Does More Education Cause Lower BMI, or Do Lower-BMI Individuals Become More Educated? Evidence from the National Longitudinal Survey of Youth 1979

by

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ABSTRACT

More educated adults have lower average body mass index (BMI). This may be due to *selection,* if adolescents with lower BMI attain higher levels of education, or it may be due to *causation*, if higher educational attainment reduces BMI gain in adulthood. We test for selection and causation in the National Longitudinal Survey of Youth 1979, which has followed a representative US cohort from age 14-22 in 1979 through age 47-55 in 2012. Using ordinal logistic regression, we test the selection hypothesis that overweight and obese adolescents were less likely to earn high school diplomas and bachelor's degrees. Then, controlling for selection with individual fixed effects, we estimate the causal effect of degree completion on BMI and obesity status. Among 18-year-old women, but not among men, being overweight or obese predicts lower odds of attaining higher levels of education. At age 47-48, higher education is associated with lower BMI, but 70-90 % of the association is due to selection. Net of selection, a bachelor's degree predicts less than a 1 kg reduction in body weight, and a high school credential does not reduce BMI.

Keywords: BMI, education, obesity, selection,

INTRODUCTION

Compared to less educated adults, more educated adults have lower average body mass index (BMI) and a lower risk of overweight and obesity. Does this suggest that education has a *causal* effect on BMI, overweight, and obesity? Or does it suggest a *selection* process, whereby adolescents with lower BMI are more likely to reach higher levels of education?

There are theoretical arguments for both causation and selection. On the causal side, education is thought to increase individuals' "learned effectiveness" (Mirowsky and Ross, 2003), making them more likely to believe weight is within their control and more knowledgeable about behaviors that restrain weight gain. Education also leads to more secure, autonomous, higher paying work, making healthy foods more affordable (Drewnowski, 2010, 2004) and reducing the stress that can lead to emotional eating. Further, the economic security of such work frees up "cognitive bandwidth" from meeting basic needs to enable prioritization of behaviors such as a healthful diet and regular exercise (Mullainathan, 2013; Polivy et al., 2005).

Theories of selection note that low-BMI children tend to have higher grades and test scores, and better chances of completing secondary and tertiary education. This is partly because low-BMI children tend to come from socioeconomically advantaged families, but socioeconomic variables explain only half of the association between BMI and academic attainment (Crosnoe, 2007; von Hippel and Lynch, 2014). Other possible explanations include personality traits such as future orientation (Bruce et al., 2011; Smith et al., 2005; Weller et al., 2008), the cognitive benefits of physical activity on academic performance (Castelli et al., 2007; Hillman et al., 2006; Kramer and Erickson, 2007), and negative perceptions about high-BMI children and adolescents (Kenney et al., 2015) which can impair academic performance and self-concept (Crosnoe, 2007).

It can be difficult to distinguish empirically between causation and selection. Because selection depends in part on social processes that are difficult to observe, it is unlikely that covariates can control for selection fully (Lynch and von Hippel, 2016). The most persuasive attempts to isolate the causal effect of education have used designs that control for unobservables – for example, by estimating BMI differences between twins or siblings who differ in educational attainment (Amin et al., 2015; Lundborg, 2012), or by using instrumental variables derived from policies that increase educational attainment (Arendt, 2005; Kemptner et al., 2011; Kenkel et al., 2006).

Such attempts to isolate education's causal effect on BMI have produced mixed results. Some studies have found no causal effect (Amin et al., 2015; Arendt, 2005; Lundborg, 2012); others have found causal effects much smaller than a simple regression of BMI on educational attainment would imply (Brunello et al., 2013; Kenkel et al., 2006; Kim, 2016; von Hippel and Lynch, 2014); and one study found a causal effect larger than a simple regression would suggest (Grabner, 2009).

These designs are improvements over approaches using only covariates to address selection. However, limitations remain. Studies taking advantage of policy changes often have limited generalizability because relevant policy changes affect only specific cohorts and levels of education. For example, increasing the age when children are permitted to leave high school is unlikely to affect college completion. In the case of twin studies, the very fact of discordant levels of education may suggest all unobservable differences are not controlled (Gilman and Loucks, 2014; Kaufman, 2013).

A simpler approach is to use individual fixed effects (FE) to control for the selection of lower-BMI individuals into higher education (von Hippel and Lynch, 2014). This approach looks for intra-individual changes in BMI, by comparing an individual's BMI before and after a change in education status. This approach has two advantages.

Firstly, it is applicable whenever longitudinal data extend from adolescence into adulthood. Secondly, it controls for both observed and unobserved confounders of the association between education and BMI. The FE approach does not control for time-varying confounders, but these may be less concerning since the timing of educational transitions is somewhat predictable.

Using individual FEs, a recent study estimated that three-quarters of the association between educational attainment and adult BMI was due to selection, and one-quarter was due to causation (von Hippel and Lynch, 2014). That study, however, was limited to a relatively recent cohort—the 1997 cohort of the National Longitudinal Study of Youth (NLSY97)—which had only reached age 29 by the time of the study. In this study we replicate the FE analysis in data from an older cohort—the 1979 cohort of the National Longitudinal Study of Youth (NLSY79). It is plausible that selection on BMI might be less pronounced for a cohort that grew up before the obesity epidemic. It is also plausible that the causal effect of education on BMI might be larger for a cohort that has reached middle age and given the benefits of education a chance to accumulate.

METHODS

Data

The NLSY79 is a complex random sample of the non-institutionalized US population born 1956-1964. The NLSY79 oversampled Hispanics, blacks, and low-income whites, and our analyses compensate for the oversampling using sample weights. The NLSY79 also includes a military sample, which we excluded due to a limited follow-up period.

Starting at ages 14-22, NLSY79 participants were interviewed annually from 1979 until 1994, and in alternate years thereafter. The most recent data available for analysis were collected in 2012, when participants were aged 48-56 years. Our complete-case analysis included 5,521 women and 5,319 men.

Dependent variable. BMI was calculated from self-reported height and weight (kg/m^2). Height was collected in 1981, 1982, 1985, and from 2006 onwards. For respondents who were over 20 in 1985, 1985 height was carried forward until 2004; for younger respondents, 2006 height was used between 1986 and 2004. Although there is downward bias in self-reported BMI, the bias is small for adolescents and adults under 60 years (Kuczmarski et al., 2001; Sherry et al., 2007). Using thresholds defined by researchers using comparable data (Ball et al., 2009) we deleted 287 extreme values of height (<0.8 m or >2.7 m), weight (>980 lbs), and BMI (<14 kg/m^2 or >55 kg/m^2).

Independent variable. We measured education with a three level ordinal variable: less than high school diploma or equivalent, high school diploma or equivalent, and bachelor's degree or higher.

Control variables. Several variables may have relationships with both education and BMI. For example, pregnancy or marriage may cause young adults to terminate their education; conversely, young adults may choose to delay marriage and pregnancy until education is complete. Because childbearing and marriage are associated with weight gain among women (Gore et al., 2003; Teachman, 2016), these events could be either confounders or mediators of the education-BMI relationship. We therefore fitted models with and without the following time-varying covariates: marital status, coded as never married, currently married, and previously married; a binary indicator of biological, adopted, or step children in the home; and for women, a binary variable for having been pregnant. Additionally, we controlled for parental education in cross-sectional models, measured in completed years of education of the most highly educated parent.

Analytic strategy

All analyses were stratified by sex because the association between education and BMI is stronger for women, and some control variables, such as pregnancy history, only apply to women. Small cell sizes precluded stratified analysis by race/ethnicity, but descriptive figures showing BMI trajectories for Hispanics, blacks, and whites are available in the online appendix.

Our first analysis asked whether overweight adolescents were less likely to complete higher levels of education. We limited the sample to the youngest NLSY79 participants, who, in the first survey round to include height and weight (1981), were aged 17 or 18 and yet to earn a high school diploma (n=1,095 & 1,220 complete cases for women and men respectively). We used weight status at age 17 or 18 to predict educational attainment at age 47 or 48 in ordinal logistic regression models. Because few adolescents were obese (n=66) we combined overweight and obese into a single category, using age-specific International Obesity Taskforce definitions (Cole et al., 2007).

We established the magnitude of the association between education and BMI in middle age by fitting the following weighted least-squares (WLS) regression at age 47 or 48, the oldest age of observation for the youngest sample members:

$$E(BMI_i) = \beta_0 + \beta_1 noHS_i + \beta_2 bach_i + \cdots \quad (1)$$

BMI_i is the BMI of individual *i*. The variables for education are $noHS_i$ which is 1 for individuals without a high school diploma and 0 otherwise, while $bach_i$ is 1 for individuals with a bachelor's degree and 0 otherwise. The reference category is adults whose highest qualification is a high school diploma. β_1 represents the predicted BMI difference between adults with and without high school diplomas while β_2 is the difference between adults with high school diplomas and bachelor's degrees. The model was fit with sample weights, and both with and without controls for marriage, pregnancy, children, and parental education.

While model *(1)* estimates the overall association between education and BMI, this association is a product of both selection and causation. To control for selection we fit a FE model:

$$E(BMI_{it}) = \alpha_i + \beta_1 noHS_{it} + \beta_2 bach_{it} + \gamma_{17} age17_{it} + \gamma_{18} age18_{it} + \cdots \qquad (2)$$

Here BMI_{it} is the BMI of individual *i* at age *t*, and α_i is the individual FE. The time-varying $noHS_{it}$ is 1 until the high school diploma or equivalent is complete, and 0 thereafter. $bach_{it}$ is 0 until the individual completes a bachelor's degree, and 1 thereafter. Because both BMI and educational attainment tend to increase with age, we included a set of dummies for age 17, 18, etc.

FE analyses require within-individual variation in the independent variables, which these data provide. Of participants with complete data in at least two waves, 2,682 women and 2,583 men made at least one education transition, completing a high school diploma or bachelor's degree. Because of the timing of education in the lifecourse, most of these transitions occurred relatively early in the panel. Although fewer education transitions occur after about the mid-20s, it is plausible that education has cumulative effects, so that following adults into their late 40s is useful.

The standard FE model compares individuals' average BMIs before and after educational transitions. This could dilute delayed or short-lived effects. To account for this possibility, we added interactions between age and education to model (2):

$$E(BMI_{it}) = \alpha_i + \beta_1 noHS \times age\ group\ 1_{it} + \beta_2 bach \times\ age\ group1_{it} \ldots + \gamma_{17} age17_{it} + \gamma_{18} age18_{it} + \cdots \quad (3)$$

In model (3), the age groups are <30 years, 30 to 39 years, and 40 to 55 years. The omitted age-education group is individuals with high school diplomas aged under 30 years old.

One limitation of our study may be the effects of attrition. In longitudinal studies like the NLSY79, attrition is more likely among participants who are in poorer health and/or have lower socio-economic status (Fitzgerald et al., 1998; MaCurdy et al., 1998). Because those who remain in the study may differ in important ways from those who are lost to follow-up, there are concerns that attrition may result in biased estimates (Williams and Mallows, 1970). However, several studies suggest that estimates from FE analysis can have little bias even when attrition is not random (Carter et al., 2012; Deeg, 2002; Kempen and van Sonderen, 2002). With individual FE, estimates from incomplete data are often similar to estimates from multiply imputed data (Young and Johnson, 2015).

RESULTS

Figure 1 shows BMI trajectories of men and women categorized by their educational attainment at age 47 or 48, and supplementary figures 1-3 available online show these trajectories separately by race/ethnicity. These plots are 2-year moving averages because data were collected in alternate years after 1994. For women, the three education categories already have different mean BMIs at age 18. Eighteen-year-old women who will never complete high school have higher mean BMIs than women who will, and women who will only complete high school have higher mean BMIs than women who will also complete a bachelor's degree. The mean BMI difference between 18-year-old women who will never complete high school and women who eventually complete bachelor's degrees is about 1.8 kg/m^2, or 4.8 kg (10.5 lb) for a woman of average height (1.63 m). By age 48, this difference grows to 2.5 kg/m^2, or 6.9 kg (15.2 lb) for a woman of average height. This pattern suggests that about 70 percent (1.8/2.5) of the association between education and BMI is due to selection.

Men's BMIs differ less by educational group. At age 18 the average BMI of men with different educational futures differ by less than 0.1 kg/m^2, and even at age 48 men with bachelor's degrees weigh only 0.4 kg/m² less than men who never completed high school—a difference of just 1.2 kg (2.7 lb) for men of average height (1.76 m). The association between education and BMI is non-monotonic for men; at age 48, men who finished high school actually weigh more than men who did not.

Table 1 shows the proportions of 17 and 18 year olds who go on to each level of education by weight category. The difference between high school graduates and high school non-completers is almost identical for women and men: normal weight women and men outnumber overweight women and men by 3 to 1 among those who will drop out of high school, and by 7 to 1 among those who will complete high school. The bivariate association between high school completion and overweight is similar for both sexes (for women OR=0.53, $\chi^2(1)=5.3$, p=0.02; for men OR=0.62, $\chi^2(1)=3.75$, p=0.05).

When bachelor's degrees are included, however, a slight difference between the sexes emerges. Among women who will complete a bachelor's degree, the ratio of normal weight to overweight grows to 9 to 1, but among men the ratio is just 7 to 1—no higher than it is for men who complete high school.

In the ordinal logistic regression shown in Table 2, young women who are overweight have 57% lower odds (95% C.I.: 0.24, 0.76) of achieving higher levels of education than do their normal weight peers, and this is only slightly attenuated to 51% lower odds with the addition of covariates. Among young men, the odds ratio relating overweight to education attainment is nonsignificant and not far from 1. This is consistent with Table 1, which showed that although overweight young men are less likely than other men to complete high school, if they complete high school they are not less likely to complete a bachelor's degree.

Table 3 shows weighted least-squares (WLS) regressions of BMI on educational attainment at age 47-48. Women with bachelor's degrees had mean BMI 1.49 kg/m² lower than high school graduates, and the addition of control variables reduced this difference to 0.75 kg/m^2 (95% CI: -1.37, -0.14). Women without a high school diploma had mean BMI 0.82 kg/m^2 (95% CI: -0.24, 1.87) higher than high school graduates; the addition of control variables reduced this difference to 0.24 kg/m^2 (95% CI: -0.86, 1.33). Men with bachelor's degrees had mean BMI 1.40 kg/m^2 (95% CI:-1.82, -0.98) lower than high school graduates in the unadjusted model and 1.30 kg /m^2 (95% CI: -1.79, -0.82) in the adjusted model. Surprisingly, men who had not completed high school also had lower BMI than high school graduates.

These WLS results do not separate causation from selection. Table 4 shows FE results which account for the selection of low-BMI individuals into higher education, producing estimates closer to the causal effect of educational attainment on BMI. The FE results detect no effect of earning a high school diploma in either sex. For women, FE estimates suggest that the effect of completing a bachelor's degree, averaged across the ages after completion, is a reduction of 0.29 kg/m^2 (95% CI: -0.51, -0.06), or 0.38 kg/m^2 (95% CI: -0.61, -0.16) with the inclusion of covariates. These are small effects – about 1 kg (2 lb) for a US woman of average height. Among men, the FE estimates suggest earning a bachelor's degree reduced BMI by 0.24 kg/m^2 (95% CI: -0.46, -0.01) without control variables, or 0.29 kg/m^2 (95% CI: -0.51, -0.06) with control variables. These effects also correspond to less than 1 kg (2 lb) for a US man of average height.

Figure 2 shows predicted mean BMI by education at age 48, comparing estimates from the WLS and FE models.

The WLS models show a BMI difference of 2.5 kg/m^2 between the most and least educated women, which is reduced to 1.4 kg/m^2 by the addition of controls. But in the FE model with controls, the causal part of the difference is estimated to be only 0.3 kg/m^2. The fact that FEs reduce the difference from 2.5 to 0.3 kg/m^2 suggests that just over 10% (0.3/2.5) of the association between BMI and education is due to causation. Nearly 90% is due to selection.

Among men, the WLS models show a difference in BMI of 0.6 kg/m^2 between men with bachelor's degrees and men with only high school diplomas. Control variables reduce this difference to 0.4 kg/m^2. FEs with control variables suggest that the causal part of the difference is approximately 0.3 kg/m^2.

The basic FE models assume that the effect of education is unchanging over time. We relaxed this assumption by adding interactions between education and age group to the FE models. The estimated effects of education level within each age group are shown in table 5. Neither a high school diploma nor a bachelor's degree results in a change in BMI before age 30 for either sex. Differences emerge after age 30. For a woman in her 30s, the effect of having earned a bachelor's degree is a 0.32 kg/m^2 (95% C.I.:0.07, 0.56) reduction in BMI, or 0.43 kg/m^2 (95% C.I.:0.18, 0.68) in the fully controlled model. This gap increases for women after age 40, to 0.46 kg/m^2 (95% C.I.:0.16, 0.77) without controls or 0.60 kg/m^2 (95% C.I.:0.03, 0.91) with controls. After age 40, the estimated effect of not finishing high school (instead of completing a diploma) is a 0.59 kg/m^2 (95% C.I.:-1.06, -0.12) decrease in BMI in without controls, or a 0.52 kg/m^2 (95% C.I.:-0.99, -0.05) decrease with controls. The finding that dropping out of high school reduces BMI is unexpected but not incorrect according to our data and models.

Men's results follow a similar pattern. In the 30s, the estimated effect of a bachelor's degree is sensitive to the addition of covariates; the unadjusted model suggests no effect while the adjusted model estimates a 0.29 kg/m^2 (95% C.I.: 0.03, 0.54) reduction in men's BMI. After age 40, the effect of having earned a bachelor's degree is a 0.48 kg/m^2 (95% C.I.: 0.21, 0.76) reduction in BMI, or a 0.55 kg/m^2 (95% C.I.: 0.27, 0.83) reduction in the adjusted model. As for women, the effect of not completing high school on men's BMI after age 40 is in the opposite direction than expected; failing to earn a high school diploma is estimated to reduce middle-age BMI by 0.49 kg/m^2 (95% C.I.: -0.88, -0.09) before controls are added and by 0.47kg/m^2 (95% C.I.: -0.86, -0.08) with the addition of controls.

All these FE estimates are small compared to the WLS estimates, and small in an absolute sense. For women of average height, an effect size of 0.3-0.5 kg/m^2 is just 0.8-1.3 kg, or 2-3 lb. For men of average height, an effect size of 0.5 kg/m^2 is 0.9-1.5 kg—again just 2-3 lb.

DISCUSSION

Our findings suggest that, at age 48, most of the association between BMI and educational attainment is due to selection rather than causation. Causation accounts for 10-30% of the association among women. After adjustment for selection with FEs, the results suggest high school credentials do not lower BMI, while a bachelor's degree reduces BMI by 0.2-0.4 kg/m^2, or less than 1 kg (2 lb) for a man or woman of average height. Effects are delayed, with no effect detected in the 20s, and larger effects detected after age 40 than in the 30s. Even after age 40, though, effects are small and some effects are opposite to expectations; for example, after age 40, the effect of a high school diploma is to increase rather than decrease BMI.

Although we use FE models that control for selection, we may still have overestimated the contribution of causation to the education gradient in BMI. This is because the differences in BMI that were apparent at the beginning of the panel would be expected to widen over time, as those with lower initial BMI can be inferred to have slower BMI growth than those with higher initial BMI. As such, our estimates of the causal effect should be interpreted as an upper bound of the likely causal effect of education.

Our results share similarities with previous results from the 1997 NLSY cohort (von Hippel and Lynch, 2014), which was born 18-29 years later than our 1979 cohort. In both cohorts, the greater part of the association between BMI and educational attainment was due to selection, and net of selection the causal effect of educational attainment on BMI was rather small. In both cohorts, high school diplomas did not lower BMI, while bachelor's degrees had a causal effect much smaller than cross-sectional regression would imply.

There are also differences between the NLSY79 and the NSLY97. In the NLSY97, the causal effect of bachelor's degrees was larger in women than in men (von Hippel and Lynch, 2014), but in our NLSY79 results the causal effect of a bachelor's degree was similar for both sexes. In the NLSY97, selection based on adolescent BMI was observed in both sexes (von Hippel and Lynch, 2014), whereas in the NLSY79 we find selection for women only. Finally, in the NLSY79 we could follow respondents into their 40s and early 50s, whereas respondents in the NLSY97 could only be followed up to age 29 at the time of the original study, and could only be followed to age 33 if the study were repeated today.

Our results are consistent with a growing body of evidence suggesting that, although the association between BMI and educational attainment is substantial, the causal component of the association is relatively small. This finding has been replicated in different cohorts – e.g. the NLSY79 and NLSY97 – and populations – e.g. in the US and in Europe – and using a variety of robust analytic approaches – e.g. fixed effects, twin studies, instrumental variables. This body of work sits within a larger literature which examines the causal relationship between education and health more generally.

Other health outcomes have shown substantial variation in the degree to which education gradients are likely to be causal. For example, selection appears to be the dominant mechanism underlying the education gradient in self-rated health (Lynch and von Hippel, 2016), yet there is evidence that education shapes health behaviors such as smoking (Conti and Heckman, 2010). In the case of health outcomes which – unlike high BMI – typically do not manifest until much later in life, education gradients are unlikely to be explained by reverse causation. Although the causal effects of education upon BMI and obesity appear limited, there are other health benefits of being highly educated.

Education is associated with advantages not only in health but also in the labor market, with highly educated individuals less likely to be unemployed, earning higher average wages, and more likely to be in better quality jobs. Just as in health, there is a question of whether these advantages arise from the causal effects of education. Education may increase human capital and subsequently improve labor market outcomes (Becker, 1962; Schultz, 1962), or high levels of education may act as a signal of high ability, reducing employers' search costs in identifying labor market talent (Arrow, 1973; Spence, 1973). As considerable policy attention is focused on increasing educational attainment and making higher levels of education more accessible with the goal of improving a range of social outcomes, it is important that the roles of signaling and selection are understood.

Further research is warranted into the mechanisms that limit the educational attainment of young women with high BMI. One possibility is that high BMI young women are less actively encouraged by their mentors to pursue higher levels of education. Teachers rate students' abilities lower as BMI z-scores increase, after controlling for standardized test scores (Kenney et al., 2015). Young women may also internalize common negative perceptions about high-body weight. High-BMI adolescents tend to have fewer friends, more vulnerability to bullying and depression, a poorer self-image, and more pessimistic expectations for the future (Crosnoe, 2007; Falkner et al., 2001; von Hippel and Lynch, 2014). In addition to causal explanations, it may be that family characteristics are determinants of both adolescent BMI and educational attainment. However, this is unlikely to fully explain the curtailed educational attainment of high BMI young women. Our analysis controlled for two of the most likely confoudners, parental income and education. Secondly, adolescent BMI predicted educational attainment only among young women, a finding consistent with work showing women face much stronger social and economic penalties for higher body weight than do men (Caliendo and Gehrsitz, 2016; Mason, 2012).

We have concluded that the association between education and BMI is primarily due to selection. To say that an association is due to selection does not mean it is unimportant. To the contrary, the fact that young women who are overweight or obese have half the odds of attaining higher levels of education may represent an underappreciated social cost of the obesity epidemic.

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TABLES AND FIGURES

Table 1: Educational attainment by weight status in adolescence

	Women				Men			
	Less than HS	High school diploma	Bachelor's degree	Total (%)	Less than HS	High school diploma	Bachelor's degree	Total (%)
	n (%)	n (%)	n (%)		n (%)	n (%)	n (%)	
Normal weight	68 (77)	668 (86)	210 (90)	822 (86)	88 (78)	723 (85)	215 (84)	1026 (84)
Overweight or obese	20 (23)	105 (14)	24 (10)	139 (14)	25 (22)	128 (15)	41 (16)	194 (16)
Total	88 (100)	773 (100)	234 (100)	961 (100)	113 (100)	851 (100)	256 (100)	1,220 (100)

Table 2: Overweight/obesity in adolescence predicts educational attainment at age 47-48. Ordinal logistic regression.

	Women				Men			
	OR	95% C.I.	OR	95% C.I.	OR	95% C.I.	OR	95% C.I.
Normal weight (Ref.)								
Overweight (including obese)	0.43**	(0.24, 0.76)	0.49*	(0.26, 0.94)	0.95	(0.64, 1.40)	1.39	(0.83, 2.33)
Aptitude test percentile			1.06***	(1.05, 1.07)			1.06***	(1.05, 1.07)
Family income age 16 (2010 equivalent $000)			1.01**	(1.00, 1.02)			1.01**	(1.00, 1.02)
Non-Hispanic white (Ref.)								
Hispanic			2.17**	(1.23, 3.84)			1.40	(0.84, 2.33)
Black			4.93***	(2.87, 8.49)			3.03***	(1.86, 4.92)
Parental education			1.21***	(1.11, 1.31)			1.17***	(1.09, 1.26)
Ever pregnant			0.16***	(0.09, 0.29)				

*** p<0.001, ** p<0.01, * p<0.05

Education of sample members is a three-level variable with ordinal categories less than high school, high school, and bachelor's degree or higher. Parental education measures the years of education of the most highly educated parent.

Table 3. Education predicts BMI at Age 47-48: Cross-Sectional WLS Estimates.

	Women				Men			
	b	95% C.I.	b	95% C.I.	b	95% C.I.	b	95% C.I.
High school diploma (Ref.)								
Less than HS	0.82	(-0.24, 1.87)	0.24	(-0.86, 1.33)	-0.74	(-1.58, 0.09)	-0.88*	(-1.76, -0.01)
Bachelor's degree	-1.49***	(-2.04, -0.94)	-0.75*	(-1.37, -0.14)	-1.40***	(-1.82, -0.98)	-1.30***	(-1.79, -0.82)
Children in the home			-0.04	(-0.62, 0.54)			-0.02	(-0.58, 0.53)
Ever pregnant			-0.07	(-0.90, 0.76)				
Never married			2.84***	(1.93, 3.76)			-0.65	(-1.38, 0.09)
Previously married			0.10	(-0.47, 0.67)			-0.60	(-1.25, 0.05)
Parental education†			-0.28***	(-0.36, -0.20)			-0.08*	(-0.15, -0.01)

*** p<0.001, ** p<0.01, * p<0.05

† Parental education measures the years of education of the most highly educated parent.

Table 4. The Effect of Educational Attainment on BMI: Longitudinal Fixed Effects Estimates

	Women				Men			
	b	95% C.I.	b	95% C.I.	b	95% C.I.	b	95% C.I.
High school diploma (Ref.)								
Less than HS	-0.06	(-0.31, 0.19)	-0.08	(-0.33, 0.18)	-0.04	(-0.27, 0.19)	-0.04	(-0.27, 0.19)
Bachelor's degree	-0.29*	(-0.51, -0.06)	-0.38***	(-0.61, -0.16)	-0.24*	(-0.46, -0.01)	-0.29*	(-0.51, -0.06)
Children in the home			-0.05	(-0.17, 0.07)			-0.10	(-0.20, 0.01)
Ever pregnant			0.26**	(0.06, 0.45)				
Married (Ref.)								
Never married			-0.34***	(-0.51, -0.17)			-0.22**	(-0.36, -0.09)
Previously married			-0.50***	(-0.64, -0.37)			-0.51***	(-0.66, -0.37)

*** p<0.001, ** p<0.01, * p<0.05

Table 5. The Effect of Educational Attainment on BMI at Different Ages: Longitudinal Fixed Effects Estimates

	Women				Men			
	Unadjusted model†		Fully adjusted model‡		Unadjusted model†		Fully adjusted model‡	
	ΔBMI	95%C.I.	ΔBMI	95%C.I.	ΔBMI	95%C.I.	ΔBMI	95%C.I.
Age<30								
High school diploma (Ref.)								
Less than HS	0.06	(-0.2, 0.32)	0.03	(-0.24, 0.29)	0.03	(-0.20, 0.27)	0.02	(-0.21, 0.26)
Bachelor's degree	-0.06	(-0.29, 0.16)	-0.06	(-0.29, 0.16)	0.02	(-0.20, 0.24)	0.00	(-0.22, 0.22)
Age 30 to 39								
High school diploma (Ref.)								
Less than HS	-0.10	(-0.44, 0.24)	-0.06	(-0.4, 0.28)	0.09	(-0.22, 0.39)	0.11	(-0.19, 0.42)
Bachelor's degree	-0.32**	(-0.56, -0.07)	-0.43**	(-0.68, -0.18)	-0.23	(-0.48, 0.02)	-0.29*	(-0.54, -0.03)
Age ≥ 40								
High school diploma (Ref.)								
Less than HS	-0.59**	(-1.06, -0.12)	-0.52*	(-0.99, -0.05)	-0.49*	(-0.88, -0.09)	-0.47*	(-0.86, -0.08)
Bachelor's degree	-0.46**	(-0.77, -0.16)	-0.60***	(-0.91, -0.30)	-0.48**	(-0.76, -0.21)	-0.55***	(-0.83, -0.27)

*** p<0.001, ** p<0.01, * p<0.05
† Adjusted only for age ‡ Adjusted for age, marital history, presence of children in the home, and, for women, pregnancy history.

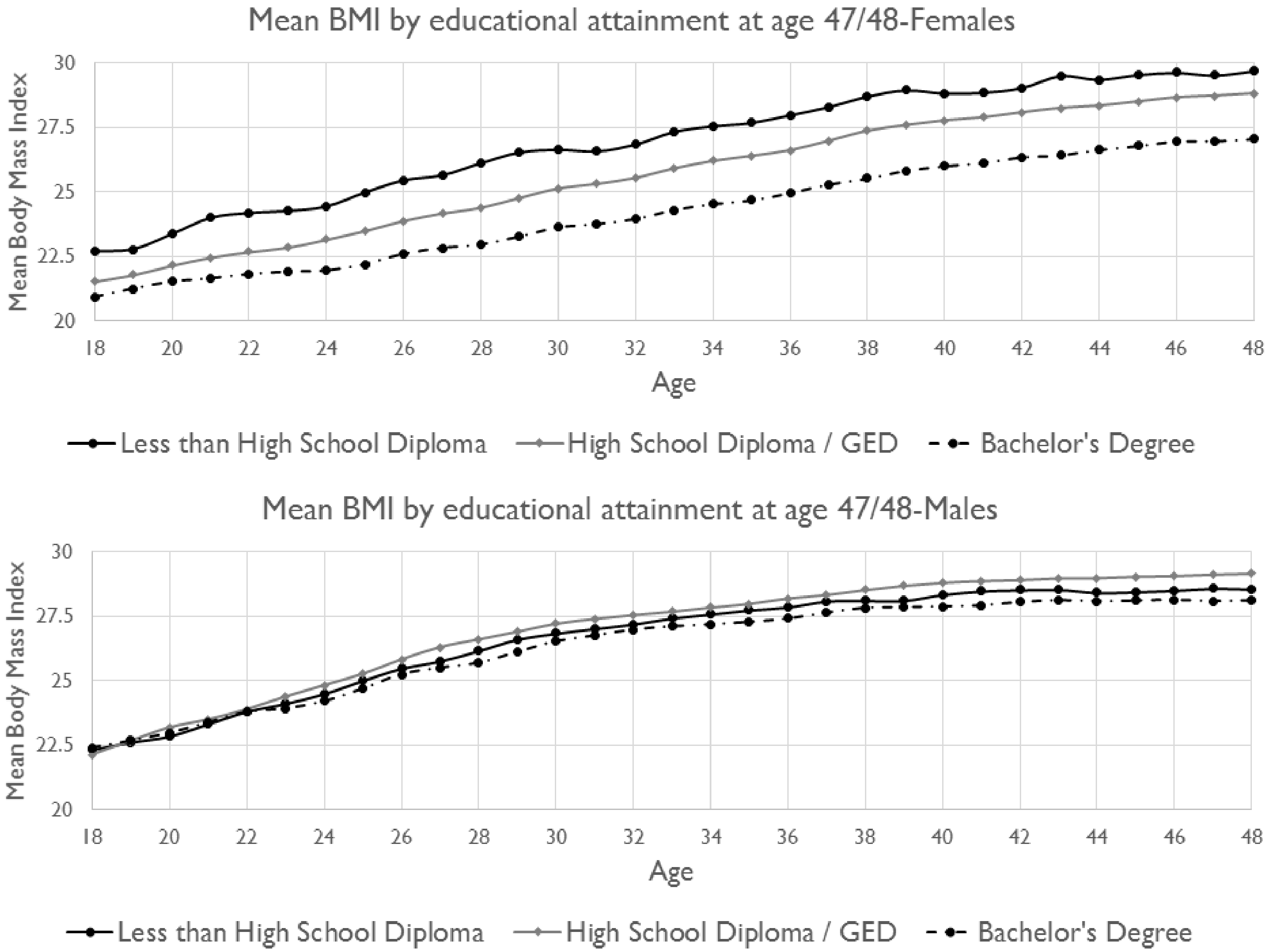


Figure 1. Retrospective mean Body Mass Index (BMI) from age 18 to 48 by highest educational attainment at age 47/48 stratified by gender. The means shown are 2-year moving averages because in later rounds participants were interviewed in alternate years.

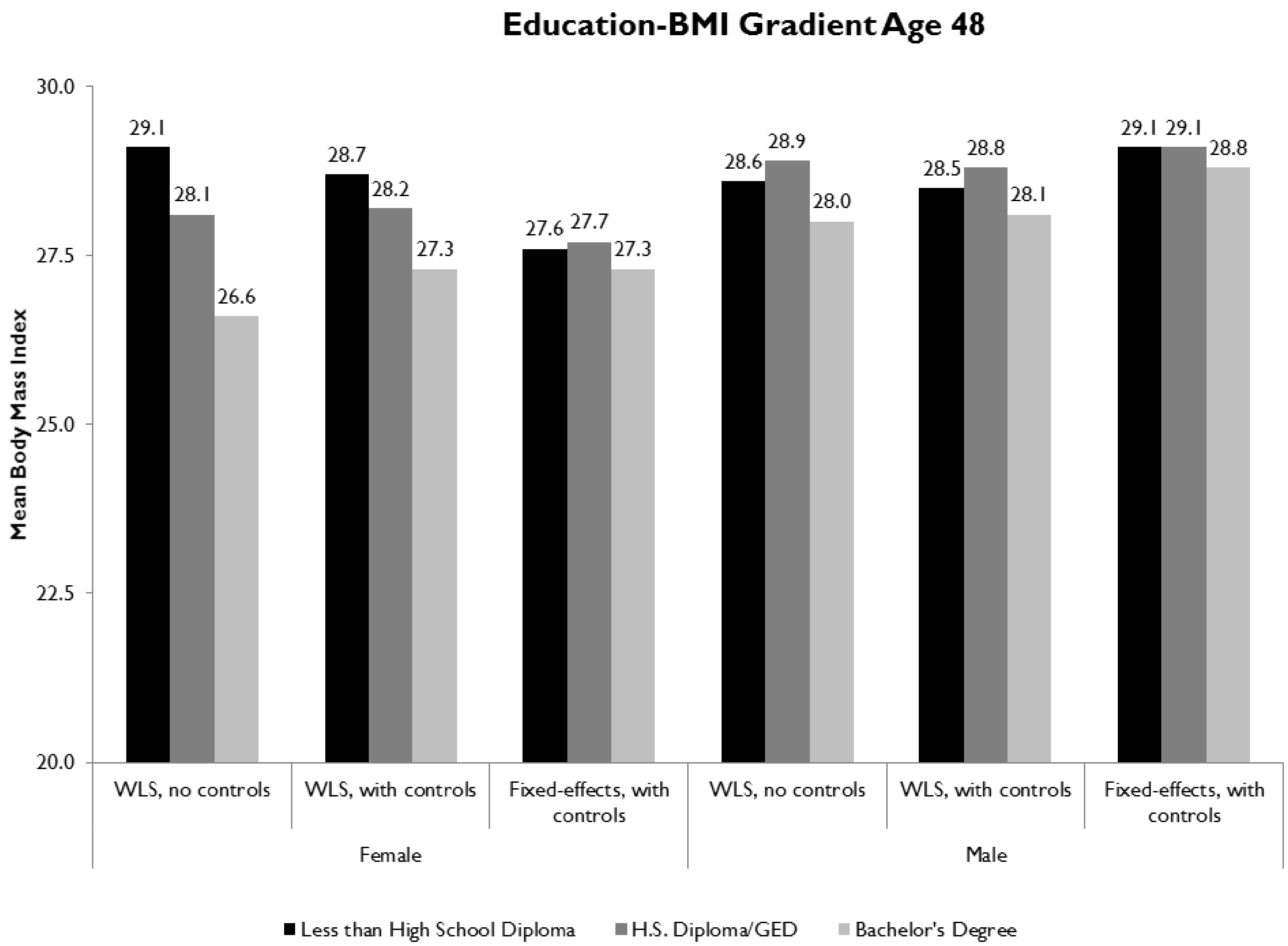
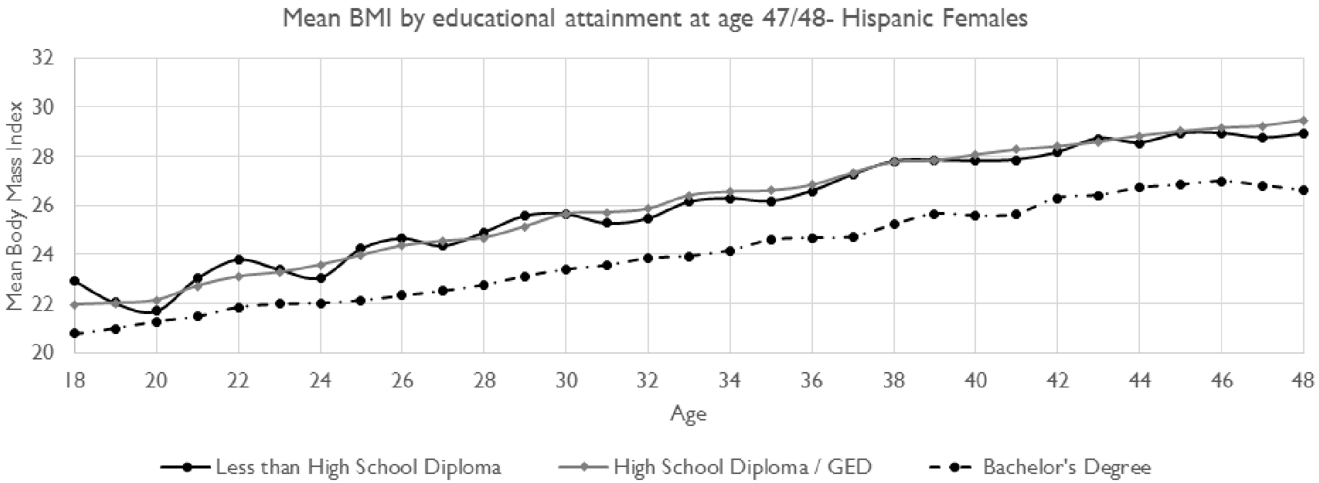
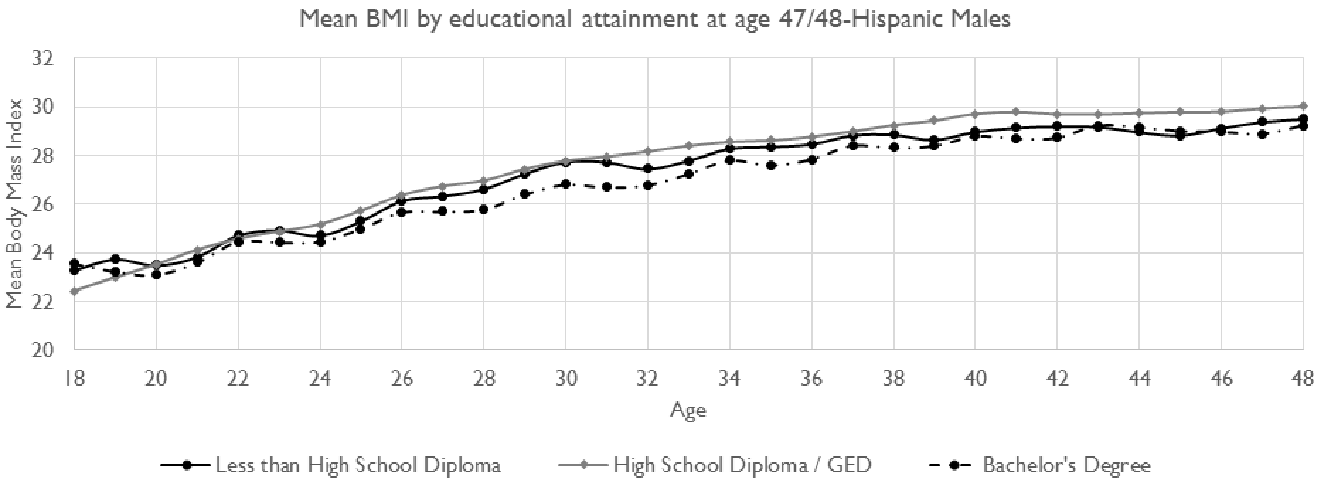


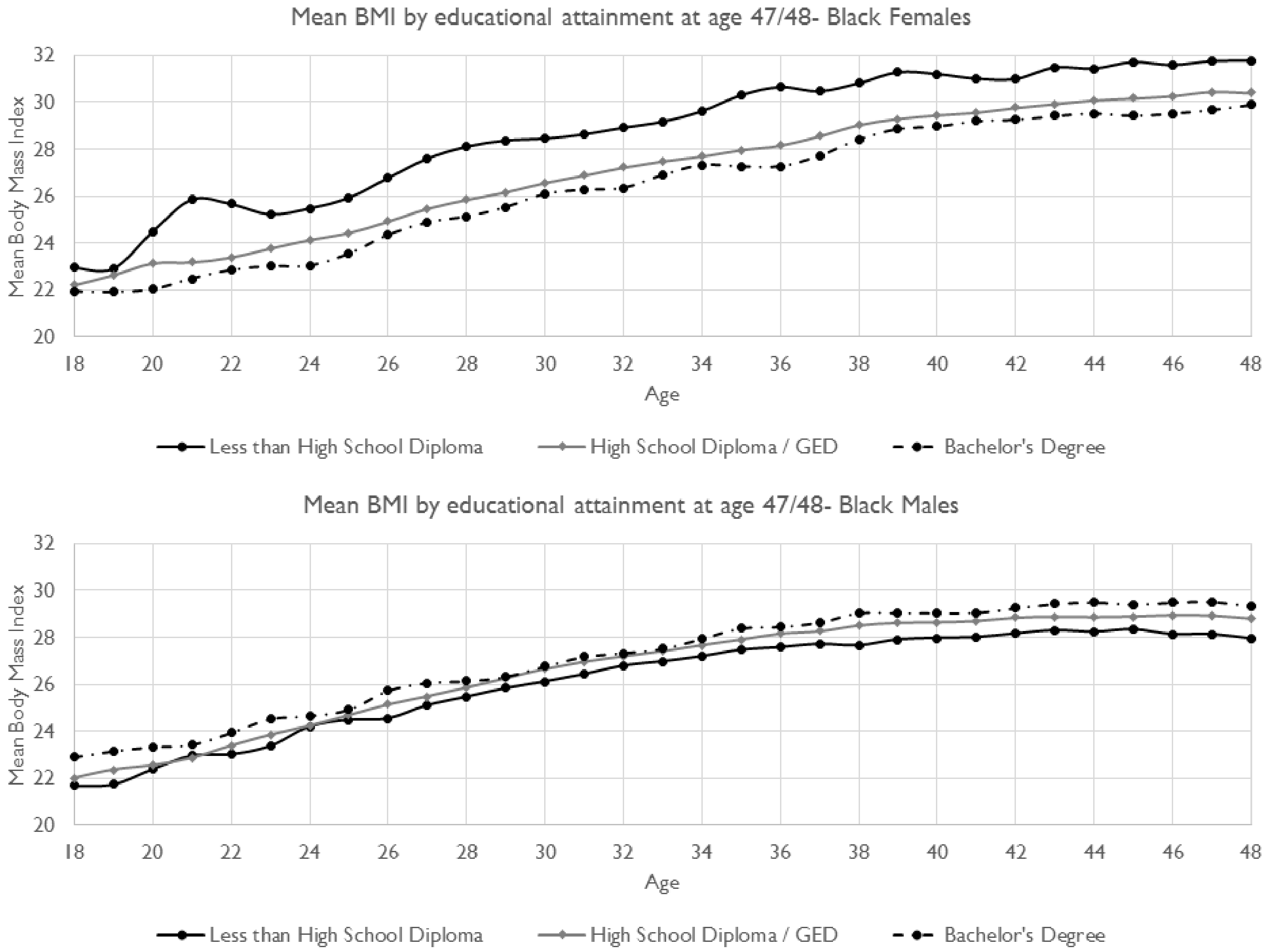
Figure 2. BMI and educational attainment, by gender, at age 48. WLS estimates without control show the association between educational attainment and BMI. Control variables eliminate the part of the association that is due to observed covariates, and fixed effects eliminate the part of the association that is due to selection.

ONLINE SUPPLEMENTARY FIGURES

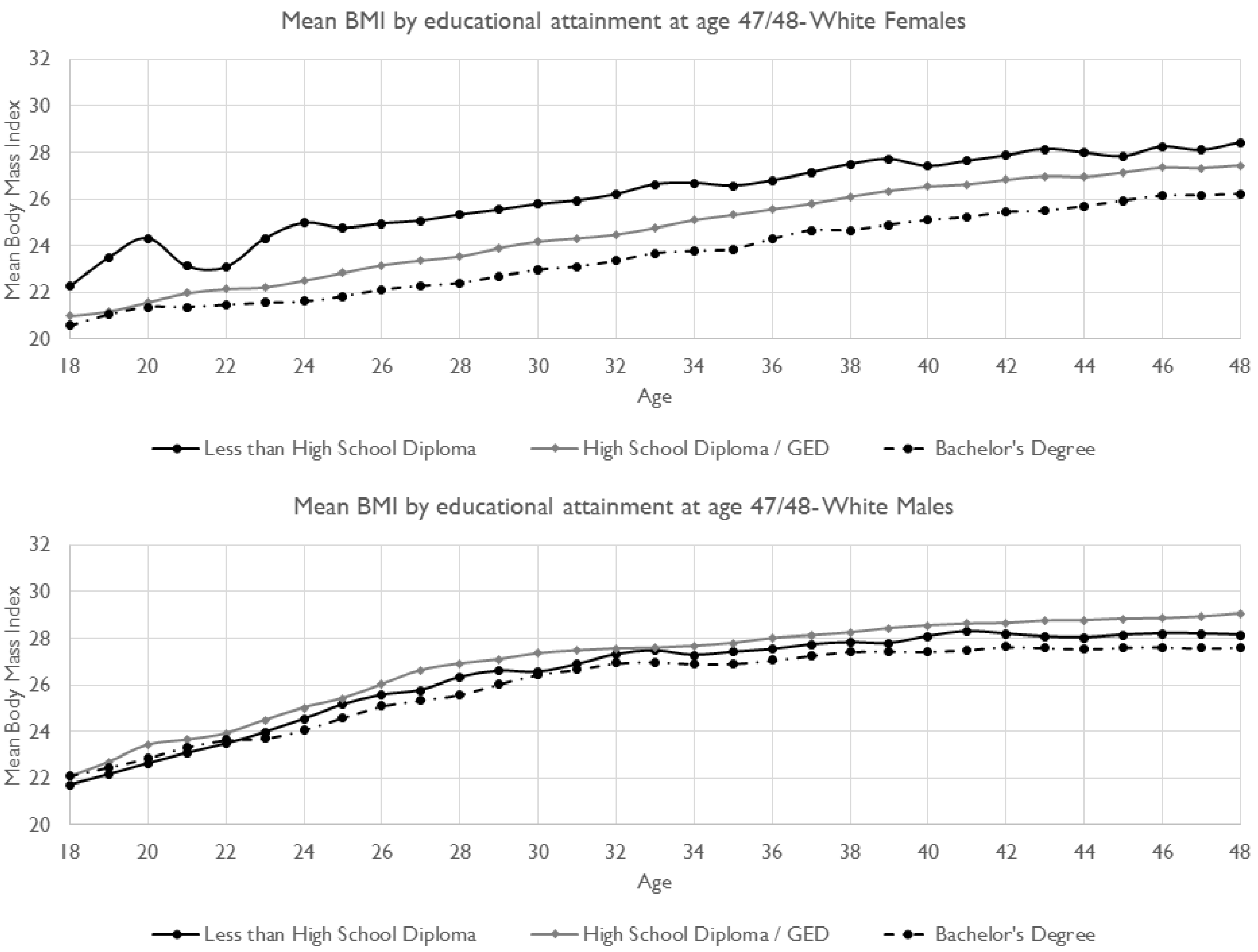




Supplementary figure 1. Retrospective mean Body Mass Index (BMI) of Hispanics from age 18 to 48 by highest educational attainment at age 47/48 stratified by gender. The means shown are 2-year moving averages because in later rounds participants were interviewed in alternate years.



Supplementary figure 2. Retrospective mean Body Mass Index (BMI) of blacks from age 18 to 48 by highest educational attainment at age 47/48 stratified by gender. The means shown are 2-year moving averages because in later rounds participants were interviewed in alternate years.



Supplementary figure 3. Retrospective mean Body Mass Index (BMI) of whites from age 18 to 48 by highest educational attainment at age 47/48 stratified by gender. The means shown are 2-year moving averages because in later rounds participants were interviewed in alternate years.