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The Multidimensional Relationship between Early Adult Body Weight and Women's Childbearing Experiences

Michelle L. Frisco^{*},

The Department of Sociology & Population Research Institute Penn State University

Margaret M. Weden, and

The RAND Corporation

Adam M. Lippert

The Department of Sociology & Population Research Institute Penn State University Kristin D. Burnett U.S. Census Bureau

Abstract

This study has three primary goals that make an important contribution to the literature on body weight and childbearing experiences among United States' women. It sheds light on the physiological *and* social nature of this relationship by examining whether the consequences of early adult weight for lifetime childbearing are shaped by historical social context, women's social characteristics, and their ability to marry. We analyze data from two female cohorts who participated in the National Longitudinal Study of Youth (NLSY79). Cohort 1 entered early adulthood before the U.S. obesity prevalence increased. Cohort 2 entered early adulthood after the obesity prevalence increased. We find that early adult weight is negatively related to the childbearing trajectories and marital status of Cohort 1 but not Cohort 2. Failing to account for race/ethnicity and women's educational background as confounders masks some of these associations, which are evident for both White and Black women. Our results suggest that the health consequences of body weight do not fully drive its impact on childbearing. Rather, the lifetime fertility consequences of early adult weight are malleable, involve social processes, and are dependent on social context.

Keywords

USA; childbearing; fertility; BMI; obesity; life course; gender; race/ethnicity; women

Introduction

In the United States (U.S.), childbearing and childrearing are gendered experiences. Both impact women's versus men's lives more due to basic biology and social conventions. Women have larger physiological roles in pregnancy, childbirth, and recovery. Their lifetime window of fecundity is also shorter, which places greater constraints on when they can bear children. U.S. women today also have more control over fertility due to improved

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^{*}Direct correspondence to Department of Sociology and Population Research Institute, The Pennsylvania State University, 211 Oswald Tower, University Park, PA 16802; 814-863-5507, mfrisco@psu.edu. .

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contraception and the legal availability of abortion. Additionally, despite men's greater involvement in child care (Sayer, 2005), U.S. women still have more overall child care responsibilities (Craig, 2006). They are also more likely than men to decrease work hours or vary work patterns following childbirth (Bianchi, Robison, & Milkie, 2006).

As a result, studies of U.S. fertility tend to focus on women's childbearing choices and constraints. They point to the wide array of physiological, social and economic factors that influence childbearing (Hirschman, 1994; Morgan & Taylor, 2006).

As the U.S. obesity prevalence has increased, women's body weight has received increased recognition as a physiological factor influencing childbearing. Clinical and epidemiological research links women's weight to fecundity, anovulatory fertility, premature birth, and assisted reproductive technology response (see Metwally, Li, & Ledger, 2007 for a review). This literature is diverse, but tends to focus on the way that adipose tissue negatively influences different aspects of gonadal function (e.g., leptin secretion). There is much variation in the operationalization of body weight and fertility across these studies. For example, the review just cited refers to 11 studies examining associations between weight and different in vitro fertilization (IVF) outcomes. Weight is assessed four different ways: using linear BMI, obesity status (BMI ≥ 30), overweight status (BMI ≥ 25), and "near-obesity" status (BMI ≥ 27). Despite this diversity and some mixed findings, most studies on women's weight and childbearing find that regardless of how excess weight is measured, it is physiologically problematic for childbearing when women are concurrently obese and actively attempting conception (Metwally et al., 2007).

We do not discount this conclusion. Instead, we ask whether the association between women's weight and fertility is more complex because obesity has gendered social consequences, not simply negative physiological consequences.

To answer this question, we analyze data from the female sample of the U.S. National Longitudinal Study of Youth (NLSY79). This population representative sample of Americans followed from 1979-2006 allows us to leverage biographical and historical time to show whether women's early adult weight has long-term consequences for lifetime childbearing. We can also test whether they arise at least in part from associations between early adult weight and women's ability to marry, an important fertility determinant. Given that weight, fertility timing, and marriage vary by women's race/ethnicity and educational background, our analyses carefully account for these important social characteristics. We also test whether relationships between early adult weight and childbearing are similar for women in two birth cohorts who entered early adulthood on opposite sides of the documented obesity spike that began in the early 1980's (Flegal, Carroll, Ogden, & Johnson, 2002).

Background

The Gendered Nature of Obesity

Obesity is a multifaceted health status with physiological and social consequences. It is a clinical risk factor for obesity-related mortality and morbidity, including conditions that influence women's fertility (U.S. Surgeon General, 2007). Obesity is also a stigmatized social status. Two of Goffman's (1963) three types of stigmata apply to obesity. It may be seen as a bodily disfigurement, a blemish of individual character, or both (Carr & Friedman, 2005).

The social consequences of weight stigma, obesity, and the political economy of obesity are gendered, reflecting U.S. female appearance norms that favor slenderness (Bordo, 1993).

These consequences include psychological burdens. Women are more likely than men to participate in unhealthy dieting behavior (Rolls, Fedoroff, & Guthrie, 1991) and to report “normative discontent”, or a negative body image that emerges regardless of weight or shape (Cash & Henry, 1995). Weight also reduces women’s socioeconomic attainment. Obese young women but not young men face reduced odds of college attendance (Crosnoe, 2007) and a wage penalty (Pagan & Davila, 1997). The actual “cost” of being obese is also nearly double for women (\$4,879) versus men (\$2,646) (Dor, Fergusson, Langworth, & Tan, 2010). Obese women also have trouble finding romantic and sexual partners (Sobal, 2006). They date less frequently and at later ages (Cawley, Joyner, & Sobal, 2006), experience sexual initiation later (Cawley et al., 2006) and have reduced odds of cohabiting and marrying (Mukhopadhyay, 2008).

Using Life Course Principles to Better Illuminate How Women’s Weight Influences Childbearing

The social burdens of female obesity—especially with respect to partnership—fuel our interest in expanding the lens used to understand how women’s weight influences childbearing. We use a life course perspective to do so. Four of its principles are particularly relevant to our study: life span development, the timing of life events, linked lives, and the role of time and place in contextualizing life trajectories (Elder, Johnson, & Crosnoe, 2003). We also consider sociodemographic variations in life course trajectories in our analysis; these variations have been a focus of life course inquiry emphasizing social stratification processes (Dannefer, 2003; DiPrete & Eirich, 2006).

The principles of life span development and timing are directly relevant to women’s lifetime childbearing experiences. The former emphasizes that long term perspectives shed light on complex biological, psychological and social processes that unfold over time to shape life course trajectories (Elder et al., 2003). Women’s fertility trajectories involve clearly recognized physiological and social processes (Bongaarts, 1978) that influence women’s timing, spacing, and number of births (Wood et al., 1994). Literature on physiological processes linking women’s weight and childbearing is quite deep. Knowledge about social contributions is sparser.

The principle of timing stresses that life course trajectories are altered and dependent upon when life events occur. This is readily apparent in women’s childbearing experiences. Their biological capability for childbearing is limited from first menarche to menopause, with peak fecundity in the late teens and early twenties (Menken, 1985). Women’s birth events also involve a non-reversible, time-limited sequence of events (Morgan & Rindfuss, 1999). This is unlike men, who can father children with multiple women simultaneously and for a longer proportion of their lives.

The principles of life span development and timing also undergird our focus on the consequences of early adult weight for lifetime childbearing. Obesity is generally viewed as consequential for childbearing when women attempt conception because adipose tissue has a negative physiological impact on fertility (Metwally et al., 2007). We contend that obesity’s consequences for childbearing are more far reaching and that they begin earlier in the life course. There are well-documented, long-term implications of health for life course trajectories (Haas, 2008). This includes long-term and accumulating consequences of body weight for morbidity, disability (even for individuals who lose weight as they age) (Ferraro & Kelley-Moore, 2003) and lifetime childlessness (Frisco, Weden, & Burnett, 2008).

One primary reason we expect women’s early adult weight to influence lifetime childbearing is because it influences their ability to form sexual partnerships (Sobal, 2006). In life course terminology, early adult weight shapes women’s ability to achieve linked lives

with potential partners for childbearing. Theoretically, this link can be quite brief, but in the U.S. there are still strong cultural norms that preference childbearing in marital unions. Obese women are less likely to marry or enter into less stable, cohabiting unions (Mukhopadhyay, 2008).

This suggests that early adult weight should influence lifetime childbearing not only because weight has a physiological impact on childbearing, but also because it influences partnership. Considering that weight stigma has remained relatively constant over time and has not diminished with the increasing obesity prevalence (Puhl, Andreyeva, & Brownell, 2008), all obese young women should be at a disadvantage for childbearing, regardless of the historical time period when they entered early adulthood.

Conversely, an alternative hypothesis arises when one considers the life course principle of place and time, which recognizes changing social and historical conditions as factors that shape life course trajectories (Elder et al., 2003). The association between early adult weight and childbearing may not be the same for women who entered adulthood during different historical time periods. If this hypothesis is supported, it is additional evidence that associations between weight and childbearing depend in part on social processes. We know of no physiological mechanisms pertaining to weight and childbearing which have changed over time—especially over the relatively short difference in historical time periods of interest in this study. We test this hypothesis by comparing two female cohorts who we refer to as Cohort 1 and 2. Cohorts 1 and 2 entered early adulthood in 1981 and 1986, respectively. We examine their childbearing experiences over a twenty year period.

Both cohorts reached their childbearing years after large scale social changes in the 1960's and 1970's gave women more control over childbearing. The oldest women in our sample were age two when oral contraceptive use was approved in 1960 and they just entered their teen years in 1972 when *Roe vs. Wade* legalized induced abortion. The oldest sample members were also children when the 1963 Equal Pay Act and the 1964 Civil Rights Act provided women with economic opportunities that produced competition between employment and childbearing. Thus, it is unsurprising that our descriptive analysis uncovers no significant differences in the number of children women in both cohorts had or in their prevalence of early, first, and higher order births (see Table 1).

Conversely, the two cohorts entered early adulthood on opposite sides of the upward spike in the obesity prevalence that occurred during the early 1980's. When Cohort 1 entered early adulthood in 1981, the obesity prevalence was still relatively low and at a level that had been constant for two decades (Flegal et al., 2002). When Cohort 2 entered adulthood in 1986, the obesity prevalence had begun a spike upward from under 15% in 1981 to 23% in 1986 (Flegal et al., 2002). Thus, it is unsurprising that we find small, yet statistically significant differences in the overweight and obesity prevalence of women in Cohort 1 and 2 (see Table 1).

This cohort difference in early adult weight may lead it to be more consequential for childbearing among women in Cohort 1 versus women in Cohort 2. This hypothesis is derived by considering how early adult weight shapes romantic partnership. As noted, the salience of physical appearance in partner selection is gendered. Young women not meeting the social ideals of female attractiveness are less likely to be considered suitable partners by men. Thus, men whose pool of potential female partners includes more lean women (i.e. when the obesity prevalence was lower) can better implement gendered social norms about attractiveness and partnership than men whose pool of potential female partners includes heavier women (i.e., when the obesity prevalence is higher).

Other historical differences in social context could also lead to cohort differences in associations between early adult weight and lifetime childbearing. For example, early adult weight could have fewer consequences for Cohort 2 because cohabitation was more prevalent when they entered early adulthood. These unions are less stable and more informal than marriage, but the number of children born to cohabiters increased precipitously in the 1980's (Raley, 2001). Although obese women are less likely than non-obese women to enter into both marital and cohabiting unions (Mukhopadhyay, 2008), obese women may be more likely to cohabit rather than to marry because individuals are less selective when choosing cohabiting partners. Thus, obese women who entered early adulthood when cohabitation was more common may have had a greater likelihood of childbearing.

Regardless of which social process underlies any observed cohort shift in the relationship between early adult weight and childbearing, the fundamental issue is whether there is a cohort difference in this relationship. If our findings demonstrate cohort differences, it points to the role that social processes play in relationships between early adult weight and childbearing.

Life course trajectories, weight trajectories, and fertility trajectories are all shaped by women's educational background and race/ethnicity. Thus, it is imperative that we account for them as confounders and consider whether they moderate the relationship between weight and childbearing.

Methods

Data and Sample

The NLSY79 is a longitudinal, nationally representative sample of 12,686, 14-21 year old Americans who were first interviewed in 1979. The original sample includes three subsamples: a nationally representative sample (N = 6,111), an oversample of Hispanic, Black, and economically disadvantaged Non-Black/Non-Hispanics (N = 5,295), and a military sample (N = 1,280). The nationally representative sample and the Hispanic and Black oversamples were followed up each year between 1979 and 1994 and biennially between 1994 and 2006. Response rates were very high. In 2006, 80.5% of the original 1979 sample had been retained (Center for Human Resources Research, 2006).

We analyze data from NLSY79 women followed by design from 1979 through 2006 (n=5,827). We exclude male respondents for substantive reasons previously discussed and because men's data on childbearing and paternity are biased downward. Men underreport non-marital births, daughters, and children from prior relationships (Rendall, Clarke, Peters, Rajit, & Verropoulou, 1999). We also exclude women who were never observed after 1981 when height and weight data were first collected (n=47), who refused to respond to any childbearing questions (n=97), and for whom no height and weight data are available (n=112).

From this sample of women (n=5,571), we identify two cohorts who entered early adulthood five-years apart. Cohort 1 entered early adulthood in 1981 (n=2,029). Cohort 2 entered early adulthood in 1986 (n=1,948). At these baseline time points, women in both cohorts ranged in age from 21-23.

The NLSY79 is recognized as the best source of U.S. data for studying women's lifetime childbearing experiences because it contains rich childbearing histories based on data obtained annually or biannually from women (Quesnel-Vallee & Morgan, 2003). This makes it an excellent dataset for our study, which was deemed exempt from human subjects review because the NLSY79 data are publicly available. We employ data from all NLSY79

waves through 2006 to estimate and contrast completed childbearing by age 41-43 among women in Cohort 1 and 2. The NLSY79 also collects height and weight data from women regularly. They first did so in 1981, when Cohort 1 entered early adulthood. These data were also collected in 1986, when Cohort 2 entered early adulthood.

We use multiple imputation to replace missing data on all analytic variables (Royston, 2005). Imputed data are used in all descriptive and multivariate analyses. The method repeatedly replaces missing values with predicted values based on random draws from the posterior distributions of the parameters observed in the sample, creating multiple complete data sets. We base prediction models on the rich set of social and economic variables available in the NLSY79 and available childbearing and weight data collected annually or biannually in each panel. We follow standard protocols to account for random variations across multiply imputed data sets (Royston, 2005). Data for this study are derived from a publicly available secondary dataset and the study was deemed exempt from human subjects' considerations by Penn State University's Office of Research Protection.

Measures

Childbearing over the Life Course—Data on childbearing through age 41-43 (the 2002 wave for Cohort 1 and the 2006 wave for Cohort 2) are abstracted from the NLSY79 childbearing and relationship history file, which results from significant editing, recoding and data quality assessment of the fertility data collected at each annual or biannual survey panel (Mott, Baker, Ball, Keck, & Lenhart, 1998). We use these data to create a variable indicating completed childbearing, or women's total number of births between baseline (1981 and 1986, respectively for Cohorts 1 and 2) and age 41-43. From this measure we identify women who ever had a birth between baseline and age 41-43 (1=one or more live births, 0=no births) and women who had a higher order birth between baseline and age 41-43 (1= two or more live births, 0=one birth, missing if women had no births). We also assess early childbearing, or a birth on or before baseline, when women were age 21-23. These outcomes represent an excellent snapshot of women's life course childbearing experiences.

Never Married—Using data on age at first marriage from the childbearing and relationship file, we construct never married. It indicates whether a woman never married by age 41-43 (1 = yes).

Baseline Body Mass Index (BMI)—We measure BMI from self-reported height and weight in 1981 (for Cohort 1) and 1986 (for Cohort 2) using Centers for Disease Control (CDC) guidelines:

$$BMI = \text{weight (lb)} / [\text{height (in)}]^2 \times 703.$$

Some analyses also utilize CDC weight categories indicating underweight (BMI < 18.5), normal weight (18.5 ≤ BMI < 25), overweight (25 ≤ BMI < 30), and obese (BMI ≥ 30).

We select women's baseline weight to ensure appropriate causal ordering between early adult weight and childbearing. Early adulthood is also a critical time for establishing and solidifying romantic partnerships, making early adult weight substantively important for our study. Furthermore, average weight trajectories increase with age until midlife (Baltrus, Lynch, Everson-Rose, Raghunathan, & Kaplan, 2005). Women who are heavy at baseline are unlikely to be leaner as they progress through their reproductive years and are thus at most risk of their weight posing problems for childbearing.

Control Variables—We control for women’s individual characteristics, observed at baseline, which may confound associations between BMI and childbearing. Chief among them are race/ethnicity (Black, Hispanic, White), women’s years of education and their mothers’ years of education. We also control for women’s age of menarche and their fertility expectations, or expected number of children. In sensitivity analyses, we also controlled for self-esteem, family poverty status, work-related health limitations, urbanicity, and region, but found that they provided no additional explanatory power.

Statistical Analyses

We first show weighted summary statistics for both cohorts (Table 1). They describe cohort differences on all analytic variables. Summary statistics and all regression models described below incorporate survey weights calculated by the CHHR to adjust for the NLSY79’s complex sampling strategy and attrition.

We use weighted logistic regression models to estimate associations between early adult weight and childbearing outcomes. For each outcome, we present two models estimated separately for each cohort. Model 1 only includes early adult weight. Model 2 adds control variables to Model 1. We tested for statistically significant cohort differences in the relationship between early adult weight and childbearing in supplemental models estimated using data from the pooled sample of women in both cohorts. These models included a dichotomous variable indicating women’s cohort membership and an interaction term between the cohort variable and each covariate. In all tables, we indicate cohort differences identified via the statistical test of cohort-interactions with a superscript “c”.

The first outcome we examine is early childbearing (Table 2). We have no observations of weight before 1981, so this analysis is cross-sectional. It provides insight into the relationship between early adult weight and women’s childbearing trajectories by showing whether there are differences in the characteristics of women who had children on or prior to ages 21-23.

For analyses estimating ever birth (Table 3) and higher-order birth (Table 4), we exclude women with births prior to ages 21-23. Since childbearing leads some women to gain weight, this restriction reduces potential reverse-causality bias. Age 21-23 is the baseline for these analyses because it is the earliest point when we observe weight in both cohorts. We estimate the relationship between weight at age 21-23 and the likelihood of ever having a birth between ages 21-23 and ages 41-43. We then subset from the sample those women who had at least one birth, and assess the relationship between weight at age 21-23 and the likelihood of a higher order birth by age 41-43.

Together, the analyses just described provide a composite picture of how early adult weight influences lifetime childbearing and whether this association is different in two historical contexts. Findings will offer evidence about whether early adult weight’s consequences for fertility are malleable because social mechanisms are involved.

To further consider the role of social factors, we analyze the relationship between early adult weight and whether women in each cohort never married (by age 41-43) in models without (Model 1) and with (Model 2) confounders (Table 5). Findings indicating the presence/absence of an association between weight and marriage provide evidence about whether marriage is a pathway linking early adult weight to childbearing. Findings on cohort-differences in this association provide evidence about its malleability in different historical contexts. If findings on cohort differences in weight’s consequences for marriage parallel findings from analyses of weight’s consequences for childbearing, we can more authoritatively adjudicate on weight’s social versus biological consequences.

Results

Cohort Characteristics

Table 1 provides descriptive statistics for Cohort 1 and 2. As noted previously, there are no significant differences in the two cohorts' childbearing histories. Their sociodemographic characteristics are also nearly identical. There are small, statistically significant cohort differences in fertility expectations (1.6 versus 1.8, respectively, for Cohorts 1 and 2), making this a particularly important control variable. The primary difference between cohorts is that Cohort 2 is heavier in early adulthood. Their BMI is 0.739 kg/m² higher and their prevalence of overweight and obesity are 4.0% and 2.0% higher, respectively. This difference reflects the documented weight increase that began in the early 1980's and suggests that these cohorts entered early adulthood in the face of historical shifts in weight context.

Early Adult Weight and Early Childbearing

Table 2 presents the cross-sectional relationship between early adult weight and early childbearing (on or prior to age 21-23). In Model 1, overweight (versus normal weight) young women in both cohorts are more likely to report early childbearing. Early adult obesity is also positively associated with early births among Cohort 2, but not Cohort 1 (although this difference is not statistically significant). When we account for confounders in Model 2, these positive associations disappear. Instead, we observe a statistically significant cohort difference in the estimated effect of weight. Early adult weight is not associated with early childbearing among Cohort 2, but among Cohort 1, there is a negative association between early adult obesity and early childbearing. Supplemental models indicate that the shift in the direction, magnitude and statistical significance of early adult weight from Model 1 to Model 2 emerges when models include race/ethnicity *and* women's years of schooling, but no other confounders.

When we estimate early adult childbearing with BMI rather than weight categories, similar findings emerge (results available upon request). In fact, we find no association between BMI and early childbearing net of confounders for women in either cohort until we include a quadratic BMI term in statistical models. It shows that models estimating early childbearing with BMI alone mask its nonlinear association with early childbearing among Cohort 1 women. No association between BMI and early childbearing emerged among Cohort 2 women. This cohort difference is statistically significant.

Before moving on, note that Model 2 in Table 2 reveals no cohort differences in the estimated effect of confounders. The coefficients from cohort stratified models are similar in magnitude for race/ethnicity, respondents' and mother's education, and age at menarche. This strengthens our assertion that real cohort differences in the association between early adult weight and early childbearing exist.

Body Weight and Adult Childbearing

Tables 3 and 4 show how early adult weight is related to having first and higher order births among women who did not give birth prior to baseline (ages 21-23 for both cohorts). Regardless of whether statistical models include confounders, early adult BMI is negatively and significantly related to ever having a birth among Cohort 1. Each increase in early adult BMI reduces the odds of first birth by 5.9% (1-exp(-0.061)). Early adult BMI is not significantly associated with first birth among Cohort 2. This cohort difference is statistically significant. Similar results emerge in Table 4. In Models 1 and 2, an increase in early adult BMI reduces the odds of higher order births among Cohort 1 women who previously had a first birth, but this relationship is not evident among Cohort 2 women. This

cohort difference is statistically significant. Sample power precludes us from estimating models predicting first and higher order births using weight categories. However a quadratic BMI term was not statistically significant and did not substantively alter the findings when it was added to models.

To better interpret these results, consider how they apply to two hypothetical Cohort 1 women with a BMI of 20 (normal weight) and 33 (obese). The obese woman has more than twice the odds of childlessness as the normal weight woman ($1/(\exp(-0.061*33)/\exp(-0.061*20))$). If she has a first birth, she has nearly twice the odds of not having a second birth. This is troubling given that normal and obese young women have equivalent fertility expectations (the average expected number of children in Cohort 1 is 2.19 with a .20 non-significant difference in expectations between obese and normal women).

The lack of associations between race/ethnicity, women's educational background and birth outcomes estimated in Tables 3 and 4 may be surprising at first glance. Supplementary analysis reveals that this results from excluding women who had early births from analyses.

The Appendix shows results from supplementary analyses suggesting that estimated negative associations between early adult weight and childbearing observed for Cohort 1 are similar for women from different racial/ethnic backgrounds. Early adult obesity has a large, statistically significant, negative association with early childbearing among Black and White women net of confounders. We also find a negative and statistically significant association between early adult BMI and ever having a birth among Black and White women who did not have births prior to baseline. In models predicting these outcomes for Hispanic women, the coefficients for early adult obesity and BMI are also negative, but are not statistically significant. We cannot determine whether this represents a null finding or a lack of statistical power, but we suspect the latter explanation applies. There are only 13 obese Hispanic women in Cohort 1. When we further constrain Cohort 1 to women without early births, the sample includes 3 obese Hispanic women. A lack of statistical power also precludes our ability to show reliable models predicting higher order births stratified by race/ethnicity.

Among Cohort 2, early adult weight is never related to childbearing in models stratified by race/ethnicity. We do not show these results due to space constraints.

Body Weight and Remaining Unmarried

Findings suggest cohort differences in early adult obesity's consequences for lifetime childbearing. When we estimate whether cohort differences in associations between early adult obesity and never marrying also exist, results suggest that the answer is yes (Table 5). We present findings for women who did not have early births because marriage is a more likely pathway for childbearing for this female subsample. Models estimated among the full sample of women in each cohort produce analogous findings. In Cohort 1, regardless of whether statistical models include confounders, overweight and obese young women have higher odds of remaining unmarried than normal weight peers. Net of confounders, obese young women's odds of never marrying are over four times higher ($\exp(1.399)$). Early adult obesity is unrelated to never marrying among Cohort 2. This cohort difference is statistically significant.

Discussion

Our overall goal was to show whether the relationship between women's weight and childbearing is more complex than currently recognized because weight is a deleterious health condition and a gendered social status. Drawing from life course theory and capitalizing on NLSY79 data that captures biographical and historical time, we evaluate

whether early adult weight has long-term consequences for lifetime childbearing outcomes, whether these consequences differ for two cohorts who entered early adulthood in different historical periods, and whether they emerge in part from women's ability to marry. To the best of our ability, given sample power constraints, we also evaluated whether these relationships are similar for women from different racial/ethnic backgrounds.

One of our primary contributions is showing how early adult weight is associated with childbearing outcomes across a woman's life course, and cohort differences in these associations. Early adult weight is not associated with any of the childbearing outcomes among Cohort 2 women. In contrast, obese women in Cohort 1 are less likely to have early births than leaner women. Additionally, heavier young women in Cohort 1 who did not have early births are less likely than leaner peers to progress to first and higher order births. These findings suggest that early adult weight has had a lasting impact on childbearing for some, but not all, women.

We posit that these cohort differences in the fertility consequences of early adult weight operate through sexual and romantic partnership. Parallel to findings for childbearing, heavier young women in Cohort 1 were less likely to marry than leaner counterparts. This is a second study contribution. It substantiates the notion that social mechanisms link early adult obesity to lifetime childbearing. We recognize that not all births occur in marital unions. This is why we restrict our analysis of weight and marriage to women for whom marital childbearing is most likely—women who did not have early births. A promising avenue for future research is investigating whether weight has different consequences for marital and non-marital childbearing.

Another study suggests more direct support for the notion that obese women's competition for sexual partners alters the association between weight and childbearing. It estimates associations between adolescent weight and childbearing among girls in different high school weight contexts. Results indicate that the odds of adolescent childbearing are 50% lower for obese versus non-obese high school girls, but as the proportion of obese students in a school increases, obese girls' odds of childbearing increase and surpass that of non-obese girls (Buher-Kane and Frisco, 2010). In other words, when obese girls face less competition on the dating market from leaner peers, they are no longer less likely to bear children.

The fact that we find cohort differences in the association between early adult weight and each of our outcomes also suggests that there are social processes that link weight to childbearing. There is no reason to suspect that a purely physiological association would change in different historical periods. We speculate that observed cohort differences arise because obese women in Cohort 1 entered early adulthood in an historical period where the obesity prevalence was lower and had been quite low for some time. They therefore faced more competition from leaner women on the dating and marriage market, which seems to have precluded their ability to marry and bear children across a 20 year period. In essence, they may have suffered more from the gendered consequences of the political economy of obesity. That said, we acknowledge that there are alternative explanations for observed cohort differences. We discuss one of them earlier in the manuscript (e.g., the higher prevalence of cohabitation in 1986 versus 1981).

An additional study contribution is showing the role of race/ethnicity and women's education in associations between early adult weight and childbearing. Both are important confounders. In models not controlling for race/ethnicity and women's educational background, early adult weight is positively related to early childbearing among women in both cohorts. In models including these controls, obese young women in Cohort 1 are less

likely to have early births; there is no association between weight and early births among Cohort 2 women.

That said, we find no evidence that early adult weight operates differently on lifetime childbearing by race/ethnicity. Where our data allows us to estimate models stratified by race/ethnicity, early adult weight is deleterious for Black and White women. We speculate that the same is true for Hispanic women, but limited statistical power precludes our ability to conclude this with certainty.

In summary, our findings do not lead us to doubt clinical evidence linking obesity to fecundity. Instead, they make a substantial contribution to the literature by showing that the impact that weight has on childbearing is more complex, lasting, and multidimensional. Future research should explore other potential complexities in relationships between weight and childbearing including the previously mentioned need for further study of weight's consequences for marital versus non-marital births. Additionally, little is known about how weight gain or loss changes women's lifetime childbearing trajectories. If weight change makes little difference, this would highlight the social contribution that early adult weight makes to lifetime childbearing. Other promising endeavors for future research include investigations of women's weight and intended versus unintended childbearing and women's weight versus weight perceptions and childbearing.

Future research should also address issues related to this study's limitations. For example, we cannot directly assess the relevance of weight-related stigma in partnership and childbearing dynamics using NLSY79 data. In addition, only 5 years separate the years when our two female cohorts entered adulthood and completed childbearing. If we studied female cohorts with more historical distance between them, we could better leverage more dissimilar U.S. historical contexts. In fact, sensitivity analyses show that varying average number of years between the cohorts from 4 to 6 does not change the direction or substantive meaning of our findings, but the difference in weight consequences between cohorts become larger in a stepwise fashion as the average number of years between cohorts increases. This limitation does offer advantages. We can examine the impact of early adult weight on lifetime fertility experiences because we analyze data from the two most recent U.S. cohorts with available lifetime fertility data. Furthermore, the short historical distance between cohorts implies that we make conservative estimates of cohort differences.

Our final limitation is that we measure body fatness using BMI calculated from self-reported height and weight. It correlates well with other body fatness assessments (e.g., dual energy x-ray absorptiometry) and has generally good reliability (Centers for Disease Control and Prevention, 2009), but is admittedly an imperfect measure and could bias our findings. This would be especially true if there were cohort differences in weight underreporting. To evaluate this possibility, we compared estimates of weight for the overall female NLSY sample to estimates of weight for a similar female birth cohort who participated in the National Health and Nutrition Study II (NHANES II). This study measured height and weight. The prevalence of obesity is comparable between the studies, suggesting that differential under-reporting is unlikely to account for the cohort differences we observe.

Despite limitations, our study reveals evidence that the relationship between early adult weight and childbearing is multidimensional and malleable; most likely because weight is not simply a physiological mechanism linking the two. The gendered and social consequences of weight also appear to reduce heavy young women's lifetime odds of bearing children and marrying in some social contexts.

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Appendix

Weighted Log-Odds of Birth vs. No Birth before Age 21-23 and First Births between ages 21-23 and 41-43 by Early Adult Weight, for White, Black and Hispanic Women in Cohort 1, NLSY79^a

Panel 1: Birth vs. No Birth before Age 21-23			
	White Women (N = 1241)	Black Women (N = 480)	Hispanic Women (N = 308)
	b (se)	b (se)	b (se)
BMI weight categories (age 21-23)			
Underweight	.027 (.288)	.265 (.478)	-.447 (.639)
Normal weight			
Overweight	.487 (.267)	-.044 (.307)	.155 (.355)
Obese	-1.177 [†] (.593)	-.762 [†] (.338)	-.035 (.752)
Panel 2: First Births (between ages 21-23 and 41-43)			
	White Women (N = 697)	Black Women (N = 180)	Hispanic Women (N = 144)
	b (se)	b (se)	b (se)
BMI (age 21-23) ^b	-.056 [†] (.027)	-.076 [†] (.032)	-.046 (.063)

[†]p<0.10;

*p<0.05;

**p<0.01;

***p<0.001.

^aStatistical models used to obtain these estimates also control for women's years of schooling, mother's years of schooling, age at first menarche. The model used to predict first birth also includes fertility expectations.

^bSample size limitations preclude the analysis of BMI weight categories; however a quadratic BMI term was not statistically significant in supplementary models.

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Table 1

Descriptive Characteristics of Two U.S. Cohorts Age 21-23 in 1981 and 1986, NLSY79

	Cohort 1: (N = 2,029) 21-23 in 1981 weighted mean/ proportion (SE)	Cohort 2: (N = 1,948) 21-23 in 1986 weighted mean/ proportion (SE)
<u>Completed Childbearing by age 41-43</u>		
Total births	1.91 (0.038)	1.81 (0.040)
Ever birth	0.817 (0.011)	0.788 (0.012)
Higher order birth, if ever birth	0.792 (0.014)	0.765 (0.013)
<u>Early Childbearing</u>		
Birth on or before age 21-23	0.327 (0.013)	0.313 (0.013)
<u>Never married before age 41-43</u>	0.120 (0.008)	0.139 (0.009)
<u>Body Weight at age 21-23</u>		
BMI	22.2 ^c (0.107)	22.9 ^c (0.119)
BMI weight categories		
Underweight	0.096 (0.009)	0.083 (0.008)
Normal weight	0.738 ^c (0.012)	0.693 ^c (0.014)
Overweight	0.112 ^c (0.008)	0.152 ^c (0.010)
Obese	0.054 ^c (0.006)	0.072 ^c (0.007)
<u>Age of 1st Menarche</u>	12.7 (0.042)	12.8 (0.044)
<u>Fertility Expectations</u>		
Expected total number of children at age 21-23	1.6 ^c (0.035)	1.8 ^c (0.034)
<u>Sociodemographics</u>		
Race/ethnicity		
White	0.800 (0.008)	0.795 (0.008)
Black	0.139 (0.007)	0.140 (0.007)
Hispanic	0.061 (0.004)	0.065 (0.004)
Years of education	12.8 (0.054)	12.8 (0.054)
Mother's years of education	11.5 (0.076)	11.5 (0.072)

^cDenotes a statistically significant difference between Cohort 1 & 2 (p<.05)

Table 2

Cohort Differences in Women's Weighted Log-Odds of Birth vs. No Birth before Age 21-23 by BMI, NLSY79

	Model 1		Model 2	
	Cohort 1 ^a (n=2,029)	Cohort 2 ^b (n=1,948)	Cohort 1 (n=2,029)	Cohort 2 (n=1,948)
	B (se)	b (se)	b (se)	b (se)
BMI weight category (age 21-23)				
Underweight	-.043 (.209)	.336 (.225)	.025 (.250)	.373 (.275)
Normal weight				
Overweight	.679 *** (.172)	.322 * (.160)	.382 (.209)	-.022 (.183)
Obese	.021 (.239)	.656 ** (.214)	-.934 *** ^c (.352)	.191 ^c (.255)
Race/ethnicity				
White				
Black			1.277 *** (.140)	.998 *** (.138)
Hispanic			.084 (.202)	-.017 (.189)
Years of education			-.662 *** (.059)	-.600 *** (.058)
Mother's years of education			-.015 (.030)	-.060 * (.028)
Age of 1st menarche			-.051 (.048)	-.043 (.041)
Intercept	-.803 *** (.068)	-.918 *** (.073)	8.182 *** (.978)	7.715 *** (.847)

*
p<0.05;

**
p<0.01;

p<0.001.

^a Cohort 1 is observed at age 21-23 in 1981.

^b Cohort 2 is observed at age 21-23 in 1986.

^c Denotes a statistically significant difference between Cohort 1 & 2 (p<.05)

Table 3

Cohort Differences in Women's Log-Odds of First Births (between ages 21-23 and 41-43) by BMI, NLSY79

	Model 1		Model 2	
	Cohort 1 (n=1,021)	Cohort 2 (n=1,148)	Cohort 1 (n=1,021)	Cohort 2 (n=1,148)
	b (se)	b (se)	b (se)	b (se)
BMI (age 21-23) ^d	-.054 ^{*c} (.020)	-.000 ^c (.017)	-.061 ^{**c} (.023)	.005 ^c (.019)
Race/ethnicity				
White				
Black			-.111 (.204)	-.161 (.176)
Hispanic			.525 [†] (.281)	.065 (.226)
Years of education			-.143 ^{**c} (.049)	.062 ^c (.051)
Mother's years of education			.035 (.037)	-.070 [*] (.034)
Age of 1st menarche			.064 (.064)	.067 (.056)
Fertility expectations			.323 ^{***} (.093)	.374 ^{***} (.080)
Intercept	2.070 ^{***} (.473)	.814 [*] (.415)	2.284 ^{*c} (1.276)	-.908 ^c (1.225)

[†] p<0.10;^{*} p<0.05;^{**} p<0.01;^{***} p<0.001.^a Cohort 1 is observed at age 21-23 in 1981.^b Cohort 2 is observed at age 21-23 in 1986.^c Denotes a statistically significant difference between Cohort 1 & 2 (p<.05)^d Sample size limitations preclude the analysis of BMI weight categories; however a quadratic BMI term was not statistically significant in supplementary models.

Table 4

Cohort Differences in Women's Log-Odds of Higher Order Births (between ages 21-23 and 41-43) by BMI, NLSY79

	Model 1		Model 2	
	Cohort 1 (n=693)	Cohort 2 (n=768)	Cohort 1 (n=693)	Cohort 2 (n=768)
	b (se)	b (se)	b (se)	b (se)
BMI (age 21-23) ^d	-.053 ^{†c} (.027)	.013 ^c (.024)	-.052 ^{†c} (.028)	.040 ^c (.027)
Race/ethnicity				
White				
Black			-.332 (.303)	-.179 (.237)
Hispanic			.098 (.402)	.128 (.324)
Years of education			.070 (.084)	.133 [*] (.062)
Mother's years of education			-.062 ^c (.053)	.045 ^c (.043)
Age of 1st menarche			.034 (.076)	.133 [†] (.077)
Fertility expectations			.131 (.093)	.260 ⁺ (.135)
Intercept	2.129 *** (.618)	.734 (.567)	1.224 *** ^c (1.629)	-4.442 *** ^c (1.648)

[†] p<0.10;

^{*} p<0.05;

^{**} p<0.01;

^{***} p<0.001.

^a Cohort 1 is observed at age 21-23 in 1981.

^b Cohort 2 is observed at age 21-23 in 1986.

^c Denotes a statistically significant difference between Cohort 1 & 2 (p<.05)

^d Sample size limitations preclude the analysis of BMI weight categories; however a quadratic BMI term was not statistically significant in supplementary models.

Table 5

Cohort Differences in the Relationship between Baseline BMI Weight Categories and Never Having a Marriage by Age 41-43 for Women Who Did Not Have a Birth Prior to Baseline, NLSY79

	Model 1		Model 2	
	Cohort 1 (n=1,021)	Cohort 2 (n=1,148)	Cohort 1 (n=1,021)	Cohort 2 (n=1,148)
	b (se)	b (se)	b (se)	b (se)
BMI weight categories (age 21-23)				
Underweight	-.577 (.429)	.241 (.389)	-.410 (.437)	.233 (.391)
Normal Weight				
Overweight	.874 ** (.296)	.162 (.271)	.823 * (.321)	.072 (.286)
Obese	1.308 *** ^c (.352)	.537 ^c (.327)	1.399 *** ^c (.398)	.366 ^c (.347)
Race/ethnicity				
White				
Black			1.419 *** (.220)	1.108 *** (.191)
Hispanic			.112 (.347)	.558 * (.253)
Years of education			.180 *** ^c (.061)	-.103 ^c (.060)
Mother's years of education			-.040 ^c (.043)	.048 ^c (.039)
Intercept	-1.849 *** (.095)	-1.759 (.117)	-4.046 *** (.812)	-1.130 * (.741)

[†] p<0.10;

* p<0.05;

** p<0.01;

*** p<0.001.

^a Cohort 1 is observed at age 21-23 in 1981.

^b Cohort 2 is observed at age 21-23 in 1986.

^c Denotes a statistically significant difference (p<.05) between Cohort 1 & 2