success” that is consistently linked to positive health outcomes (4,5). For example, among a nationally representative sample of 10,039 young adults, at 7-year follow-up, women with obesity in young adulthood were 20% less likely to be married 7 years later, compared with women without obesity in young adulthood (5). Young adult men with obesity were 11% less likely to be married seven years later, compared with young men without obesity (5). Among a population-based Finnish cohort of 9,754, among women only, obesity at age 14 years was associated with not being married at age 31 years (4).

Reasons for the observed association between childhood obesity and adult educational attainment, income and partnered status are not clear, but are likely to include variables such as social discrimination against children with obesity and stronger social norms for thinness among higher income populations, especially for women (1,5–7,10,11). Cross-sectional studies have observed that children with obesity report lower self-evaluations of academic

competence, lower self-esteem, feelings of hopelessness and feeling less social connectedness, compared with children without obesity (12–17). In a study of 4742 male and 5201 female 7th, 9th and 11th grade students, girls with obesity were more likely to report being less likely to hang out with friends, greater feelings of hopelessness, a suicide attempt during the past year, and being held back a grade, compared to girls without obesity. Boys with obesity were more likely than boys without obesity to report being less likely to hang out with friends; having a serious problem in the last year; that their friends don't care about them; that they were poor students and that they expected to quit school (14).

The present study prospectively examined the association between childhood obesity and educational attainment, income and partnered status in young adulthood. It examined potential important mediators of the association, including depression, self-esteem and weight-related teasing. It was hypothesized that children with obesity in adolescence would have lower educational attainment and income and would be less likely to be partnered in young adulthood, compared with children without obesity in adolescence. These effects were hypothesized to be more likely among girls than boys, due to the stronger social norms for thinness applied to women compared with social expectations for men. Mediators were examined in an exploratory fashion in an effort to understand the process through which adolescent obesity might result in lower educational, income and partnered status outcomes in adulthood.

Methods

Sample and Recruitment

Data for this analysis were drawn from the population-based, Project EAT (Eating and Activity in Teens and Young Adults) longitudinal study of dietary intake, physical activity, weight control behaviors, weight status, and factors associated with these outcomes among young people. In 1998–1999 (Project EAT-I), middle school and high school students (N=4,746; mean age=14.8 ± 1.6) from 31 public schools in the Minneapolis and St. Paul metropolitan area completed surveys and anthropometric measures (18,19). Follow-up mailed assessments were conducted at five-year intervals: EAT-II (N=2,516; mean age=19.4 ± 1.7); EAT-III (N=2,287; mean age=25.3 ± 1.7); and EAT-IV (N=1,830; mean age=31.0 ± 1.6) to examine changes among participants as they progressed through adolescence and young adulthood.(20) Young adults who completed at least one of the follow-up studies at EAT-II or EAT-III were invited to participate in EAT-IV. Given the focus of the current study, the analytic sample for this paper includes 1796 participants (778 males and 1,018 females) who responded to both EAT-I and EAT-IV surveys and had measured body weight at baseline, representing 66.1% of participants who could be contacted at EAT-IV. The University of Minnesota's Institutional Review Board Human Subjects Committee approved all protocols.

EAT Survey Development and Measures

To allow for longitudinal comparisons and examination of secular trends, key items included on the EAT-I survey were retained on subsequent EAT surveys. Decisions to retain or drop items were based on their relevance to the current study aims, and the performance of

represented constructs in the peer-reviewed literature. Additions to the survey were also made to reflect the study's life course perspective and intergenerational influences on weight-related outcomes (20). The psychometric properties of survey measures were examined at each wave of data collection. Test-retest reliability for the EAT-I survey was determined in a separate sample of 161 adolescents who completed identical versions of the survey approximately two weeks apart (18,19). For the EAT-IV survey, estimates of item test-retest reliability were determined in a subgroup of 103 participants who completed the survey twice within a period of one to four weeks.

Anthropometric, demographic, and psychosocial, measures were collected in 1998–99 (EAT-I) and 2003–2004 (EAT-II). Outcome measures (adult educational attainment, household income and marital/partnered status) were collected in 2015–2016 (EAT-IV).

Adolescent obesity status—Body weight and height were measured by trained research staff following a standard protocol at EAT-I. Weight was measured without shoes and heavy clothing. Body mass index (BMI) was calculated as weight in kg/height in m². Obesity was defined as BMI>95th percentile for age and sex (21, 22).

Demographic Variables—Sex, school grade, age, ethnicity/race, parent education, parent employment status, family receipt of public assistance, and eligibility for free/reduced school meals were self-reported by students at EAT-I. A composite measure of socioeconomic status (SES) was created by using a classification and regression tree approach (23). Variables included parent education and employment status and eligibility for public assistance and free/reduced school meals. The 5-level SES variable was validated in a substudy of 902 parents, 876 of whom provided information on education, employment status, and income. The Spearman correlation for the association between parents' and adolescents' reports of SES was .67, and the weighted kappa (Cohen) was .79.

Psychosocial Variables—Psychosocial variables self-esteem, depression and perceived weight-related teasing were self-reported. Measures of these were used from EAT-I and EAT-II (with identical questions used).

Depression: Depression was measured using the Kandal-Davies scale (24, 25). Seven items were summed to measure depressed mood. For example “ During the past 12 months, how often have you been bothered or troubled by: feeling too tired to do things; having trouble going to sleep or staying asleep; feeling unhappy, sad or depressed; feeling hopeless about the future; feeling nervous or tense; worrying too much about things; changes in your appetite”. Response options were not at all; somewhat; very much. In the present sample, the alpha coefficient was 0.84 and the range was 10–30.

Self-esteem: Self-esteem was measured using the Self-Esteem scale (26). Six items were used, with response options: strongly agree, agree, disagree, strongly disagree. Respondents were asked to “Indicate how strongly you agree with the following statements: (1) On the whole, I am satisfied with myself; (2) I feel that I have a number of good qualities; (3) At times, I think I am no good at all; (4) I am able to do things as well as most other people; (5)

I wish I could have more respect for myself; (6) I certainly feel useless at times”. In the present sample, the alpha coefficient was 0.85 and the range was 6–24.

Weight-related teasing: Weight-related teasing was measured at both EAT-I and EAT-II with the following question: “How often do any of the following things happen to you? You are teased about your weight.” Response options ranged from “never” to “at least once a week”. Additionally, bother caused by weight-related teasing was measured at baseline using four questions: (1) “Have you ever been teased or made fun of by other kids because of your weight?” (2) “If yes, how much did this bother you?” (3) “Have you ever been teased or made fun of by family members because of your weight?” and (4) “If yes, how much did this bother you?” Response options and scoring for these questions was as follows: 0= not ever teased about weight; 1= not at all bothered; 2=a little bit bothered; 3=somewhat bothered; 4= very much bothered.

Outcomes in 2015–2016 (EAT-IV)

Educational Attainment: Educational attainment was assessed by asking “What is the highest level of education that you have completed?”. The response options provided were “middle school or junior high; some high school; high school graduate or GED; vocational, technical, trade or other certification program; associate degree; bachelor degree; graduate or professional degree” (Test-retest agreement=97%).

Income: Income was assessed by asking “What was the total income for your household before taxes in the past year?”. Response categories were “less than \$20,000; \$20,000–34,999; \$35,000–49,999; \$50,000–74,999; \$75,000–99,999; \$100,000 or more” (Test-retest $r=0.94$).

Partnered Status: Partnered status was assessed by asking (yes/no) “Do you have a significant other (for example, boyfriend, spouse, partner)?”. If the response was affirmative, then the respondent was also asked to indicate their relationship status. The following response categories were provided “casually dating; committed dating relationship or engaged; married; domestic partner” (Test-retest agreement=95%).

Statistical Analysis

Data for the present study included measures from the EAT-I, EAT-II, and EAT-IV surveys. The analytic sample includes those with non-missing obesity data at EAT I and non-missing outcomes at EAT-IV ($N= 1796$). Attrition from the original school-based sample did not occur at random. Therefore, in all analyses, the data were weighted using the response propensity method (27). Response propensities (i.e., the probability of responding to the EAT-IV survey) were estimated using a logistic regression of EAT-IV response on a large number of predictor variables from the 1998–1999 school-based survey. The weighting method resulted in estimates representative of the demographic make-up of the original school-based sample, thereby allowing results to be more fully generalizable to the population of young people in the Minneapolis-St. Paul metropolitan area in 1998–1999. Specifically, the weighted sample was 48.2% white, 18.8% African American, 19.4% Asian, 5.7% Hispanic, 3.4% Native American, and 4.5% mixed or other race/ethnicity. The

weighted sample was well-distributed across four categories of educational attainment: 30.1% equivalent of high school degree or less; 27.2% vocational, technical or associate degree; 29.4% bachelor's degree, and 13.3% graduate or professional degree.

Descriptive proportions and means of demographics, mediating and outcome variables are reported stratified by adolescent obesity status. For the current analysis, all outcome measures were dichotomized. Educational attainment was divided by having at least a bachelor's degree or not, household income by \$50,000 or more versus less than \$50,000, and marital status by marriage or domestic partnership versus otherwise.

The total effect of adolescent obesity on all three 15-yr longitudinal outcomes was estimated and tested with a multivariate logistic regression that allowed for correlated outcomes and controlled for race, parental socioeconomic status, and age at baseline and non-response propensity weights (27).

For outcomes where a total effect of adolescent obesity was found to be statistically significant, indirect effects were also tested. The indirect effects (mediated effects) were estimated with separate models for each proposed mediator (i.e. self-esteem, depressive mood and weight-related teasing) using multivariate probit regressions, allowing for correlated outcomes and controlling for race, parental SES and age and weighting with non-response propensities. The MODEL INDIRECT command in Mplus (Muthen & Muthen, Mplus Users Guide, 7th Edition, Los Angeles, CA, 1998–2012) was used to estimate the indirect effect of adolescent obesity on each outcome through the mediator and α (the estimated coefficient representing the relationship between childhood obesity and the mediator), and β (for the relationship between the mediator and the outcome). Standardized probit coefficient estimates describe the effects and bootstrapping is used to test statistical significance. Mediators were measured at EAT-I and EAT-II and were fit in separate analyses. The reason for this was to examine the mediator variable's potential role when contemporaneously measured with the exposure variable (adolescent obesity at EAT-I) and when measured several years after the exposure variable (at EAT-II), but prior to the measurement of the outcome variables (at EAT-IV). Mediation models using measures from the EAT-II further restricted the analytic sample to those with non-missing EAT-II mediators. All mediation analyses controlled for the baseline covariates that were included in the main model, along both the α and β paths.

All analyses were stratified by sex, since previous research showed different patterns of association by sex, and there were sex-specific hypotheses in the present study. To incorporate weighting, survey procedures in SAS software version 9.4 (SAS Institute, Inc. Cary, NC) were used for descriptive statistics. Analyses for the total and indirect effects were conducted using Mplus version 7.11, which incorporates survey weights.

Results

Descriptive Characteristics

At baseline, 13% of adolescents (mean age 14 yrs (sd = 1.8)) were categorized as having obesity (BMI > 95th percentile), with higher prevalence among boys (16%) than girls (10%)

(Table 1). Adolescents with obesity were slightly less likely than those without obesity to be white (41% versus 49%, respectively). Socioeconomic status was lower at baseline among adolescents with obesity compared with adolescents without obesity (45% versus 35%, respectively). Self-esteem was slightly lower (by approximately 0.7 points) among adolescents with obesity compared with adolescents without obesity. Depression was about 0.3 points higher at baseline among children with obesity compared with adolescents without obesity. Weight-related teasing was higher among adolescents with higher baseline weight status compared with adolescents at lower baseline weight status.

Prospective Associations Between Obesity in Adolescence and Young Adult Educational Attainment, Income and Marital Status

Prospective associations between baseline obesity status and young adulthood outcomes are shown in Table 2. In the main effects model, as well as all mediation models, all three outcomes (i.e., education, income, partnered status) were highly correlated ($p < 0.01$). With regard to education, among girls (Table 2, top), those with obesity in adolescence were significantly less likely to have achieved at least a Bachelor's degree by young adulthood compared to those without obesity in adolescence (OR 0.32, 95% CI [0.18, 0.58], $p < .001$). Boys with obesity in adolescence were no less likely to achieve a Bachelor's degree by young adulthood compared to boys without obesity in adolescence (Table 2, bottom). With regard to income, girls with obesity, but not boys with obesity, were less likely than those without obesity to earn $> \$50,000$ annually by the time they reached young adulthood (girls: OR 0.57, 95% CI [0.33, 0.99], $p = .044$). With regard to partnered status, girls with obesity were less likely to be married or partnered in young adulthood compared with girls without obesity in adolescence (OR 0.45, 95% CI [0.27, 0.75], $p = .002$). Among boys, there was no association between adolescent obesity status and partnered status in young adulthood.

Mediators of Lower Educational Attainment, Income and Partnered Status Among Adolescent Girls with Obesity

Mediation results for the impact of obesity in adolescent girls on future education and income are shown in Figure 1. Depression level at the first follow-up (EAT-II) mediated 8.5 percent of the association between baseline obesity and the attainment of a bachelor's degree (indirect effect = -0.056 , 95% CI [-0.11 , -0.003], $p=0.041$). This indirect effect was composed of a positive association between obesity and depression ($\alpha = 0.95$, 95% CI [0.24, 1.66], $p=0.008$) and a negative association between depression and education level ($\beta = -0.06$, 95% CI [-0.09 , -0.03], $p < 0.001$). EAT-II survey depression level also mediated the obesity-income relationship (indirect effect = -0.07 , 95% CI [-0.13 , -0.01], $p=0.029$), with a similarly negative mediator-outcome association ($\beta = -0.07$, 95% CI [-0.10 , -0.04], $p < 0.001$). Twenty-three percent of the total effect of obesity on income was mediated through depression at the EAT-II survey.

Mediation effects were also observed for self-esteem as measured at the baseline EAT-I survey for 12.4 percent of the effect of baseline obesity on income in young adulthood (indirect effect = -0.043 , 95% CI [-0.09 , 0.00], $p = 0.048$). Obesity and self-esteem at baseline were negatively associated ($\alpha = -1.10$, 95% CI [-1.89 , -0.30], $p = 0.007$), while self-esteem and income were related positively ($\beta = 0.04$, 95% CI [0.02, 0.06], $p = 0.001$).

Mediation of the relationship between obesity in adolescent girls and young adult marital status was not observed, nor was any mediation seen in boys for any of the three outcomes. Details of the mediation analyses for girls are reported in Table S1.

Discussion

Adolescent girls, but not boys, with obesity are at significantly higher risk of lower educational attainment, lower income and lower likelihood of being partnered 15 years later in young adulthood, compared with their peers without obesity. These findings are consistent with earlier prospective studies in population-based samples, and suggest that girls with obesity continue to experience less positive economic and social outcomes in early adulthood (1, 4, 5). Depression and self-esteem appear to be partial mediators between adolescent obesity and later adverse social and economic outcomes in young adulthood.

The present results suggest that females with obesity may be experiencing discrimination in educational, employment and social situations. The reasons for these negative outcomes for women with obesity are not clear, and few studies are available to explain the reasons for this association (1). In the present study, no such negative outcomes were observed for men with obesity. Currently, 20% of youth ages 12–19 have BMI values that categorize them as having obesity (28). Given the high prevalence of obesity in youth, it might be expected that obesity-based stigma and discrimination would be less common than in previous decades (1,7,29,30). Social awareness about the multifaceted contributing causes to obesity would also be expected to buffer against obesity-based discrimination in professional and social arenas (1,7,10,11,30, 31). The sex-specific nature of the discrimination attests to the continued challenges that women face in economic and social arenas regarding standards of physical attractiveness and these standards are being used as the basis for professional and social opportunities (6,7,11, 29,30).

It has been suggested that the lower educational and income-related outcomes experienced by people with obesity, and women with obesity in particular, may be bidirectional in cause or caused by some third variable that affects both obesity and socioeconomic status (31, 32). Others have hypothesized that the effects of obesity on lower educational attainment, income or likelihood of marriage/partnership may be due to psychosocial variables, such as lower self-esteem or depression. This theory could explain the sex-specific negative outcomes associated with obesity, given that girls and women with obesity are more stigmatized compared with boys and men with obesity (1,7,10,11,30,31). The results from the present study suggest that in girls, depression may mediate the effects of adolescent obesity on later income and educational attainment. Self-esteem may mediate the effects of adolescent obesity on later income, but the results for self-esteem were less consistent across outcomes than were those of depression. At least one previous large prospective study did not find that self-esteem at follow-up differed by obesity status at baseline (5). However, self-esteem was not examined as a mediator of the lower educational attainment and income observed among overweight women in the study (5). Perhaps it is the case that depression or self-esteem partially mediates these negative economic and social outcomes among some obese women, but not others. Other possible partial mediators warrant further research, including

discrimination and/or harassment by others regarding women with obesity in employment, educational and social settings (6,7,11,30,31,32).

There were both strengths and limitations to the current study. One important strength was the longitudinal study design, allowing for the examination of associations between obesity in adolescence and education, income, and partnered status fifteen years later into young adulthood. Another unique strength was the ability to examine mediators (i.e., depression, self-esteem and weight-related teasing) of the associations between adolescent obesity and adult education, income, and partnered status. This strength greatly advances the field, given that prior research has not prospectively examined mediators of this association. A limitation of the study was that findings from this study may not be generalizable to other more diverse populations, due to participants being recruited only from the Minneapolis, St. Paul, and Osseo, Minnesota school districts and the modest follow up survey response rate. It is possible that current obesity status contributed to the lower income and lower likelihood of being partnered in adulthood observed among women who were obese in adolescence. Residual confounding from socioeconomic status in adolescence is a potential threat to validity of the observed results. Social desirability bias may have been present for the self-reported measures included in the survey. Only a selected number of possible mediators were examined due to the questions available on the survey. While all baseline covariates were included as potential mediator-outcome confounders, time-varying covariates were not included in mediation analyses. No objective information was collected on active discrimination that may have contributed to the lower educational attainment or income outcomes observed related to baseline obesity status.

Conclusions

The present results have important implications for assessment of the social repercussions of childhood obesity. Greater public awareness of the multifaceted causes of obesity and greater public acceptance of obesity might help reduce the discrimination faced by women with obesity in educational, occupational and social settings, and might buffer against depression and lower self-esteem that may result among some adolescents with obesity.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Study Importance Questions

What is already known about this subject

- obesity in childhood is associated with lower educational attainment, income and likelihood of being partnered in adulthood
- associations are particularly consistent for women compared with men
- little is known about the mediators of this association

What does your study add?

- the association between childhood obesity and adulthood lower education, income and partnered status persists in contemporary society
- the association continues to be more pronounced in women versus men
- depression in adolescence is one mediator of the association between adolescent obesity and adulthood outcomes

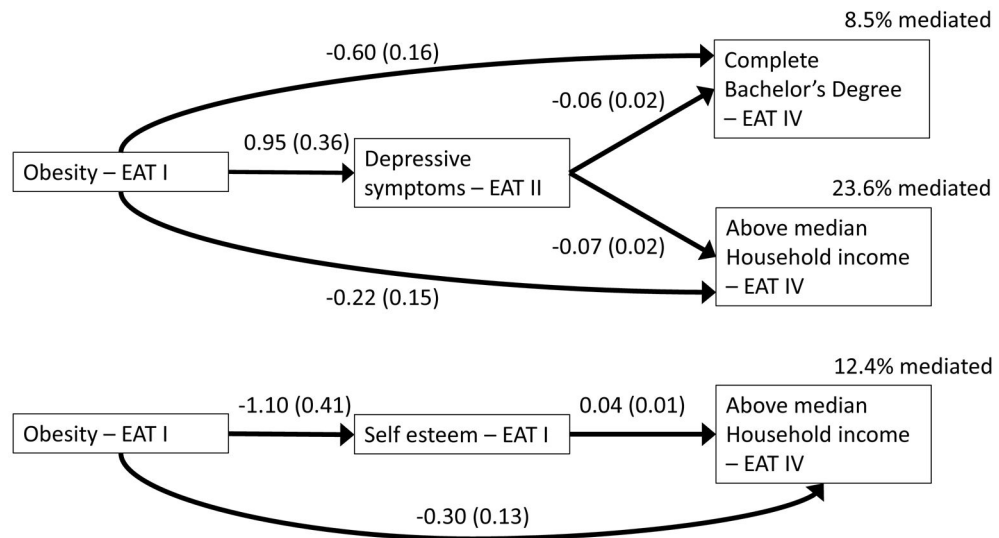


Figure 1. Mediators of the effect of obesity on education and income in Adolescent Girls to Adult Women.

Table 1

Demographic and Psychosocial Variables among Adolescents Participating in Project EAT by Baseline Weight Status

	<=95th Percentile Body Mass Index at Baseline (N=1560)		>95th Percentile Body Mass Index at Baseline (N=236)	
	Raw N/Weighted mean	Weighted %/SD	Raw N/Weighted mean	Weighted %/SD
Age at baseline EAT-I	14.9	1.57	14.7	1.93
Sex				
Female	913	49.8 %	105	40.2 %
Male	647	50.2 %	131	59.8 %
Ethnicity/race				
White	1082	49.8 %	143	41.8 %
Black	118	16.8 %	28	22.8 %
Hispanic	44	5.0 %	19	10.2 %
Asian	232	19.7 %	28	14.9 %
Other	84	8.7 %	18	10.3 %
Bachelor's degree at Follow Up				
No	692	54.2 %	151	71.2 %
Yes	858	45.8 %	85	28.8 %
Marital Status at Follow Up				
Single/dating/relationship	706	50.7 %	142	63.9 %
Married/domestic partner	844	49.3 %	94	36.1 %
Household Income at Follow Up				
Less than 20,000	100	8.1 %	29	17.1 %
20,000 – 34,999	182	15.0 %	43	19.8 %
35,000 – 49,999	233	17.7 %	46	18.5 %
50,000 – 74,999	346	22.3 %	51	22.4 %
75,000 – 99,999	275	16.3 %	31	11.6 %
100,000 or more	397	20.6 %	33	10.5 %

Table 2

Adjusted* Odds of Adult Bachelor's Degree Attainment, Being Partnered, and Income (\geq \$50,000 Annually) at Follow Up Among Adolescents with High Baseline Weight Status (BMI $>$ 95th percentile) Compared to Those with Lower Baseline Weight Status (BMI \leq 95th)

	Odds Ratio	S.E. of coefficient	95% CI	p
Females				
Bachelor's degree (yes)	0.324	0.300	[0.180, 0.583]	<0.001
Married/Partnered (yes)	0.451	0.261	[0.270, 0.752]	0.002
Household Income (\geq \$50,000 Annually)	0.568	0.282	[0.327, 0.987]	0.044
Males				
Bachelor's degree (yes)	0.909	0.244	[0.564, 1.467]	0.698
Married/Partnered (yes)	0.955	0.245	[0.591, 1.544]	0.850
Household Income (\geq \$50,000 Annually)	0.801	0.264	[0.477, 1.344]	0.400

* Adjusted for baseline race/ethnicity, socioeconomic status, and baseline age.

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