# Obesity is in the Eye of the Beholder: BMI and Socioeconomic Outcomes

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ACKNOWLEDGEMENTS
We thank Maurice Gesthuizen and Richard Breen for their comments and suggestions, and Sam Stabler, Luke Wagner, and Kate Bradley for providing superb research assistance.

This research uses data from the National Longitudinal Survey of Youth 1979 and 1997, and also data from Add Health, a program project directed by Kathleen Mullan Harris and designed by J. Richard Udry, Peter S. Bearman, and Kathleen Mullan Harris at the University of North Carolina at Chapel Hill, and funded by grant P01-HD31921 from the Eunice Kennedy Shriver National Institute of Child Health and Human Development, with cooperative funding from 23 other federal agencies and foundations. Special acknowledgment is due Ronald R. Rindfuss and Barbara Entwisle for assistance in the original design. Information on how to obtain the Add Health data files is available on the Add Health website (http://www.cpc.unc.edu/addhealth). No direct support was received from grant P01-HD31921 for this analysis.

ABSTRACT
What is the threshold for being "too fat" in the social world, and is this a static or fluid concept? We use semi-parametric methods to investigate where in the distribution of body mass (BMI) the association between BMI and socioeconomic outcomes such as wages, being married, and family income actually turns negative. We show that the relationship between BMI and outcomes is distinctively shaped by gender, race, and outcome rather than by having a BMI of 30 or higher. For white men, the association between BMI and outcomes is positive across the "normal" range of BMI and turns negative near the cusp of the overweight range, a pattern that persists across cohorts. For white women, thinner is nearly always better, a pattern that also persists across cohorts. For black men in the 1979 cohort, the returns to BMI are positive across the normal and overweight range for wages and family income and inverse u-shaped for marriage. For black women in the 1979 cohort, thinner is better for wages and marriage. By the 1997 cohort, however, there is ample evidence that the association between body mass and outcomes largely disappears for black men and women but not for white Americans. The biological and social costs of body mass cannot be conceptualized in the same way**.** The socioeconomic costs of body size are instead shaped by who is being judged, who does the judging, and in which social domain.

## Introduction

Obesity is associated with poorer health, including higher rates of diabetes, heart disease, and disability, and is often characterized as the nation's leading public health challenge (Flegal et al. 2010; Ogden et al. 2007; Solomon and Manson 1997). But the relationship between obesity and wellbeing is not just a medical and public health concern. Obesity has also been linked to poorer socioeconomic outcomes, including lower wages, family income, education, marriage rates, spousal earnings, and spousal occupational prestige (Glass, Haas, and Reither 2010; Conley and Glauber 2006; Averett and Korenman 1996). Although the direction of causality in these socioeconomic relationships is difficult to establish and findings are mixed, the existing literature suggests that women who are obese hold lower social status while obese men do not face similar disadvantages. Several studies also examine whether the relationship between obesity and social outcomes differs by race or ethnicity. If the effect of obesity on social status results in part from the socially constructed stigma of being "too fat," then what is defined as undesirably fat may differ by social group or change over time. The existing evidence suggests that the social costs indeed do differ by subgroup. Obese white women, for example, are more disadvantaged than comparably sized black and Hispanic women (Cawley 2004; Averett and Korenman 1996), a finding that is in line with broader cultural beliefs that black Americans are more accepting of larger female bodies than white Americans.

But does using the medically-based definition of "obese" make sense in the social world? Obesity is a condition defined as having excessive body fat. Because body fat is difficult to measure directly, obesity is usually approximated by body weight adjusted for height using standard cutoffs along the body mass index (BMI) (Ogden et al. 2007). The continuous BMI scale is divided into four major intervals (underweight, normal, overweight, obese) with sub-classifications of mild, moderate, and severe within these groupings.[1] Although other measures of body fat exist (e.g., waist to hip ratio, waist circumference, body volume index) these are far less commonly used in the larger research literature.

The use of standard BMI cutoffs for defining obesity makes studies comparable across topics and disciplines but the application of medically-based categories of BMI to the social world is both arbitrary and limiting. If body size has an effect on life chances, net of lower

[1] BMI is calculated as weight in kilograms divided by height in meters squared. A BMI score below 18.5 is called "underweight"; from 18.5-24.9 is "normal"; from 25-29.9 is "overweight"; and 30 and above is considered "obese."

productivity due to health limitations, this would function through the social construction of "fatness" rather than a predefined set of cutoffs along the BMI continuum (Saguy 2014). The existing standard categories do not reflect social norms about what might constitute a thin or overweight body, or how these norms might differ by social group, socioeconomic outcome, or change over time. Alternatively, there could be no penalty for being too fat per se but rather a reward for being thin. Taking a binary view of the relationship between body size and social outcomes—predefined as having a BMI of 30 versus not—ignores these possibilities.

Our study extends the existing literature by examining the relationship between BMI and three socioeconomic outcomes (wages, the probability of being married, and total family income) across the entire distribution of BMI. Rather than taking the medically-based cutoffs for being labeled as "obese" or "overweight" as given, we use semi-parametric methods to examine where the relevant cutoffs actually occur (if at all) for different socioeconomic outcomes and social groups. We study these associations separately by gender and race, and compare two birth cohorts to determine whether these associations have changed over time as the distribution of BMI has itself shifted. Our study asks: What is the threshold for being "too fat" in the social world, and is this a static or fluid concept? Does this threshold differ depending on who is being judged—or perhaps by who is doing the judging—or by social context, for example, in the labor market versus in the marriage market? This threshold for what is "too fat" or "thin enough" and how it differs by social group and domain, and changes over time, is the very thing that we should study in order to understand how body size shapes socioeconomic outcomes.

## Background

The prevalence of obesity among Americans has increased significantly over the past 30 years. From 1988 to 1994, the prevalence increased by 8%, and data for 1999 to 2000 show further increases in all age groups for both men and women (Flegal et al. 2010). This growing girth of Americans has spurred intense interest in the relationship between body size and wellbeing not only in the medical and public health literature but also among social scientists. The BMI cutoff of 30 is used internationally as a standard definition of adult obesity. The standard cutoffs are based on the association between BMI and mortality, although this association is debated (WHO 1995; Lewis et al. 2009). In general, these cutoffs allow for systematic comparison between groups and provide a way to identify groups that are at increased risk of poor health or increased mortality. The use of standard cutoffs also allows for simpler and more standard public health interventions (WHO 1995).

Although, sociologically, it might be taken as given that what counts as “too fat” or “thin enough” is socially constructed, quantitative research on the relationship between body mass and socioeconomic outcomes has not taken this perspective. Instead, the social science literature has overwhelmingly taken the medically-based categories of overweight and obese as given and used these to study categorical differences in outcomes such as wages, family income, the probability of being married, spouse’s wages and earnings, and employment and occupational attainment (Glass, Hass, and Reither 2010; Han, Norton and Stearns 2009; Finkelstein, Ruhm and Kosa 2005; Morris 2005; Baum and Ford 2004; Cawley 2004; Morris 2004; Pagan and Davila 1997; Averett and Korenman 1996; Hamermesh and Biddle 1994; Sargent and Blanchflower 1994; Loh 1993; Register and Williams 1990). A few studies have used other parametric approaches such as linear measures (Han, Norton and Stearns 2009; Norton and Han 2008; Cawley 2004; Pagan and Davila 1997), weight or weight quadratic, or log BMI (Judge and Cable 2011; Morris 2005; Cawley 2004; Conley and Glauber 2006; Maranto and Stenoien 2000). Across the entire literature, we found only one published study on the United States that uses a semi-parametric approach, applied only to wages (Gregory and Rhum 2011).

Although the categorical approach to defining obesity has been remarkably similar, the results relating this measure of body size to social outcomes cover a wide range. This is in part because of sample definitions, differences in the specific outcome studied, the ages at which these relationships have been studied, and the social groups considered. Below, we review the existing results for adults for the three outcomes we use in our analyses: wages, marriage, and family income. We first discuss the research examining the association between BMI and each outcome. We then turn to the literature on body size norms, biases, and stigma, which are important potential mechanisms linking BMI and socioeconomic outcomes, in order to motivate our approach.

*Wages*

Some studies find an obesity wage penalty for both men and women (Baum and Ford 2004; Maranto and Stenoien 2000; Averett and Korenman 1996) while others either find penalties for women but not for men, or find that the penalty is in wage growth for men rather than wage levels (Conley and Glauber 2006; Register and Williams 1990; McLean and Moon 1980; Loh 1993). Using an instrumental variables approach, Cawley (2004) finds that obesity has a significant wage penalty only for white women. One hypothesis is that wage penalties are due to the association between low socioeconomic background and obesity, although wage penalties persist even after controlling for socioeconomic background (Baum and Ford 2004; Conley and Glauber 2006; McLaren 2007). At the other end of the weight spectrum, underweight men also face a smaller but significant wage penalty (Lundborg et al. 2014).

The obesity wage penalty is not explained by health limitations but is instead tied to occupational differences, which account for more than 20% of the effect of obesity on wages for both black and white women (Averett and Korenman 1999). Similarly, the negative relationship between BMI and wages is larger in occupations requiring interpersonal skills (Han, Norton, and Stearns 2009). These effects might be driven by the experiences of those in the most severe obese categories (Obese II/III), who are more likely to report experiencing institutional and interpersonal discrimination in professional settings (Carr and Friedman, 2005).

The categorization of BMI into a binary obese/not obese contrast, however, appears to miss a key aspect of the relationship between BMI and wages. Maranto and Stenoien (2000) show that the association between wages and BMI differs both by gender and race and is best described as linear for women and quadratic for men. Similarly, using a semi-parametric approach, Gregory and Ruhm (2011) find an inverted u-shape association between BMI and men's wages. Our study extends these approaches by considering two additional outcomes (being married and family income), and using change point models to estimate exactly where in the distribution of BMI the thresholds for social outcomes might fall. We also examine whether the relationship between BMI and socioeconomic outcomes has changed across birth cohorts as the distribution of BMI has increased across the entire population.

*Marriage*

Couples match on BMI in the marriage market and converge in BMI while married (Speakman et al. 2007; Silventoinen 2003; Jeffrey and Rick 2002). Moreover, the association between being married and body weight differs by gender, race, and marital history, with never married black men and divorced white men having lower probabilities of obesity than other demographic groups (Carmault et al. 2008). Focusing in on the effect of BMI on marriage, several studies show that women who are obese are less likely to be married later in adulthood (Conley and Glauber 2006; Averett and Korenman 1996; Gortmaker et al 1993). Holding socioeconomic background constant, the findings are mixed for men with two studies finding a negative association between BMI and the probability of marriage (Averett and Korenman 1996; Gortmaker et al. 1993) and another finding no significant effect for men (Conley and Glauber 2006. Not only do obese women have lower probabilities of being married, but if they are married, their spouses earn less than the spouses of thinner women and are less physically attractive (Oreffice and Quintana-Domeque 2010; Carmault et al. 2008). For white women, the lower probability of marriage and lower spousal earnings account for the bulk of the differences observed in family income between obese and thinner women (Averett and Korenman 1999).

*Family Income*

For family income, the most consistent finding is that obesity is associated with lower family income for white women, but not for men (Conley and Glauber 2006; Chang and Lauderdale 2005; Sarlio-Lähteenkorv, Silventoinen and Lahelma 2002; Averett and Korenman 1996; Gortmaker et al 1993). Similarly, retirement-aged women who are overweight or obese have lower net worth but excessive weight predicts higher net worth for retirement-aged men (Fonda et al. 2004). There is also some evidence that body weight and family income are positively associated for black and Mexican-American men (Chang and Lauderdale 2005).

*Body Size Norms, Biases, and Stigma*

The existing literature has suggested several mechanisms through which the association between excessive weight and social outcomes could arise (McLaren 2007; Sobal and Stunkard 1989). Although overweight and obese individuals face prejudice or discrimination in multiple domains of life (Puhl and Heuer 2009; Puhl and Brownell 2001), these mechanisms may have similar or distinct effects depending on the specific domain. In the labor market, for example, excessive weight might be associated with lower productivity, which may result in lower wages or worse occupational outcomes. Employees who are obese might also have poorer health and incur higher medical costs. The existing literature has not found support for either of these hypotheses (Averett and Korenman 1996; Gregory and Ruhm 2011). Alternatively, individuals who are overweight or obese may face the double penalty of failing to meet beauty norms that reward thinness and evoking negative stereotypes that cast people who are excessively fat as lazy, less intelligent, or lacking self-control (Puhl and Heuer 2009).

Individuals may also face these biases and stigma in dating and marriage markets, although potentially less so because couples tend to match on numerous characteristics including education, income, and BMI, making marriage markets more homogenous than labor markets (Kalmijn 1998; Speakman et al. 2007). Marriage is also distinctive for having extremely high levels of racial homogamy (Kalmijn 1998), suggesting that in this domain cultural norms about weight operate across gender but largely within race. In contrast, in the labor market, differences in weight-related norms are likely to operate across both gender and race. Family income is an outcome that sits at the intersection of the labor and marriage market, and is likely to encompass a combination of these mechanisms.

The literature consistently shows that obese individuals are stigmatized, albeit with some differences by race and gender. Obese black Americans experience lower stigma than obese white Americans, regardless of gender, while obese women are more stigmatized than obese men (Hebl and Turchin 2005; Hebl and Heatherton 1998; Puhl and Brownell 2001). Men also judge obese individuals more harshly than women do (Fletcher 2014). But the existing results are inconsistent about differences in group-specific norms and biases, despite prevailing beliefs that African Americans and Latinos are more accepting of people with larger bodies than whites. Several studies find no difference in body size preferences by race-ethnicity (Allison et al. 1993; Cachelin et al. 2002; Altabe 1998) while others find whites to be less accepting of larger bodies than blacks and Latinos (Crandall and Martinez 1996; Desmond et. al 1989; Glasser, Robnett and Feliciano 2009). Individuals also have different body size ideals for their own race-ethnic group versus across race (Fletcher 2014; Hebl and Turchin 2005).

Very few studies examine whether there is a particular threshold that evokes biases, or if this threshold has changed over time. Studies show that the odds of reporting weight-based discrimination are higher for those with BMIs of 35 and higher (Carr and Friedman 2005; Carr, Jaffe, and Friedman 2008). At the same time, the literature on body size preferences reviewed above suggests that for some groups or outcomes the relevant norm may be having a thin body rather than being above a certain threshold of "too fat." This means that the thresholds for being "too fat" or not "thin enough" may depend both on who is doing the judging and in what context. For a black woman, for example, the stigma of being not thin in the labor market, where she is more likely to be judged by a white man, may be quite different than in the marriage market, where strong within-group sorting means that she is very likely to be judged by (and herself judging) a black man.

Increases in the prevalence of obesity across cohorts, especially among those groups with lower socioeconomic status, may have strengthened status distinctions by body weight, making body size more central in wage and marriage markets over time. Alternatively, as BMI has increased across all groups, the stigma of excessive weight might have declined in certain domains, suggesting weaker socioeconomic penalties than in the past. Moreover, changes over time might differ in important ways by gender and race. A large literature on gender and bodies shows that norms about thinness apply more strongly to women than to men (Bordo 1993; Sobal and Stunkard 1989), and thus may change more slowly for women than men. Extending these ideas to the intersection of gender and race, the literature reviewed above suggests a potentially more nuanced interaction, with persistence or even increasing norms of thinness for white women but weaker norms or faster change for black women. The central point of departure in this study is that the association between BMI and socioeconomic outcomes is likely to depend on social context—who is being judged in what context and by whom—rather than on a predefined cutoff on the BMI scale.

Broader life course mechanisms may also link BMI and socioeconomic outcomes. Family socioeconomic status, for example, may be a precursor of both early adulthood BMI and outcomes such as wages or marriage. BMI is also correlated across the life course (Ferraro et al. 2003) making it is possible that outcomes in adulthood are anchored to characteristics from much earlier in the life (Crosnoe 2007; Sargent and Blanchflower 1994). Alternatively, BMI from adolescence might mediate patterns in adulthood (Carr and Friedman, 2006; Carr and Jaffe, 2012). Our study takes a narrow life course view by focusing only on the relationship between BMI in early adulthood and socioeconomic outcomes measured seven years later.

## Analytical Approach

### *Data*

The analyses use two nationally representative birth cohorts of Americans from the National Longitudinal Surveys of Youth in 1979 (NLSY-79) and 1997 (NLSY-97). The NLSY surveys include detailed longitudinal information on employment, wages, marriage, fertility, education, and family income, and are similar in design across cohorts. The 1979 sample includes respondents who were ages 14 to 22 when first surveyed in 1979. The 1997 sample includes respondents who were 12 to 17 when first interviewed in 1997. In order to make the cohorts comparable, we exclude the military and poor white oversamples from the 1979 cohort but retain the oversamples of black youth. Because the Hispanic samples are too small to analyze separately, we omit this group and restrict our analyses to black and white respondents. We conduct all our analyses separately by race, sex, and birth cohort. Our analytic sample includes 5,890 respondents from the 1979 cohort and 6,082 respondents from the 1997 cohort.

In order to ensure the correct time ordering of BMI to outcomes, and keep our study comparable to the existing literature, we measure BMI in early adulthood and use this early measure of BMI to predict outcomes seven years later, when respondents are in their late 20s and early 30s. This approach has the advantage of reducing confounding and reverse causality between BMI and socioeconomic outcomes at the cost of ignoring potential changes in BMI during the 7-year gap that might inform these outcomes.[2] We restrict the analyses to respondents ages 19 and older so we do not confound adolescent and adult BMI measures. BMI classifications and distributions for adolescents are different than those for adults, and the two distributions do not converge until age 19 (Gordon-Larsen 2004, CDC 2000). The height and weight information in these datasets are self-reported. We checked the sensitivity of our results to using self-reported height and weight information by replicating a subset of our results using a different dataset that has both measured and self-reported weight. We describe these analyses below in the section on sensitivity checks.

Appendix Table A1 shows the full distribution of BMI across the two samples. At ages 19 to 24, most respondents in the 1979 cohort had BMIs concentrated in the normal range. Because the 1979 cohort has very few respondents with BMI values above 35 and we use statistical methods that can be sensitive to extreme outliers, we restrict our analyses for this cohort to respondents with BMIs between 17 and 35. This omits 0.8% of the 1979 sample at the low end of the distribution (n=45) and 1% of the sample at the top end of the BMI distribution (n=60). The 1997 cohort had higher BMIs in early adulthood, which reflects the increase in BMI

[2] The contemporaneous relationship between BMI and wages may also be bidirectional. BMI may cause one to earn lower wages, but lower wages might cause one to depend on cheaper, higher calorie foods, which in turn could increase BMI.

in the national population. At ages 19 to 23, the 1997 cohort has BMIs concentrated in the normal and overweight range. For this cohort, we censor BMI at 17 and 40 (rather than 35) in order to keep the censoring at the upper part of the distribution similar to the previous cohort. This omits 0.4% of the 1997 sample at the low end of the distribution (n=23) and 2% of the sample at the top end of the BMI distribution (n=129). Our substantive results do not change, however, if we instead censor the 1997 cohort at a BMI of 35 or even 45. Similarly, our substantive results do not change if we extend the 1979 cohort to a BMI of 40, although this introduces substantial uncertainty in the results for the top of the BMI distribution because there are very few respondents in this range in the 1979 cohort.

In order to maintain as many cases as possible and to help adjust for measurement error, we construct the baseline measures of BMI using an average across two waves. For the 1979 cohort we use an average of BMI measured in 1981 and 1982 and for the 1997 cohort we average BMIs computed from the 2003 and 2004 waves. When a respondent has only one measure of BMI available across the two waves, we use that value as the baseline measure. For simplicity, we call these average baseline measures "BMI in 1981" and "BMI in 2003." We measure outcomes seven years later, in 1988 and 2010, respectively, when respondents were ages 26 to 31. These two cohorts are separated by 22 years, and straddle the increase in the distribution of BMI documented in the United States.

We study the relationship between body mass and socioeconomic outcomes across two domains: work and marriage. The outcomes include wages, the probability of being married, and total family income. Wages are measured as log hourly wages reported for the respondent's current job at the time of the interview in 1988 or 2010. We convert the 2010 values to 1988 dollars so that values across cohorts can be compared in real terms. We analyze the probability of being currently married from the respondents' marital status in 1988 or 2010 for those who were never married in the baseline year when BMI is measured (1981 or 2003). Total family income is an NLSY-constructed variable that combines the incomes of household members related to the respondent by blood or marriage.[3] We recode respondents with a family income of zero to a value of $5 and use log family income as our dependent variable (rescaled to 1988 dollars). Our substantive results do not change if we omit those with zero family income from

[3] This variable is "net" family income in NLSY-79 while it is the "gross" family income in NLSY-97. The surveys top coded this variable at $100,001 in 1988 and to $290,810 in 2010.

the sample (N=47 in NLSY-79 and N=115 in NLSY-97 cohort), and BMI is not associated with having zero family income.

Wage and marriage outcomes depend on other characteristics that are correlated with BMI such as education, occupational characteristics, and region of residence. Omitting these variables from the analyses may overstate the association between BMI and outcomes. On the other hand, if these characteristics are themselves caused by BMI then including them as controls will bias our results. We have conducted all analyses both with and without controls for education, occupational characteristics, and region, and the results are substantively the same. Below, we report the results with the background factors included.

The results reported below control for education, the percentile score on a test of cognitive skills (Armed Forces Qualification Test (AFQT) in NLSY-79 and the Armed Services Vocational Aptitude Battery (ASVAB) in NLSY-97), age in single year categories, urban/rural residence, region of residence, and metropolitan statistical areas (SMSA).[4] The models with wages as dependent variables also control for years of work experience and occupational sector, using a collapsed six-category Census occupation coding for 1980 and 2000. These categories are (1) managerial, professional; (2) technical, sales, administrative; (3) service; (4) farming, forestry, fishing; (5) skilled crafts/construction; and (6) operators/laborers. The models for family income include an additional control for whether the respondent was living with at least one parent. All covariates are measured in the same year as the outcomes (1988 or 2010), except for scores on standardized tests of cognitive skills, which were administered in 1980 and 1997, respectively.

In each cohort, we analyze outcomes separately for each of the four social groups (white men, black men, white women, black women). Table 1 shows sample statistics for the variables used in the analyses, stratified by social group, for those with valid information on wages. The sample sizes for each outcome differ depending on the valid responses available for each outcome and are shown in Table 2, which is discussed in the Results section.

*Methods*

[4] The ASAVAB data are missing for about 17% of the NSLY-97 sample. BMI is not associated with having a missing value on the ASVAB variable. Below, we report on sensitivity analyses that confirm that our results are robust to this sample selection.

Rather than measuring the relationship between BMI and social outcomes using a set of predefined cutoffs, we examine these associations across the full distribution of BMI. We first use semi-parametric locally weighted least squares, controlling for covariates, to relate BMI to each social outcome (Yatchew 1998). This allows us to trace out the relationship between each social outcome and BMI, across the distribution of BMI. The approach is an extension of bivariate locally weighted regression.

The semi-parametric model is estimated using the following regression:

(1) $Y = f(BMI) + X\beta + \varepsilon$,

Where f(BMI) is assumed to be a smooth nonparametric function with bounded first derivatives, $X\beta$ is a vector of control variables that enter linearly, and $\varepsilon$ is an independent and identically distributed mean-zero error term. The method works by first ordering the observations from the smallest to largest value of BMI. All the variables of the first two observations are then differenced and this difference becomes the first observation of a "new" dataset. Next, observations 2 and 3 are differenced, and then 3 and 4 are differenced, and so on, and each time the difference is kept as an observation in the new dataset. The idea is to compare cases that are very close in BMI values but may differ on the other covariates. Using these first-differenced observations, the outcome is regressed on all covariates except BMI. This regression gives unbiased estimates of the coefficients for the control variables, $\beta$ in equation (1).

These coefficients are then used to net out the association between the control variables and the original dependent variable:

(2) $Y - X\hat{\beta} \approx f(BMI) + \varepsilon$

The difference on the left is the original outcome residualized with respect to the control variables (but not BMI). This residual is then used in a standard bivariate locally weighted regression model with the original BMI variable. When $\hat{f}(BMI)$ is added back to the mean value of the original dependent variable, this traces out a semi-parametric curve of the relationship between each socioeconomic outcome and BMI, net of set of covariates, in the original metric of each outcome. We then bootstrap these regressions to trace out a 95% confidence interval around these semi-parametric curves.[5]

The curves traced out by locally weighted regression depend on the bandwidth used for setting the local window in which the relationships are described. Because we use these semi-parametric curves as a way of visualizing how the patterns across the entire distribution of BMI map to those between the standard thresholds (18.5, 25, 30), we choose narrow bandwidths for displaying our semi-parametric graphs. We use a bandwidth of 0.2 for whites and 0.3 for blacks, which given the differences in sample sizes by race, produce similarly detailed curves for the groups. This level of detail ensures that the relationships around specific thresholds are measured close to that actual location, rather than being averaged with BMIs that are further away.

Locally weighted regression is an extremely flexible descriptive tool but it does not say anything precise about the association between BMI and a given outcome. In order to quantify these relationships, we use change point models to estimate the slopes and curvature in the relationship between BMI and each outcome (Hall et al. 2000; Bhattacharya 1994; Zacks 1982). This approach is an extension of a standard linear spline specification in which the locations of the "knots" are empirically derived using maximum likelihood. This allows us to estimate empirically where the association between BMI and a given outcome changes direction or becomes steeper or flatter. We estimate models that allow for up to two change points (three different slopes) and then use likelihood ratio (LR) tests to determine whether the two change point model fits the data better than the single change point model. We again bootstrap to get 95% confidence intervals for the change points and slopes reported.

We also use LR tests to assess whether the single change point model fits better than a line with a single slope. This is a test on 2 degrees of freedom: the change point and two slopes versus single slope. The simple line with only one slope is nested in the a model with one knot and two slopes, which is in turn nested in a model with two knots and three slopes. We use this series of LR tests to determine the best-fitting specification to describe the relationship between BMI and each socioeconomic outcome.

Our approach and findings are descriptive. Our results describe correlations rather than causal relationships and we interpret them only in this way. These descriptive results, however,

[5] We do not show coefficients from these regressions because our interest is the relationship between each outcome and f(BMI), net of a set of basic controls, rather than the association between the controls and the outcomes (β).

are an essential part of understanding the relationship between BMI and socioeconomic outcomes. Before we can estimate the causal effect of BMI on socioeconomic outcomes, we must know whether taking a binary view of bodies as simply having a BMI of 30 or higher is a reasonable assumption for studying outcomes in the social world.

## Results

Figure 1 to Figure 4 show the semi-parametric regression results for the relationship between BMI in early adulthood and wages and the probability of being married measured seven years later, adjusting for covariates. To condense our results, we omit the semi-parametric figures for family income (these are available as online supplementary material). The figures include dotted vertical lines showing the standard BMI cutoffs for being "underweight" (<18.5), "normal" weight (18.5-24.9), "overweight" (25 to 29.9) and "obese" (30+). Table 2 shows the results for the accompanying set of change point models for both cohorts. Although our discussion of the results integrates the information shown in the figures and Table 2, it is important to remember that the semi-parametric regressions and the change point models are two unrelated statistical approaches. The change point models do not trace out the semi-parametric curves shown in the figures. Instead, these models fit two or three-piece linear splines in which the knots (change points) are estimated empirically. We first describe the results for the 1979 cohort so that we can compare patterns across outcomes within cohort, and then turn to changes across cohorts by describing the results for the 1997 cohort.

### *1979 Cohort Wages*

Figure 1 shows the semi-parametric regression results for the relationship between BMI in 1981 and log hourly wages in 1988. For white men, wages increase as BMI increases across the underweight and normal ranges, with the curve peaking at the cusp of the overweight weight range. The change point model results summarized in Table 2 show that wages peak for white men at a BMI of 25.1, with a 95% confidence interval from 20.8 to 25.8. Each one-unit increase in BMI from 17 to 25.1 is associated with an increase in log hourly wages of .031. In contrast, the wages of white men decrease across the entire overweight and obese ranges with a slope of -.034. The LR test result shows that we can reject the hypothesis that a simple line fits this pattern. White men's wages begin to decline not only before the standard cutoff for obesity, but at the start of the overweight range. The confidence interval for the change point straddles the normal weight range. Moreover, wages *increase* as BMI increases across the normal BMI range. This suggests that white men are disadvantaged both when they are quite thin and when they are corpulent. For this group, log wages are highest at the upper end of the normal weight range.

For black men, the non-parametric results suggest that the relationship between BMI and log hourly wages is also inverted u-shaped, although the rise across the normal range is not as steep and the peak not as distinct as it is for white men. The curve is upward sloping across the normal and overweight range. The change point model results show, however, that a simple upward sloping line captures the pattern as well as the nonlinear model (LR test of the null hypothesis that a line fits at least as well as the nonlinear model has p-value of .124). When we fit this simple line, it has a slope of .011 ($p<.075$). Figure 1 shows that the support for this positive association between BMI and wages for black men comes from those with BMIs between 20 and 27—the semi-parametric curve rises steadily across the normal and overweight ranges—rather than from BMIs above 30.

The relationship between log hourly wages and BMI is much different for women than it is for men. For white women, Figure 1 shows a flat relationship across the normal and overweight range and then a decline that begins at a BMI of about 31. The change point model estimates a flat slope from a BMI of 17 to 31.5 and then a negative slope (-.125) from 31.5 to 35.[6] The LR test results show that this two-slope specification fits the data better than a simple line. The results for white women in the 1979 cohort are consistent with the idea of an "obesity penalty." The association between BMI and wages appears flat until the top of the BMI distribution. Starting at a BMI of about 32, white women's wages show a linear decline with each additional unit increase in BMI.

For black women, log wages rise from the underweight range up to a BMI of 21, then decline across the remainder of the distribution of BMI. The change point model estimates a slope of .055 from a BMI of 17 to 20.7, and a downward slope of -.011 from a BMI of 20.7 to 35. The change point itself has a wide confidence interval from 18 to 31.6. This suggests that, although we cannot tell precisely where the curve turns from positive to negative, the interval where it turns covers little of the obese range. The LR test rejects the hypothesis that a simple line fits the data. Although black women do not have the same sharp decline in wages in the

[6] The lower bound of the confidence interval is wide because the curve is a flat line in the first interval.

obese range as observed for white women, the negative association between BMI and log wages across the normal and overweight range is inconsistent with the idea that black women are less penalized for having larger bodies than white women. The negative association between wages and BMI for this group begins at a threshold of BMI that is quite thin.

*1979 Cohort Marriage*

Figure 2 shows the results for the probability of being married for the 1979 cohort. For white men, the probability of being married increases across the underweight and normal ranges, then decreases across the overweight and obese ranges. The change point results show that a one-unit increase in BMI is associated with an increase of 0.028 in the probability of being married up to a BMI of 23.3, and then a decrease of -.018 from a BMI of 23.3 to 35. Black men in this cohort display a similar pattern. For blacks, the probability of being married increases up to a BMI of 26.7, and then decreases from a BMI of 26.7 to 35. Regardless of race, the results for marriage show a positive correlation between body mass and being married for thin men, with the association turning from positive to negative near the threshold of the overweight range.

In contrast, for women in the 1979 cohort, the relationship between BMI and the probability of being married is adequately captured by a simple downward sloping line. For white women, the slope of this line is -.019, while for black women the slope is -.011. For both black and white women, the probability of being married is highest at very low BMIs and declines steadily thereafter. These results show no evidence for an obesity penalty in marriage, nor do they support the idea that black men are more accepting of larger women than white men. Instead, the evidence suggests that a consistent beauty ideal of thinness prevailed in the domain of marriage for both white and black women for the 1979 cohort.

*1979 Cohort Family Income*

For white men, BMI and family income have a positive association across the normal range, and this association turns negative in the overweight and obese ranges. The change point model estimates that the association turns from positive to negative at a BMI of 27. The estimated slopes on either side of the cut points have the opposite sign but are about equal in magnitude (.04 and -.036, respectively). For black men, the LR test does not reject the hypothesis that a simple upward sloping line fits as well as the nonlinear model. The association between family income and BMI for black men is captured by a single positive slope of 0.055. For white women, the association between BMI in 1981 and log family income seven years later is negative across nearly the entire range of BMI (18.7 to 35). For black women, there appears to be no meaningful association between family income and BMI.

To summarize the results for the 1979 cohort, the association between BMI and all three outcomes is inverted u-shaped for white men with the association turning from positive to negative well below the standard threshold for being “obese.” For black men, the pattern is similarly inverted u-shaped for marriage, but primarily upward sloping for wages and family income. For white and black women, the predominant pattern is one of negative associations between BMI and socioeconomic outcomes across nearly the entire distribution of BMI. The exceptions to this overall pattern are wages for white women, which show a pattern consistent with an obesity penalty, and family income for black women, which has no meaningful association with BMI. We turn next to examining whether the patterns we see in the 1979 cohort are still apparent 20 years later.

*1997 Cohort Wages*

Figure 3 shows the association between BMI in 2003 and log wages in 2010 (adjusted to 1988 dollars) for the 1997 cohort. For ease of comparison, the graphs also show the curve for the 1979 cohort with a dashed line. For white men, the association between BMI and wages is quite similar across cohorts. The relationship is again inverted u-shaped, with a change point at 24.4., and slopes .047 and -.014 on either side of this change point. For black men, the association between BMI and wages flattens out across cohorts, especially across the normal and overweight range. The change point results show that the positive association between log wages and BMI observed for the 1979 cohort does not exist for the more recent cohort.

For white women in the 1997 cohort, the pattern changes substantially and we now cannot reject the hypothesis that a simple downward sloping line across the entire distribution of BMI fits as well as the nonlinear model. The “obesity penalty” observed in the 1979 cohort transforms to a pattern more consistent with beauty norms rewarding thinness. For black women, the semi-parametric curve for the 1997 cohort is flatter in the normal range but otherwise has a similar shape across cohorts. The change point results also capture this flattening at the lower

BMI range, with the downward sloping line of the 1979 cohort transforming to a flat line in the 1997 cohort.

For wages, the patterns in the 1979 cohort were similar by gender, but in the 1997 cohort, the patterns are more similar by race. The results suggest that perceptions of body size may have transformed across cohorts differently by race and gender in ways that are consistent with a normalizing of corpulence for blacks, a reinforcement of thin beauty ideals for white women, and a status quo of a middle range BMI that is neither too thin nor too large for white men. We discuss the implications of these changes across cohorts in the discussion section below.

*1997 Cohort Marriage*

Figure 4 shows the relationship between BMI in 2003 and the probability of being married in 2010. For white men in the 1997 cohort, a two-change point model fits the data. The association between BMI and the probability of marriage is flat from a BMI of 17 to about 24, then positive between BMIs of about 24 and 27, and then negative across the rest of the overweight and obese ranges (BMI of 26.8 to 40). The overall shape of the association between BMI and wages, however, remains inverted u-shaped for white men in both cohorts. The entire curve is lower for the 1997 cohort compared to the 1979 cohort, reflecting the broader demographic trends of the increasing age at marriage and the overall decline in the probability of marriage across cohorts.

For black men in the 1997 cohort, the probability of being married has a flatter relationship with BMI than it did in the previous cohort, especially at higher levels of body mass. The likelihood of being married rises across the normal range of BMI and then remains flat across the overweight and obese ranges. The change point model estimates a rising slope of .038 from a BMI of 17 to about 24, and then no association between BMI and the probability of marriage across the remainder of the distribution of BMI. The negative association between the probability of being married and body mass for larger black men disappears across the two cohorts, while the positive association across the normal range persists across cohorts.

Women in the 1997 cohort also display a flattening of the association between the likelihood of being married and BMI. For white women, the relationship is still negative. The change point results show that this association is captured by simple downward sloping line, albeit with a shallower slope of -0.006 ($p<.050$) for the 1997 cohort. For black women, both the semi-parametric curve and the change point model suggest no association between BMI and the probability of being married in the 1997 cohort, compared to a negative linear association for the previous cohort. Taken together, the results show that, for all groups, the association between the likelihood of being married and body mass was weaker in the 1997 cohort than it was in the 1979 cohort. Moreover, for black men and women, there is no meaningful association between the probability of marriage and BMI in the 1997 cohort, suggesting that black Americans have become more accepting of larger bodies than white Americans in the domain of marriage.

*1997 Cohort Family Income*

For all groups, there is no meaningful association between BMI and family income for the 1997 cohort. For all groups except black women, this is a different pattern from that observed in the earlier cohort. In the 1979 cohort, white men had an inverted u-shaped pattern, black men had a positive association, and white women had a negative association across nearly the entire distribution of BMI. By the 1997 cohort, these patterns had flattened out completely. For black women, the association was flat in both cohorts.

**Sensitivity Tests**

In order to check the sensitivity of our results to measurement error resulting from self-reported height and weight data, we used a different dataset that includes both measured and self-reported height and weight and offers a longitudinal sample of young adults surveyed in nearly the same years at the NLSY-97. The National Longitudinal Study of Adolescent Health (Add Health) is a nationally representative panel data set designed to assess the health behaviors of adolescents. The Add Health sample has a school-based design that is not directly comparable to the NLSY cohorts, which are household samples of distinct birth cohorts. However, the Add Health sample offers a subset of respondents who are the same age as those of the NSLY-97 sample and interviewed in nearly the same years. Wave III, which was conducted in 2001 and 2002, includes a subset of respondents who were ages 19 to 23 (the NLSY-97 respondents are 19 to 23 in 2003) and provides a baseline measure of BMI. Wave IV, which was fielded seven years later in 2008 and 2009, allows for a comparable measure of outcomes when the Add Health respondents were ages 26 to 30 (the NLSY-97 respondents were 26 to 30 in 2010).

The Add Health has two outcome measures that we can compare to our analyses. Although the survey did not measure hourly wages in the same way as the NLSY surveys, it did measure annual labor earnings. We are also able to measure the probability of being married for those respondents who were never married at Wave III. Using these data, we construct the most comparable possible analyses to those reported above in order to see if the patterns differ between self-reported and measured BMI (N=6,706). We show these results in Figure 5 and Figure 6.

For each outcome, we estimated the semi-parametric regressions separately for measured BMI and self-reported BMI. We then graphed the resulting semi-parametric curves together on the same graph. The dashed lines show the curves for self-reported BMI, the solid lines show the curves for measured BMI, and the confidence intervals shown are those for the measured BMI curves. For both outcomes and all groups, the results are strikingly similar. The self-reported and measured curves differ slightly at the extremes of BMI, but the substantive patterns are identical and the self-reported curves fit entirely within the confidence intervals of the measured curves. The change point results (not shown) are also quite similar.

We also checked many alternative specifications for our models. Overall, our results are quite robust to different choices about the data or models. We report on two such alternatives. First, we estimated all models without controlling for the cognitive test score (AFQT/ASVAB) in order to retain the observations with missing values on this variable in the analytical sample. This is important because the ASVAB score is missing for about 17% of the NLSY-97 sample. The results for the 1979 cohort are the same whether or not AFQT is controlled. The results for the 1997 cohort are also substantively the same with two exceptions. In the marriage models, the relationship between BMI and the likelihood of being married has a marginally significant negative slope at higher values of BMI for black men and black women whereas these associations are not significant when we control for the ASVAB score.

Second, we re-estimated the family income models to adjust for differences in household size by dividing family income by the square root of the number of household members. This rescaling of family income changes only one of the eight results in a substantively meaningful way. For white men in the 1979 cohort, the estimated change point moves from 22.8 to 32.8, with a flat slope from a BMI of 17 to 32.8, rather than the positive slope estimated when family income is not rescaled. The slope from a BMI of 32.8 to 35 is negative.

## Discussion and Conclusion

Examining the association between body mass and socioeconomic outcomes across the entire distribution of BMI gives a different picture of the social costs of body size than that implied by the categorical approach to studying obesity. First, the thresholds for being “too fat” or “thin enough” differ systematically by gender, race, and social outcome, and have changed in important ways across cohorts. Second, the association between BMI and social outcomes is often not constant within the ranges of the standard cutoffs, which itself calls into question the categorical approach to studying these relationships.

For white men, the relationship between body size and socioeconomic outcomes is distinctly nonlinear. At higher BMIs, heavier white men have worse outcomes, but at low and lower-middle BMIs, outcomes improve as BMI increases. This pattern largely persists across cohorts. This inverted u-shaped pattern centered in the middle of the BMI distribution sheds light on why many studies using the categorical approach find no significant effect of obesity on wages for men. In fact, there is both a positive and negative association, which when studied in a binary way, averages to zero.

For white women, most of what might be attributed to obesity is instead due to the systematic negative association between BMI and socioeconomic outcomes across the entire distribution of BMI. The meaningful patterns are about being thin rather than being obese. White women’s wages in the 1979 cohort are the exception, but this pattern is not present for any other outcome and does not persist in the 1997 cohort. In six of the eight models for white women, the results show a negative association between BMI and outcomes starting at very low BMIs. Perhaps when few white women were corpulent, as was the case with the 1979 cohort, larger white women were particularly stigmatized in the labor market. Then, as the prevalence of corpulence increased, the norms for white women in the labor market shifted to a more drastic regime, in which thinner is better across the distribution of BMI.

For black men and women, the association between BMI and socioeconomic outcomes dissipates across cohorts. In the 1979 cohort (respondents born between 1957 and 1962), we find little support for widely-held beliefs about the greater acceptance of larger women for black Americans. In contrast, by the 1997 cohort (respondents born between 1980 and 1984), there is ample evidence across multiple social domains that the association between body mass and socioeconomic outcomes becomes systematically weaker for black Americans, using a large, representative sample of the U.S. population. These findings suggest that body norms used to differ by gender rather than race in previous cohort but have come to differ by race rather than gender in the more recent cohort. Although black women often experience the double burden of gender and race-based disadvantages in their outcomes, in this particular dimension of social stratification, race has come to have a protective effect over gender in outcomes.

For all social groups, the association between BMI and the likelihood of being married weakens across cohorts. As average BMIs increases for all groups, it may be that our acceptance of marrying partners who are larger necessarily shifts as well. This weakening association between body mass and marriage in the 1997 cohort, combined with broader demographic shifts in age at marriage and ever marriage, in turn translates to a flattening of the association between family income and BMI for all groups. For white Americans, the association between BMI and being married weakens but continues to show a distinct negative relationship that differs by gender. This negative association between BMI and the probability of being married was present for black Americans in the 1979 cohort as well, but disappears by the 1997 cohort.

White Americans also have a negative association between BMI and wages across both cohorts, albeit at quite different thresholds by gender. Why would the associations differ between the marriage market and labor market? And why do black Americans not show similar patterns in wages? One possible explanation is that the negative stereotypes regarding people who are fat as lacking self-control or being perceived as lazy (Puhl and Heuer 2009) may apply more narrowly to the domain of work, or the perceived costs associated with these stereotypes may seem more relevant for employment than marriage. These stereotypes may also apply more strongly to white Americans than black Americans. The lack of a systematic negative association between BMI and wages for black Americans by the 1997 cohort suggests that the acceptance of larger bodies for black Americans may be shared not only by blacks but also by whites. Although marriage markets are quite segregated, the labor market is less so, at least in so far as whites are likely to play a large role in determining the wages paid to both white and black Americans.

The patterns for all women in the 1979 cohort and white women in the 1997 cohort remind us that norms of thinness dominate in women’s lives at work and home. But we are also struck by the evidence that a body ideal operates for white men in multiple domains as well. This ideal is not a systematic reward to thinness, as it is for white women, but instead a body that is not too thin and not too large. Many of the semi-parametric curves for white men peak near the cusp of the “normal” and “overweight” ranges. BMIs in this range may be due to having more muscle mass or some extra fat, producing frames that are neither too thin nor too large. Together, this is consistent with gendered norms in which women are thinner and men are bigger, but neither partner is particularly corpulent.

In terms of the stability versus fluidity in these patterns, the cohort patterns show both: stability for white Americans and fluidity for black Americans. It is important to note, however, that these relationships are embedded in a social fabric that is itself changing. The changing association between BMI and these socioeconomic outcomes is no doubt a composite of many factors. Not only is the distribution of BMI shifting across cohorts, but the timing of demographic transitions such as marriage, childbearing, and home leaving also shift between cohorts. In more recent cohorts, individuals marry later, have lower probabilities of ever marrying, older ages of leaving home, and later transitions to the labor market (Furstenberg 2010). We have used ages that make our study comparable to the established literature on these topics so that readers can compare our results to those using the same data but a different approach to how body mass is parameterized. Nonetheless, it is important to recognize that the underlying dynamics are multidimensional.

Our findings highlight interesting differences in the association between body mass and social class. Social class is a multidimensional construct capturing both life chances and life styles (Weeden and Grusky 2005), and the outcomes we have studied tap several important dimensions of social class (wages, income, marriage). Viewed from this perspective, our results suggest that body mass may send a different signal about social class for different groups. For white Americans, corpulence is associated with lower social class standing for both men and women, and for white women, being thin signals higher social class position. For blacks Americans, the potential signal between corpulence and social class has changed over cohorts. In the more recent cohort, neither thinness nor corpulence is associated with the dimensions of social class analyzed above for black Americans, making body mass a poor signal of social class for this group.

Taken together, our results show that the biological and social costs of body mass cannot be conceptualized or measured in the same way. Our findings argue against taking a binary view of bodies as simply being obese versus not. The singular focus on one specific threshold of BMI in the existing literature has obscured the fact that the most relevant associations between body size and outcomes are shaped by gender, race, and context rather than any given value of BMI. The relationship between body size and socioeconomic outcomes depends on who is being judged, who is doing the judging, and in which social domain.

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Table 1. Sample Summary (Wages) by Cohort, Race, and Sex (NLSY 1979 and 1997)

| | White Men | | Black Men | | White Women | | Black Women | |
|---|---|---|---|---|---|---|---|---|
| | 1979 | 1997 | 1979 | 1997 | 1979 | 1997 | 1979 | 1997 |
| BMI in 1981/2003 | 23.75<br>(3.13) | 25.34<br>(4.34) | 23.34<br>(2.80) | 26.14<br>(4.68) | 21.75<br>(3.17) | 24.17<br>(4.68) | 23.07<br>(3.62) | 26.24<br>(5.56) |
| Log wage in 1988 dollars (1988/2010) | 2.23<br>(.54) | 2.26<br>(.61) | 1.98<br>(.50) | 2.05<br>(.58) | 1.98<br>(.54) | 2.16<br>(.59) | 1.82<br>(.48) | 1.96<br>(.58) |
| Married in 1988/2010 | .51 | .33 | .31 | .22 | .56 | .40 | .31 | .15 |
| Log Total Family Income in 1988 dollars (1988/2010) | 10.25<br>(.86) | 10.38<br>(.80) | 9.79<br>(1.25) | 9.93<br>(.98) | 10.29<br>(.72) | 10.40<br>(.79) | 9.78<br>(1.07) | 9.82<br>(1.05) |
| Age (1988/2010) | 28.21<br>(1.70) | 27.89<br>(1.42) | 28.15<br>(1.67) | 27.95<br>(1.38) | 28.28<br>(1.68) | 27.92<br>(1.42) | 28.24<br>(1.70) | 27.94<br>(1.47) |
| Education (1988/2010) | | | | | | | | |
| ≤11 years | .11 | .13 | .23 | .26 | .06 | .09 | .10 | .14 |
| 12 years | .44 | .23 | .46 | .30 | .44 | .16 | .44 | .20 |
| 13 – 15 years | .19 | .24 | .20 | .27 | .23 | .23 | .30 | .35 |
| 16 years | .17 | .20 | .08 | .09 | .18 | .24 | .12 | .13 |
| ≥17 years | .08 | .20 | .03 | .08 | .08 | .29 | .04 | .18 |
| AFQT/ASVAB in 1980/1997 | 55.7<br>(28.2) | 58.4<br>(28.4) | 22.43<br>(22.3) | 29.0<br>(23.6) | 56.0<br>(25.5) | 60.4<br>(25.8) | 25.94<br>(20.2) | 34.67<br>(24.6) |
| Years Work Exp. in 1988/2010[b] | 8.57<br>(2.14) | 6.63<br>(2.17) | 7.17<br>(2.57) | 5.97<br>(2.4) | 7.96<br>(2.34) | 6.77<br>(2.09) | 6.62<br>(2.81) | 6.20<br>(2.33) |
| Occupation in 1988/2010<br>Manager/Professional | .22 | .34 | .10 | .19 | .28 | .45 | .17 | .32 |
| Technical/Sales | .20 | .13 | .17 | .19 | .44 | .29 | .43 | .35 |
| Service | .08 | .19 | .17 | .30 | .17 | .22 | .24 | .29 |
| Farming/fishing | .05 | .01 | .04 | .002 | .01 | .002 | .01 | .002 |
| Skilled/Crafts/construction | .23 | .19 | .19 | .10 | .03 | .003 | .03 | 0 |
| Operators/laborers | .22 | .14 | .33 | .21 | .08 | .04 | .13 | .04 |
| SMSA in 1988/2010<br>Not in SMSA | .25 | .07 | .19 | .06 | .22 | .05 | .17 | .04 |
| SMSA, not central city | .36 | .57 | .17 | .43 | .36 | .57 | .20 | .41 |
| SMSA, city unknown | .28 | .01 | .36 | .004 | .33 | .001 | .38 | .005 |
| SMSA, in central city | .11 | .35 | .28 | .52 | .09 | .38 | .24 | .55 |
| Region in 1988/2010<br>North | .17 | .18 | .15 | .14 | .16 | .16 | .14 | .14 |
| Central | .37 | .30 | .17 | .16 | .33 | .27 | .16 | .16 |
| South | .29 | .31 | .59 | .62 | .34 | .34 | .63 | .65 |
| West | .18 | .21 | .09 | .08 | .17 | .23 | .07 | .05 |
| Urban Residence in 1988/2010 | .76 | .73 | .86 | .81 | .76 | .74 | .84 | .84 |
| Lives with parent 1988/2010 | .04 | .10 | .06 | .08 | .03 | .07 | .03 | .06 |
| Family size in 1988/2010 | 2.68<br>(1.39) | 2.86<br>(1.46) | 2.98<br>(1.87) | 3.01<br>(1.59) | 2.75<br>(1.28) | 2.92<br>(1.42) | 3.35<br>(1.73) | 3.33<br>(1.66) |
| Sample size (Wages) | 1291 | 1234 | 740 | 450 | 1222 | 1096 | 708 | 510 |

*Notes*: Sample sizes differ for each outcome and race/sex group, and are show in Table 2. Means reported above are for the sample describing log wages, which is the largest sub-sample for all groups.

Table 2. Results from Change Point Models by Cohort

| | 1979 Cohort | 1997 Cohort |
|---|---|---|
| **Wages** | | |
| White Men | | |
| Change Point | 25.1 | 24.4 |
| 95% CI | [20.8, 25.8] | [20.8, 30.3] |
| Slope 1 | 0.031* | 0.047* |
| Slope 2 | -0.034* | -0.014* |
| Change point fits [a] | p<0.000 | p<0.000 |
| Slope of simple line | -- | -- |
| N | 1291 | 1234 |
| Black Men | | |
| Change Point | 27.6 | 32.5 |
| 95% CI | [18.1, 34.9] | [18.5, 33.2] |
| Slope 1 | 0.021* | 0.008 |
| Slope 2 | -0.028 | -0.035 |
| Change point fits [a] | p<0.124 | p<0.277 |
| Slope of simple line | 0.011† | -0.0005 |
| N | 740 | 450 |
| White Women | | |
| Change Point | 31.5 | 23.1 |
| 95% CI | [18.0, 33.6] | [18.4, 30.7] |
| Slope 1 | 0.003 | -0.025* |
| Slope 2 | -0.125* | -0.009† |
| Change point fits [a] | p<0.015 | p<0.522 |
| Slope of simple line | -- | -0.012* |
| N | 1222 | 1096 |
| Black Women | | |
| Change Point | 20.7 | 22.2 |
| 95% CI | [18.0, 31.6] | [18.0, 34.9] |
| Slope 1 | 0.055* | 0.021 |
| Slope 2 | -0.011* | -0.010† |
| Change point fits [a] | p<.025 | p<0.499 |
| Slope of simple line | -- | -0.006 |
| N | 708 | 510 |
| **Married** | | |
| White Men | | |
| Change Point | 23.3 | 23.8 ; 26.8 |
| 95% CI | [18.7, 33.9] | [18.0, 27.8]; [25.5, 34.9] |
| Slope 1 | 0.028* | -0.006 |
| Slope 2 | -0.018* | 0.050* |
| Slope 3 | -- | -0.015* |
| Change point fits [a, b] | p<0.024 | p<0.047 |
| Slope of simple line | -- | -- |
| N | 1105 | 1359 |
| Black Men | | |
| Change Point | 26.7 | 23.6 |
| 95% CI | [18.8, 33.5] | [20.6, 34.2] |
| Slope 1 | 0.017* | 0.038* |
| Slope 2 | -0.028† | -0.007 |
| Change point fits[a] | p<.094 | p<0.028 |
| Slope of simple line | 0.004 | -- |
| N | 762 | 636 |

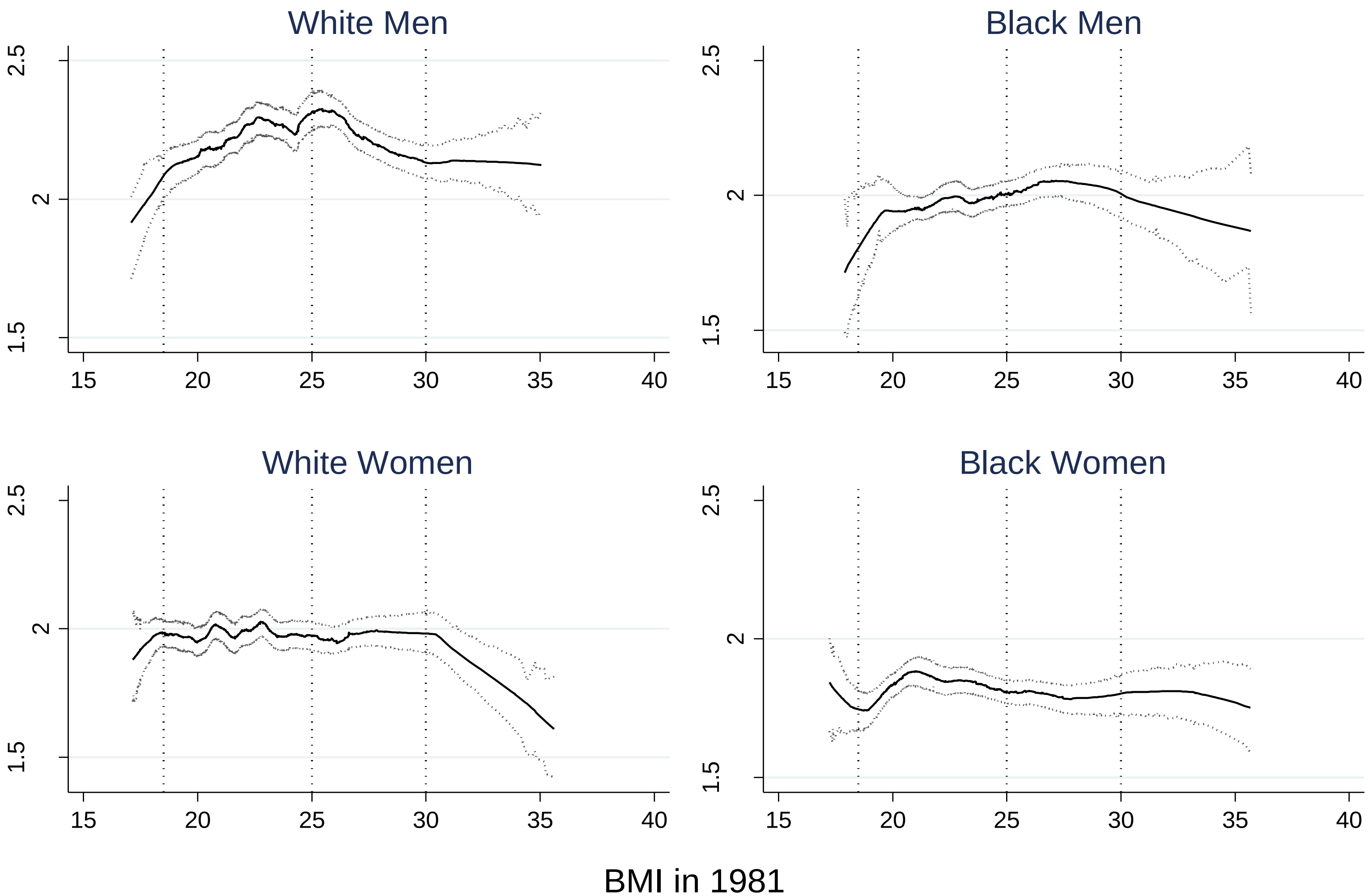
*Continues on next page*

Table 2. Results from Change Point Models by Cohort, continued

| | | |
|---|---|---|
| **Married, continued** | | |
| White Women | | |
| Change Point | 28.2 | 32.7 |
| 95% CI | [18.0, 34.4] | [18.0, 39.9] |
| Slope 1 | -0.012† | -0.003 |
| Slope 2 | -0.056* | -0.026† |
| Change point fits [a] | p<0.229 | p<0.381 |
| Slope of simple line | -0.019* | -0.006* |
| N | 931 | 1127 |
| Black Women | | |
| Change Point | 22.2 | 18 |
| 95% CI | [18.0, 34.1] | [18.0, 39.0] |
| Slope 1 | -0.032* | -0.537† |
| Slope 2 | -0.005 | -0.003 |
| Change point fits [a] | p<.342 | p<0.212 |
| Slope of simple line | -0.011* | -0.004 |
| N | 718 | 638 |
| **Log Family Income** | | |
| White Men | | |
| Change Point | 27.0 | 19.9 |
| 95% CI | [22.4; 33.4] | [18.4, 33.5] |
| Slope 1 | 0.043* | 0.250† |
| Slope 2 | -0.090* | 0.001 |
| Change point fits [a] | p<0.001 | p<0.160 |
| Slope of simple line | -- | 0.007 |
| N | 1151 | 1311 |
| Black Men | | |
| Change Point | 33.9 | 19.5 |
| 95% CI | [18.1, 34.9] | [18.6, 34.7] |
| Slope 1 | 0.066* | 0.649 |
| Slope 2 | -0.985 | 0.030 |
| Change point fits [a] | p<0.424 | p<0.767 |
| Slope of simple line | 0.055* | 0.033 |
| N | 602 | 533 |
| White Women | | |
| Change Point | 18.7 | 25.9 |
| 95% CI | [18.0, 34.7] | [18.1, 39.9] |
| Slope 1 | 0.258* | -0.174 |
| Slope 2 | -0.033* | 0.003 |
| Change point fits [a] | p<0.030 | p<0.676 |
| Slope of simple line | -- | -0.006 |
| N | 1287 | 1184 |
| Black Women | | |
| Change Point | 21.7 | 35.0 |
| 95% CI | [18.6, 34.2] | [19.4, 39.5] |
| Slope 1 | -0.090* | -0.036* |
| Slope 2 | -0.011 | 0.122 |
| Change point fits [a] | p<0.157 | p<0.183 |
| Slope of simple line | -0.009 | -0.020 |
| N | 728 | 605 |

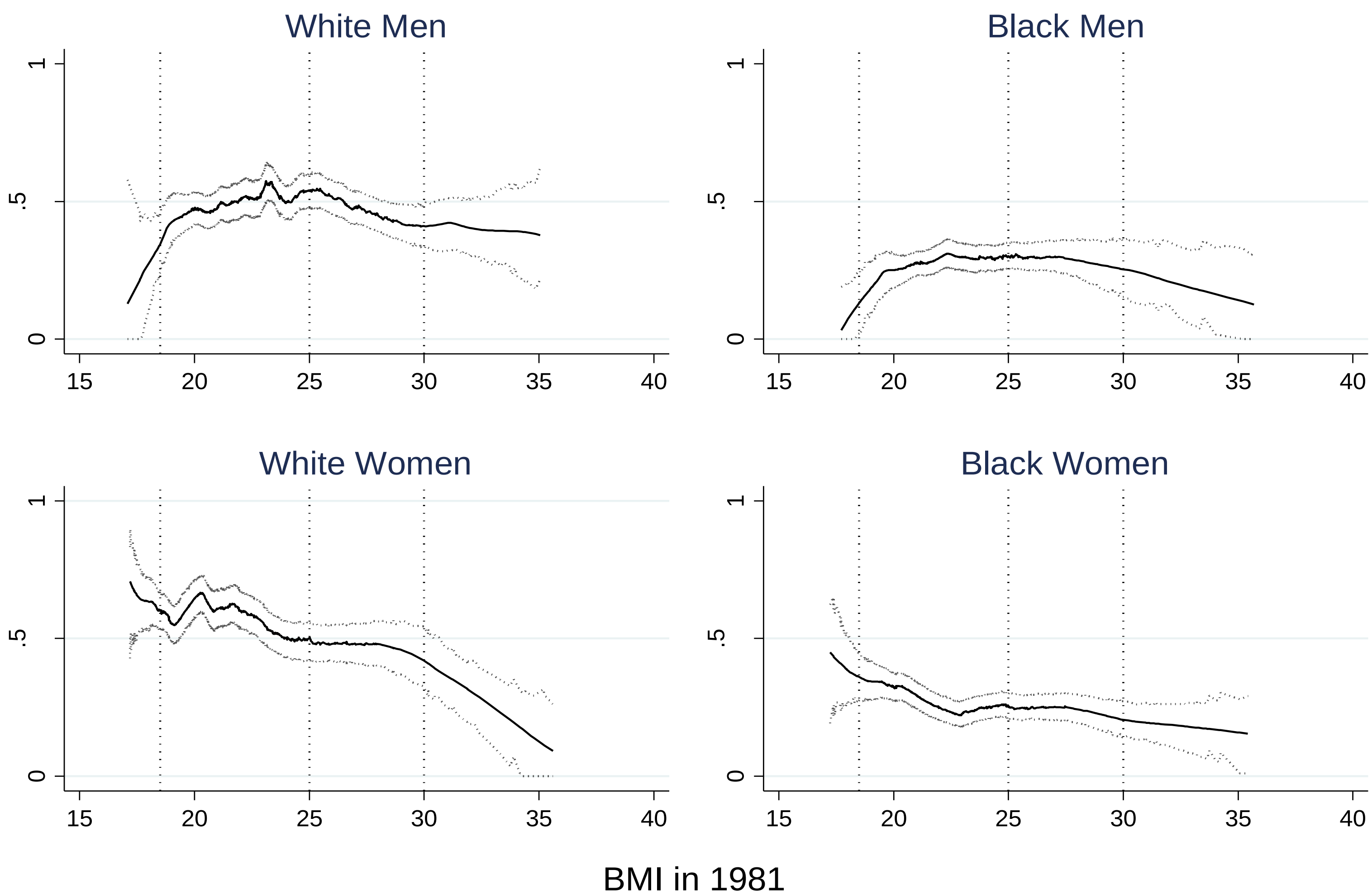
*Notes*:
[a] P-value for LR test that endogenous change point with slopes on each side fits better than single slope line.
[b] P-value for LR test that endogenous 2 change point model with 3 slopes fits better than single slope line.

Figure 1. Results from semi-parametric regression of log wages in 1988 on BMI in 1981, NLSY-1979



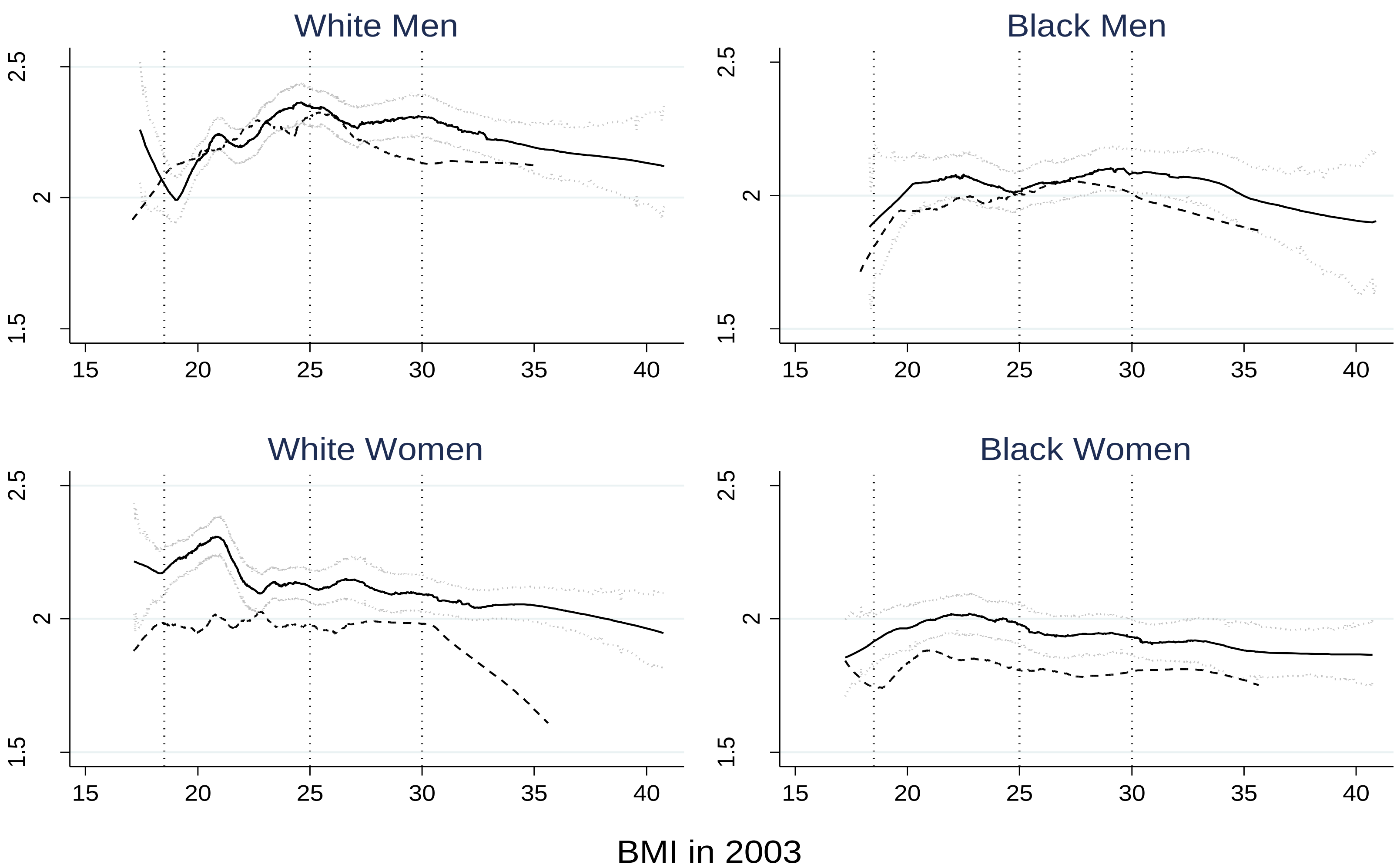

*Notes: Dotted lines show standard BMI cutoffs: <18.5 "Underweight" 18.5-24.9 "Normal" 25-29.9 "Overweight" 30+ "Obese." Models control for education, age, AFQT, region of residence, work experience, and industry.*

Figure 2. Results from semi-parametric regression of the probability of being married in 1988 on BMI in 1981, NLSY-1979



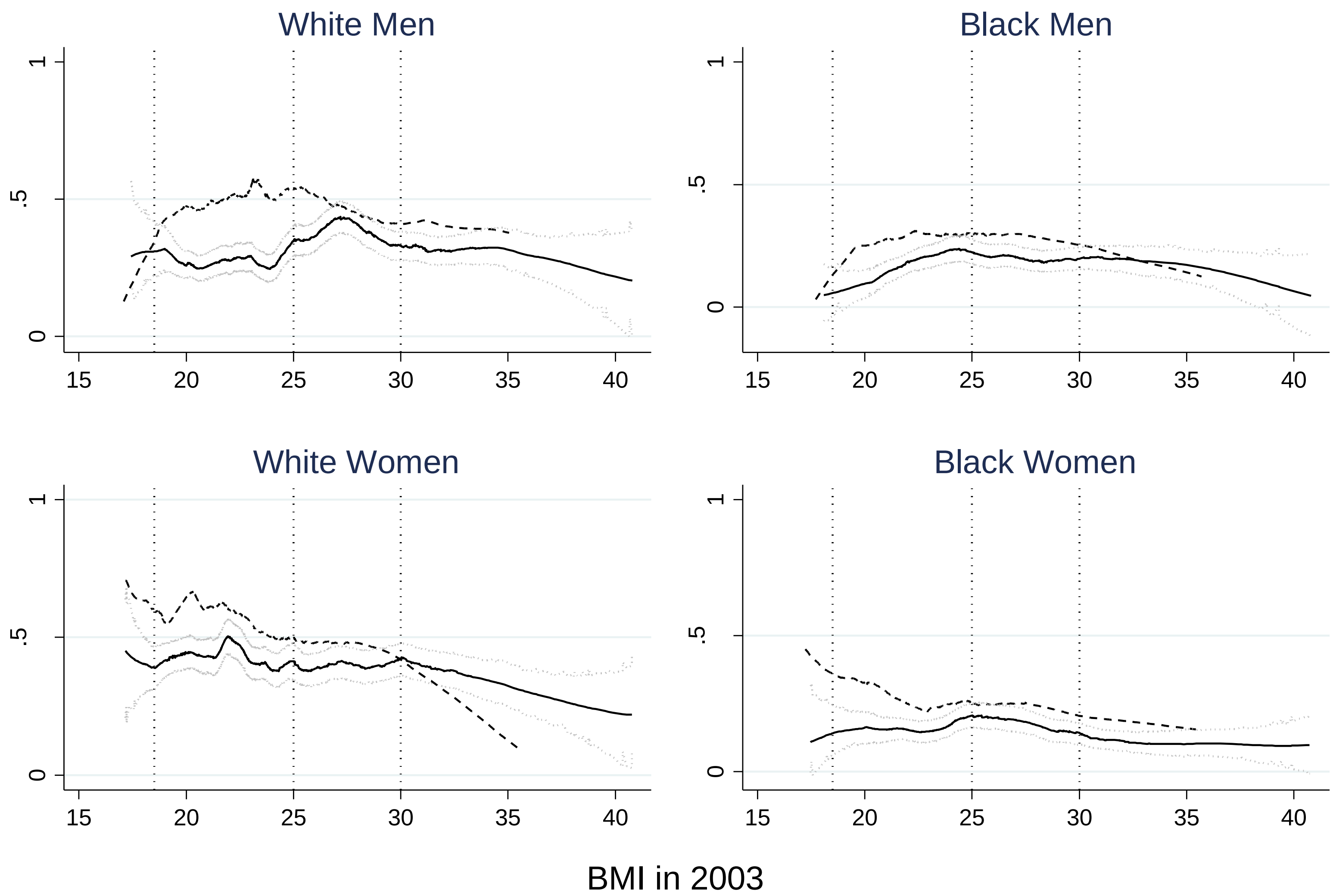

*Notes: Dotted lines show standard BMI cutoffs: <18.5 "Underweight" 18.5-24.9 "Normal" 25-29.9 "Overweight" 30+ "Obese." Models are linear probability models estimated only for those never married in 1981 and control for education, age, AFQT, and region of residence.*

Figure 3. Results from semi-parametric regression of log wages in 2010 on BMI in 2003, NLSY-1997



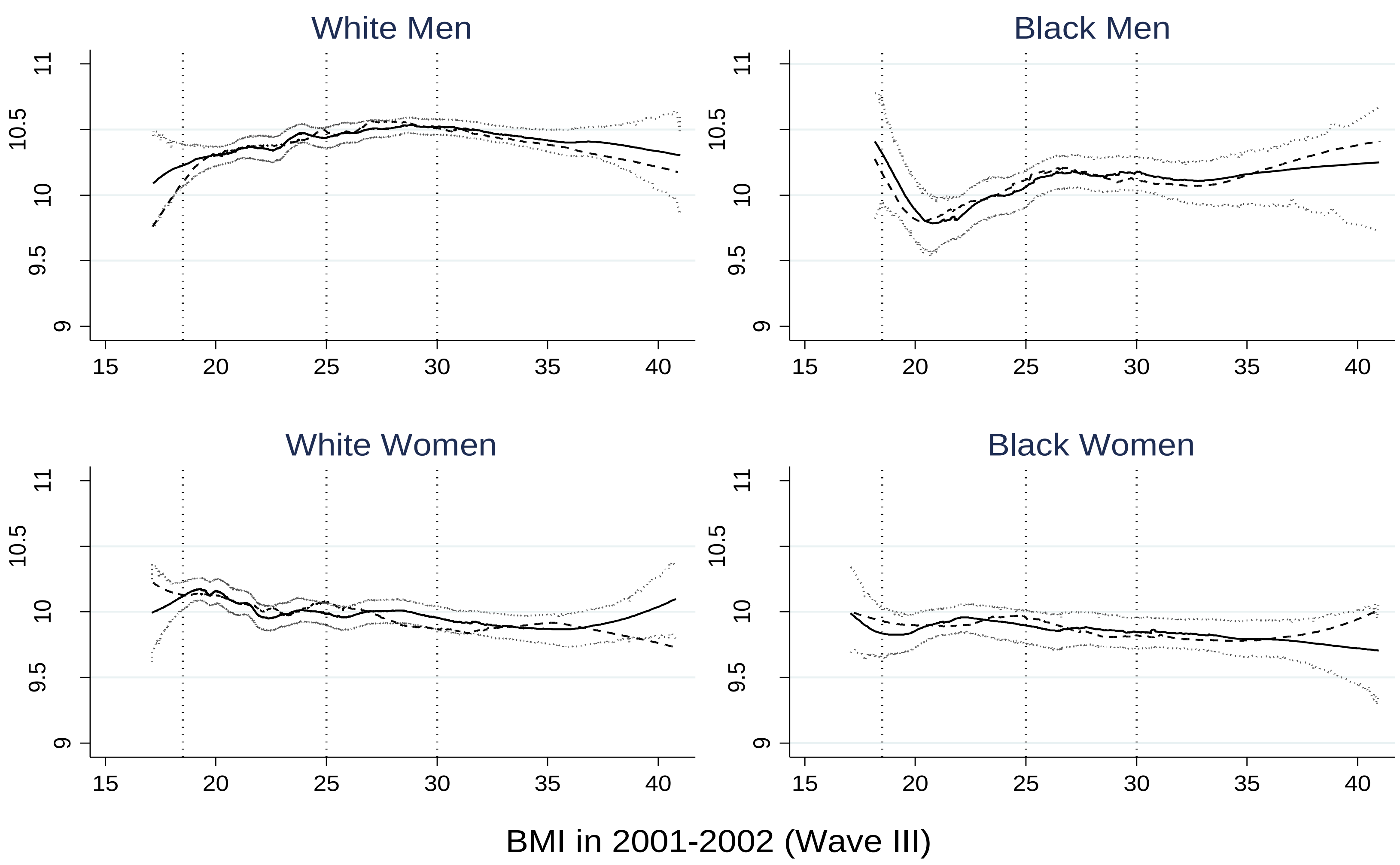

*Notes: Dotted lines show standard BMI cutoffs: <18.5 "Underweight" 18.5-24.9 "Normal" 25-29.9 "Overweight" 30+ "Obese." Models control for education, age, ASVAB, region of residence, work experience, and industry. Wages adjusted to 1988 dollars.*

Figure 4. Results from semi-parametric regression of the probability of being married in 2010 by BMI in 2003, NLSY-1997



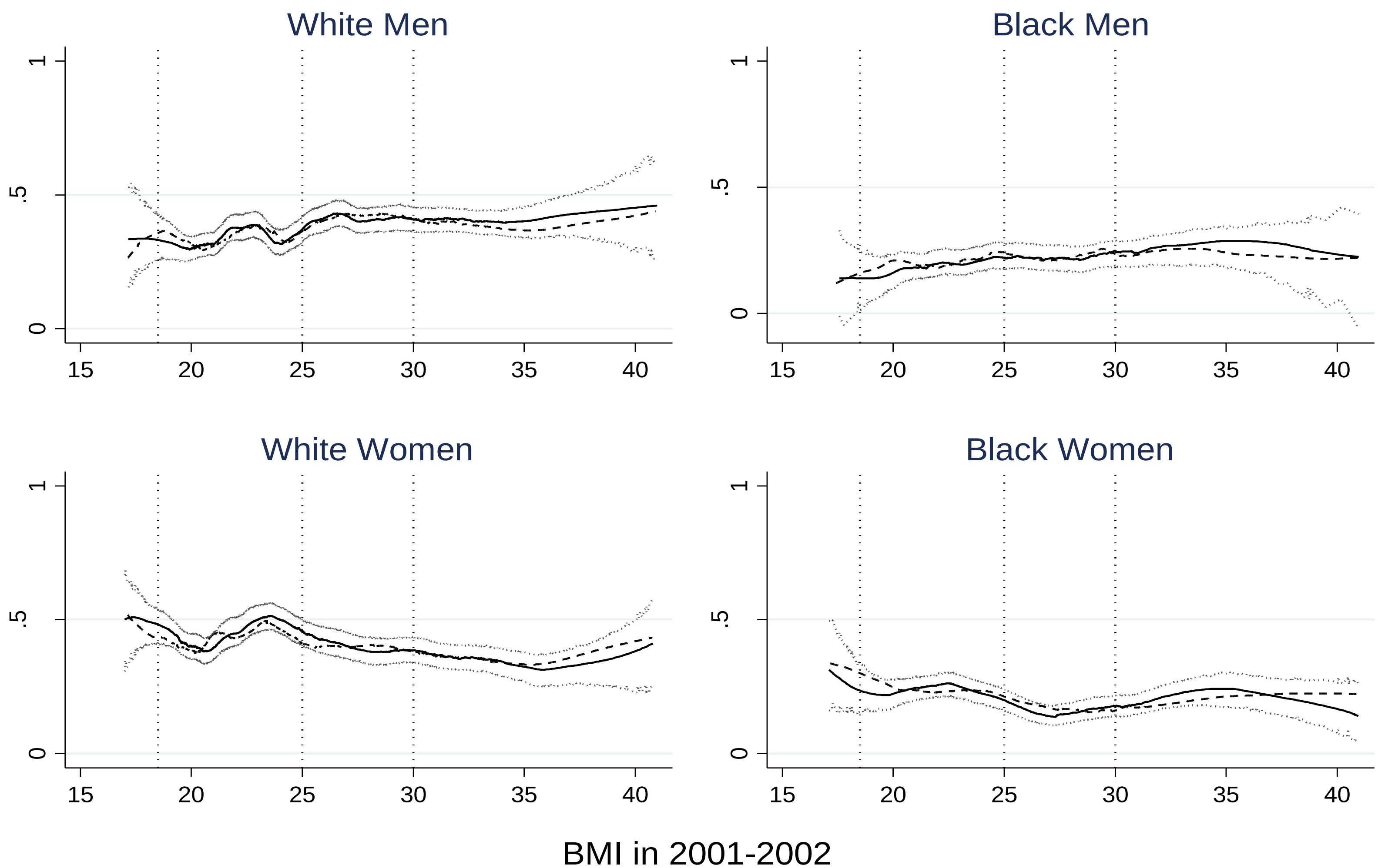

*Notes: Dotted lines show standard BMI cutoffs: <18.5 "Underweight" 18.5-24.9 "Normal" 25-29.9 "Overweight" 30+ "Obese." Models are linear probability models estimated only for those never married in 2003 and control for education, age, ASVAB, and region of residence.*

Figure 5. Results from semi-parametric regression of log annual earnings in 2008-2009 (Wave IV) on BMI in 2001-2002 (Wave III) using measured versus self-reported BMI, Add Health (N=6,706)




*Notes: Confidence intervals shown are for measured BMI. Dotted lines show standard BMI cutoffs: <18.5 "Underweight" 18.5-24.9 "Normal" 25-29.9 "Overweight" 30+ "Obese." Models control for education, age, ASVAB, and region of residence.*

Figure 6. Predicted probability of being married at Wave IV (2008/2009) by measured and self-reported BMI at Wave III (2001/2002), Add Health (N=6,706)




*Notes: Confidence intervals are for measured BMI. Dotted lines show standard BMI cutoffs: <18.5 "Underweight" 18.5-24.9 "Normal" 25-29.9 "Overweight" 30+ "Obese." Models are linear probability models estimated for those never married in 2003 and control for education, age, ASVAB, and region of residence.*

Appendix Table A1. Full Distribution of BMI in the 1979 and 1997 NLSY Cohorts

| | NLSY-1979 | | | | NLSY-1997 | | | |
|---|---|---|---|---|---|---|---|---|
| BMI | White Men | Black Men | White Women | Black Women | White Men | Black Men | White Women | Black Women |
| ≤14 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 |
| 15 | 0 | 1 | 6 | 0 | 0 | 0 | 2 | 2 |
| 16 | 2 | 2 | 26 | 7 | 4 | 1 | 11 | 1 |
| 17 | 13 | 3 | 89 | 23 | 16 | 3 | 32 | 14 |
| 18 | 42 | 18 | 246 | 52 | 35 | 13 | 89 | 30 |
| 19 | 102 | 42 | 343 | 93 | 95 | 29 | 163 | 47 |
| 20 | 177 | 89 | 354 | 132 | 148 | 64 | 236 | 65 |
| 21 | 284 | 135 | 326 | 128 | 184 | 83 | 230 | 79 |
| 22 | 289 | 149 | 208 | 103 | 213 | 114 | 212 | 86 |
| 23 | 271 | 127 | 162 | 89 | 238 | 114 | 184 | 91 |
| 24 | 176 | 115 | 94 | 79 | 201 | 105 | 127 | 79 |
| 25 | 168 | 61 | 78 | 49 | 209 | 89 | 118 | 76 |
| 26 | 113 | 32 | 61 | 37 | 159 | 68 | 79 | 40 |
| 27 | 76 | 28 | 39 | 28 | 114 | 65 | 68 | 41 |
| 28 | 55 | 20 | 27 | 20 | 91 | 60 | 62 | 46 |
| 29 | 44 | 10 | 22 | 28 | 77 | 44 | 56 | 45 |
| 30 | 25 | 6 | 20 | 12 | 66 | 30 | 35 | 43 |
| 31 | 21 | 8 | 18 | 14 | 58 | 26 | 34 | 31 |
| 32 | 13 | 1 | 9 | 11 | 49 | 29 | 37 | 34 |
| 33 | 10 | 5 | 11 | 11 | 37 | 11 | 19 | 23 |
| 34 | 9 | 2 | 11 | 6 | 25 | 16 | 22 | 20 |
| 35 | 2 | 3 | 4 | 4 | 21 | 10 | 18 | 17 |
| 36 | 2 | 1 | 5 | 6 | 15 | 10 | 13 | 9 |
| 37 | 3 | 1 | 2 | 2 | 10 | 6 | 13 | 8 |
| 38 | 1 | 0 | 4 | 5 | 8 | 9 | 17 | 12 |
| 39 | 1 | 1 | 2 | 3 | 9 | 4 | 8 | 18 |
| 40 | 0 | 0 | 1 | 1 | 4 | 5 | 7 | 8 |
| 41 | 0 | 1 | 0 | 5 | 3 | 2 | 6 | 16 |
| 42 | 0 | 0 | 2 | 0 | 4 | 3 | 4 | 7 |
| 43 | 1 | 1 | 1 | 1 | 2 | 1 | 3 | 10 |
| 44 | 0 | 0 | 0 | 0 | 1 | 2 | 3 | 11 |
| 45 | 0 | 1 | 0 | 0 | 2 | 1 | 1 | 8 |
| ≥46 | 0 | 0 | 4 | 2 | 5 | 7 | 12 | 15 |
| N | 1900 | 863 | 2176 | 951 | 2104 | 1024 | 1921 | 1033 |
| BMI distribution in standard categories (proportion shown) | | | | | | | | |
| <18.5 | .02 | .01 | .10 | .05 | .02 | .01 | .04 | .03 |
| 18.5-24.9 | .70 | .78 | .75 | .69 | .52 | .50 | .63 | .45 |
| 25-29.9 | .24 | .18 | .10 | .17 | .31 | .32 | .20 | .24 |
| ≥30 | .05 | .04 | .04 | .09 | .15 | .17 | .13 | .28 |