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Article

Motherhood, fatherhood and midlife weight gain in a US cohort: Associations differ by race/ethnicity and socioeconomic position[☆]

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ABSTRACT

While there is an association of greater short-term weight gain with childbearing among women, less is known about longer-term weight gain, whether men have similar gains, and how this varies by race/ethnicity and socioeconomic position. Our cohort consisted of a nationally representative sample of 7356 Americans with oversampling of Black and Hispanic populations. We estimated the associations between number of biological children and parental weight, measured as both change in self-reported body mass index (BMI) from age 18 and overweight/obese status (BMI ≥ 25) at age 40. We performed multivariate linear and logistic regression analysis and tested for effect modification by gender. For change in BMI, men gained on average 0.28 BMI (95% CI: (0.01, 0.55)) units per child, while women gained 0.13 units per child (95% CI: (-0.22, 0.48)). The adjusted odds ratios for overweight/obesity associated with each child were 1.32 (95% CI: (1.11, 1.58)) for men and 1.15 (95% CI: (1.01, 1.31)) for women. Stratified analyses by race/ethnicity and socioeconomic position suggested that the observed full-cohort differences were driven primarily by gendered differences in low-income Hispanics and Whites – with the greatest associations among Hispanic men. For example, among low-income Hispanic men we observed a positive relationship between the number of children and weight change by age 40, with average weight change of 0.47 units per child (95%CI: (-0.65, 1.59 For low-income Hispanic women, however, the average weight change was -0.59 units per child (95%CI: (-1.70, 0.47), and the P-value for the test of interaction between gender and number of children was $P < 0.001$. Our findings suggest that the shared social and economic aspects of raising children play an important role in determining parental weight at mid-life.

Introduction

Post-adolescence and early adulthood are sensitive stages of physical development that set the course for lifetime body weight (Guo et al., 2000; Pudrovska, Logan & Richman, 2014; Hirko et al., 2015). Becoming a parent is a profound life change that often occurs during this time and marks a transition point when people may modify their diet and behavior (Bellows-Riecken & Rhodes, 2008; Kerr, Capaldi, Owen, Wiesner & Pears, 2011; LaRoche, Wallace, Snetselaar, Hillis & Steffen, 2012; Rhodes et al., 2014). The burdens of childbearing and rearing are unequally shared between men and women (Renk et al., 2003), and gendered expectations of the accompanying roles and demands differ between racial/ethnic and economic strata (Hoff, Laursen & Tardif, 2002; Glauber, 2008; Bornstein & Bradley, 2014).

Americans gain on average 10 to 15 kg over 15 years during young adulthood (Truesdale et al., 2006). This gain increases the risk for adverse health outcomes such as diabetes, cardiovascular disease, and premature death (de Mutsert, Sun, Willett, Hu & van Dam, 2014; Loria, Signore & Arteaga, 2010). Though the requisite weight change from pregnancy has focused attention on weight control during and immediately after childbearing for women (Yaktine & Rasmussen, 2009; Gunderson & Abrams, 1999), there is evidence that having a child is associated with increased risk of long-term weight gain and obesity and its sequelae in both women (Brown, Kaye & Folsom, 1992; Weng, Bastian, Taylor, Moser & Ostbye, 2004; Brown, Hockey & Dobson, 2010; Abrams, Heggeseth, Rehkopf & Davis, 2013; LaRoche et al., 2013; Skilton, Sérusclat, Begg, Moulin & Bonnet, 2009) and men (Weng et al., 2004; LaRoche et al., 2013; Umberson, Liu, Mirowsky & Reczek, 2011; Garfield et al., 2015; Davis, Zyzanski, Olson, Stange & Horwitz, 2009), although some studies only observe changes in subcohorts defined by

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race or gender (LaRoche et al., 2013; Skilton et al., 2009). However, while women's weight gain during and after pregnancy has been shown to vary by race and socioeconomic position (LaRoche et al., 2013; Davis et al., 2009; Bakhshi et al., 2008), it is unclear if these differences are mirrored in men, as current evidence is inconsistent. For example, Weng et al., (2004) observed a higher probability of obesity associated with each additional child in both women and men. LaRoche et al. (2013) observed a significant association between having children on BMI change among both black and white women but did not see a similar association among men of either race. Skilton et al. (2009) observed associations between parenthood and weight gain in both men and women, as well as life contexts in which these associations appeared strongest.

Given this prior work, our study is motivated by the importance of understanding whether the association between number of children and weight gain is most consistent with primarily a biologically programmed process, or whether differences exist across populations. Divergent magnitudes of association between number of children and weight gain across gender, race/ethnicity and socioeconomic position would suggest a greater importance for social context in impacting how weight gain is associated with number of children. A second motivation is to provide a comprehensive descriptive background for supporting further studies to better understand the reasons for gender, race/ethnicity and socioeconomic position based differences in weight gain over the life course. Weight and obesity have been observed to differ by socioeconomic group and number of children, and the strength of this relationship differs across racial/ethnic groups (Headen, Davis, Mujahid & Abrams, 2012; Zhang & Wang, 2004).However, the underlying factors behind these differences are not well understood. Differences in how the number of children manifest in weight gain could contribute to these differences, and thus a description of this is useful for understanding how to reduce gender, racial/ethnic and socioeconomic disparities in obesity.

We therefore studied the relationship between number of children and parental weight at age 40 in a longitudinal United States representative cohort with oversampling of Black and Hispanic populations. Our objective was first to describe gendered differences in the association between the number of biological children and weight at age 40, as measured by change in BMI by 40, and overweight and obese status. Secondarily, we examined whether these differences are modified by race/ethnicity and socioeconomic position.

Methods

Cohort description

The National Longitudinal Survey of Youth 1979 (NLSY79) is a U.S. nationally representative longitudinal survey conducted by the U.S. Bureau of Labor Statistics, which enrolled 12,686 men and women between the ages of 14 and 22 in 1979. Participants were recruited and surveyed every 1–2 years since, with the last available data from 2014. Detailed information on the recruitment, sampling strategy, survey timing and study questions are available at the study website (http://www.bls.gov/nls/nlsy79.htm).

NLSY79 augmented the primary nationally representative sample with several supplemental samples targeting Hispanics, Blacks, military personnel, and economically disadvantaged Whites. Data collection ceased for the military personnel and economically disadvantaged Whites in 1990 so we included only the primary sample and supplemental samples of Hispanics and Blacks in this analysis (n = 9763). Of these, we excluded 975 (10%) who reported having a child prior to their first reported weight and 68 (1%) who reported their first weight when older than 25, for a target population of 8720 eligible respondents. Our final analytical population consisted of the 7425 members of the target population with a self-reported weight at age 40.

Study variables

Respondents reported their weight in the 1981 and 1982 surveys, then again in 1985 and in all subsequent rounds. They also reported their height in the 1981, 1982 and 1985 surveys as well as in all rounds after 2006. We calibrated these self-reported responses using gender and age-based correction factors derived from the National Health and Nutritional Examination Survey III (Kuczmarski, Kuczmarski & Najjar, 2001; Burkhauser & Cawley, 2008) and used their most recent values to calculate Body Mass Index (BMI (weight kg / height m^2)) at each wave. We defined midlife BMI change as the difference between the first BMI estimate after age 18 and the first BMI estimate after age 40. Overweight and obese statuses were categorized as BMI greater than 25 and 30, respectively, at the first BMI estimate after age 40 (World Health Organization).

Respondents reported the birthdates for each of their biological children in every survey. We used these dates to determine the number of biological children born to each cohort member between age 18 and 40. We truncated this measure at 4 children in our analysis due to small numbers (2% of the cohort had 5 children, 1% had 6 and 0.7% had 7).

The NLSY79 collects information on the social and economic lives of the study respondents. We created a set of variables that we considered *a priori* as possible confounders of the relationship between number of children and parental weight. These included gender, race/ethnicity (categorized as Asian, Black, Hispanic or White), education of each participants' parents (categorized as less than High School, High School Grad, Some College, or College Grad), being born in an urban locale (binary), being born in a Southern locale (binary), BMI category at first measurement (underweight, normal weight, overweight, obese), ever smoking (binary), average equivalized (to year 2000 dollars) household income between ages 18 and 40, and wealth at age 25, as calculated at each survey from self-report of savings, debt, and home and vehicle ownership. Average household income and wealth at age 25 were modeled as categorical variables with bins defined by their population quartiles.

Living with and supporting young children may be associated with parental weight gain (Umberson et al., 2011), so we used data on household composition at each wave to calculate the percent of years when each parent lived with a child less than 10 years old. This percent was dichotomized into two levels, less than and greater than 95%; the cut-off was chosen due to the left-skewed distribution of this variable. We also determined whether or not the respondent's household ever reported paying child support during the study period.

Statistical analysis

We used least squares regression to model the association between number of children and change in BMI from baseline to age 40 as a function of the observed covariates in the analytical cohort. We used logistic regression to model the predictive ability of child count on the probability of overweight/obese (BMI > 25) statuses at age 40. We included an interaction term to assess gender differences in these associations, and assessed the significance of this term using a Wald test. All other measured potential confounders were included as adjustment terms in each model.

Fifteen percent (n= 1268) of the eligible 8720 subjects were missing a report of weight after age 40 due to loss to follow up. We used an inverse probability approach to adjust for the potential bias from differential non-response (Vansteelandt, Carpenter & Kenward, 2015; Seaman & White, 2013). This adjustment consisted of two steps. First, we modeled the probability of observing the age 40 BMI in the cohort given the measured covariates using logistic regression. Second, we weighted fully observed subjects in all regression models by the inverse of the predicted probability from this model. Lower predicted probabilities (and therefore a higher sample weight) imply that a subject is underrepresented relative to the total target population. The final analysis was performed using a weighted sample of 7452 respondents, 75% of the original sample and 85% of those meeting the inclusion criteria.

We performed stratified analyses fitting the same regression models in subsets of the cohort to assess effect measure modification by race and socioeconomic position. The first stratification was on race/ethnicity, fitting separate models for the Black (n= 2055), Hispanic (n= 1177), and White/other (n = 4158) cohorts. Asians (n = 62) were dropped from the stratified analyses due to insufficient sample size. The second stratification was by average total equivalized household income across the follow-up period. Within each of the racial/ethnic strata, models were fit on substrata defined by cut-offs at the median average income ($29,474) of the full data sample. Six additional data sets were thus created: Blacks above median income (n = 673), Blacks below median income (n = 1382), Hispanics above median income (n = 646), Hispanics below median income (n = 531), Whites above median income (n = 2812), and Whites below median income (n = 1346).

Our primary research targets were the regression parameters associated with both child count and the interaction of child count and gender. We considered a P value < 0.05 for these parameters to be statistically significant, and a P value between 0.05 and 0.1 to be marginal. The significance of the child count parameter indicates the degree to which it is associated with the weight outcome, while the significance of the interaction parameter indicates the degree to which this association varies by gender. We illustrate these by first predicting the weight change (or probabilities of overweight/obese status) at various numbers of children separately for men and women. We then plot these estimates, as well as 95% confidence intervals (95% CI), for each of the stratified models.

We performed sensitivity analyses by including additional variables in the regression model. In addition, we varied the functional form of the primary relationship of interest by modeling child count as a categorical variable. We also used multiple imputation to account for survey non-response. All regression analyses used the NLSY custom sampling weights and stratum information for the longitudinal sample between 1979 and 2012, as well as the inverse probability weights adjusting for non-response. Analyses were performed using the 'surveyglm' procedure in the 'survey' library in R 3.1.1 (Lumley, 2004; R Core Team R, 2014), which implements a sandwich type robust variance estimator, accounting for the uncertainty due to weight estimation.

Results

Fig. 1 shows the distribution of BMI change from young adulthood to age 40 for both men and women. Women had a larger increase and more variance for BMI change at age 40, with an average value of 6.2 BMI kg/m^2 (standard deviation (SD) 5.4), compared to a mean of 5.3 kg/m^2 (SD 4.2) for the men, who reported a higher BMI at baseline. Measurements were taken at similar ages in both groups (see Table 1).

Table 1 displays characteristics of the cohort. The mean number of children was 1.9 and 1.8 for women and men, respectively, and the mode for both genders was 2. More men than women reported having no children. Men were more likely than women to report living in a household that paid child support. Women reported living with children under the age of 10 for more years than men. Race-ethnicity, education, income, location of childhood residence and smoking rates were similar between genders.

We used inverse-probability weights to correct for informative imbalances in observing respondent's age 40 BMI. These weights were derived from a model estimating the association between each covariate and the probability of observing this measurement. Female gender, having more children, overweight or obese status at baseline, and higher income and wealth were all associated with a higher probability of observation.

We regressed BMI change between ages 18 and 40 on number of children, gender, and their interaction, adjusting for all measured covariates. Table 2 contains the adjusted estimates of changes in BMI associated with each additional child. We observed a positive, but not statistically significant, association between number of children and BMI change and an insignificant difference across gender (interaction $P = 0.16$). Our model suggests that each additional biological child was associated with in increase in BMI of 0.13 kg/m^2 (95% CI: (-0.22, 0.48)) for women and 0.28 BMI kg/m^2 (95% CI: (0.01, 0.55)) for men (see Table 2). Fig. 2 illustrates this interaction by displaying the predicted weight change by number of children for the population averaged men and women in the NLSY. There appears to be an association between number of children and BMI increase for men, but not for women, although this difference is not statistically significant.

Using a logistic model, we regressed overweight/obese status (BMI > 25) at age 40 on number of children, gender and their interaction, including all measured covariates. Table 2 contains the adjusted odds ratios associating the probability of overweight/obesity with each additional child. The probability of overweight/obesity increased with child count ($P < 0.01$), and this relationship differed by gender ($P = 0.01$). Each additional child was associated with a significantly larger probability of overweight/obesity in men (adjusted odds ratio (OR): 1.32 (95%CI: (1.11, 1.58))) than in women (OR: 1.15 (95%CI: (1.01, 1.31))). Fig. 3 displays these relationships, plotting the probabilities of overweight/obesity at age 40 as a function of child count for the average man and woman in our sample.

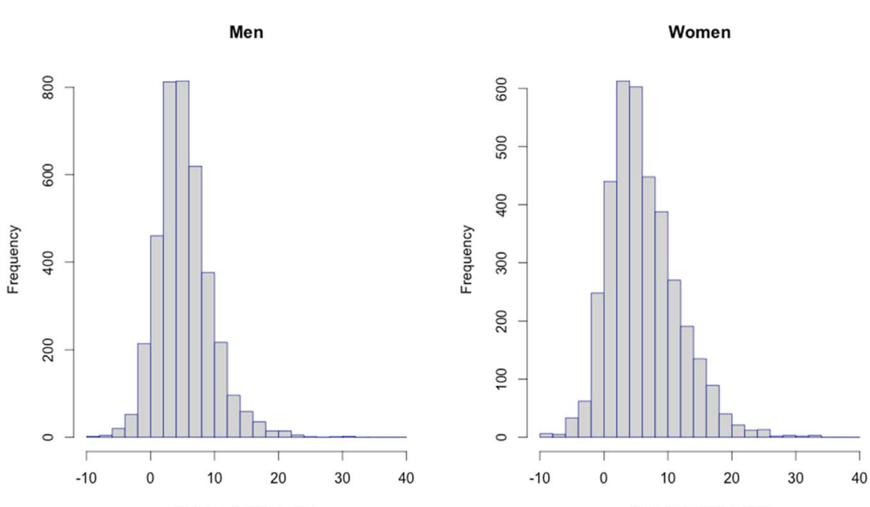

Fig. 1. Change in BMI from young adulthood to age 40 in the analytic sample of the NLSY79 cohort by gender.

Table 1
Distribution of demographic variables in analytic sample of the National Longitudinal Survey of Youth (1979–2014).

	Total	Men	Women
Count: n (%)	7452 (100%)	3822 (51%)	3630 (49%)
First BMI: mean (SD)	23.0 (5.8)	23.5 (5.2)	22.3 (5.8)
Age at first BMI: mean (SD)	20.0 (2.7)	20.1 (2.8)	20.0 (2.4)
Weight category at first BMI measurement (%)			
Underweight (< *18.5* kg/m²)	6%	2%	9%
Normal (*18.5–25* kg/m²)	73%	73%	73%
Overweight (*25–30* kg/m²)	17%	21%	13%
Obese (> *30* kg/m²)	4%	4%	4%
Final BMI: mean (SD)	28.2 (9.4)	28.4 (6.3)	27.9 (10.4)
Age at final BMI: mean (SD)	41 (2.3)	41 (2.3)	41 (1.9)
Change in BMI: mean (SD)	5.2 (6.7)	4.8 (5.1)	5.5 (6.8)
Overweight/Obese (BMI > 25) at age 40 (%)	67%	75%	59%
Obese (BMI > 30) at age 40 (%)	31%	31%	31%
Child Count: mean (SD)	1.9 (1.4)	1.8 (1.5)	1.9 (1.3)
Child Count (%)			
Zero	24%	27%	21%
One	17%	17%	18%
Two	34%	32%	36%
Three	17%	16%	18%
Four or more	9%	9%	8%
Race/ethnicity (%)			
Asian	1%	1%	1%
Black	13%	13%	13%
Hispanic	5%	5%	5%
White	81%	81%	81%
Average household equivalized income: mean (SD)	$41,500 ($76,905)	$41,680 ($58,683)	$41,308 ($59,793)
Average household income category (%)			
< *$16* K	34%	34%	34%
$16–30 K	15%	15%	15%
$30–46 K	22%	22%	23%
> *$46* K	28%	28%	28%
Wealth at age 25: mean (SD)	$41,794 ($227 K)	$40,718 ($211 K)	$42,992 ($196 K)
Wealth at age 25 Quartile (%)			
< *$.2* K	21%	20%	21%
$.2–6 K	27%	28%	25%
$6–23 K	33%	33%	34%
> *$23* K	20%	19%	20%
Mother's education (%)			
< *HS*	33%	32%	33%
HS Grad	46%	47%	45%
Some College	11%	11%	12%
College Grad	10%	10%	11%
Father's education (%)			
< *HS*	38%	37%	38%
HS Grad	33%	32%	34%
Some College	11%	11%	10%
College Grad	18%	19%	18%
Urban Childhood (%)	78%	78%	78%
Southern Childhood (%)	31%	30%	31%
Ever Paid Child Support (%)	22%	26%	17%
Ever Smoker (%)	57%	58%	56%
% of years that child under age 10 spent in the respondent's home: mean (SD)[a]	89% (50%)	80% (60%)	97% (20%)
> 95% of under age 10 child years spent in respondent's home[b]	75%	60%	90%

Note: All percents, means and standard deviations (SDs) are calculated from a weighted population incorporating both survey and inverse probability of missingness weights.

[a] % of years that child under age 10 spent in the respondent's home was calculated by dividing the total number of years that subject's children who were < 10 years old lived in the respondent's house by the total number of years that the subject's children was < 10 years old.

[b] > 95% indicates that the respondent reported that their child was living in their household for more than 95% of the years when any of their children were less than 10 years old.

Table 2
Point estimates and 95% Confidence Intervals (CI) for the associations between each additional child and change in BMI or odds of overweight/obesity at midlife.

Women		Men	
BMI change - linear model			
Estimated change	**CI**	**Estimated change**	**CI**
0.13	(-0.22, 0.48)	0.28	(0.01, 0.55)
Overweight/obesity probability - logistic model			
Odds ratio	**CI**	**Odds ratio**	**CI**
1.15	(1.01, 1.31)	1.32	(1.11, 1.58)

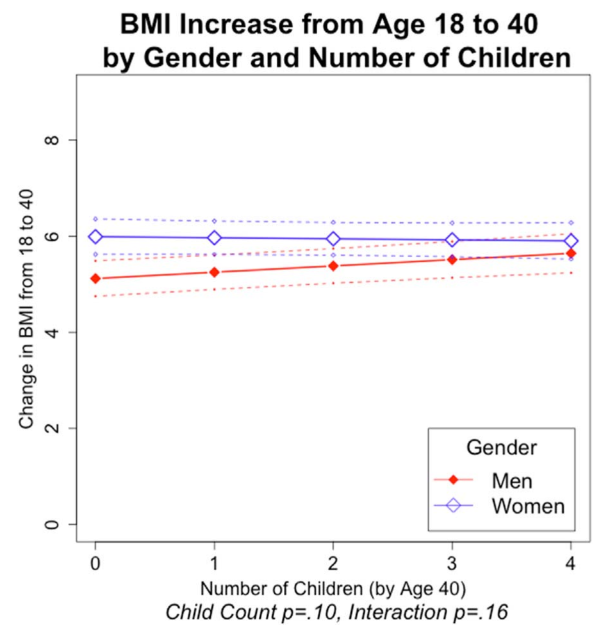

Fig. 2. Predicted change (and 95% confidence interval) in BMI from young adulthood to age 40 by gender and number of children. P-values below the graph are those associated with the model parameters for linear number of children and the interaction between number of children and gender. Solid lines indicate the prediction and dashed lines the 95% confidence intervals around it.

Fig. 4 displays associations between number of children and parental weight from our *a priori* specified stratified analyses. Each graph presents the adjusted estimates from a stratified regression model; the sample size and *P*-values associated with the child count and the child-count/gender interaction are reported below each plot. The first row of graphs present results stratified by race/ethnicity and gender. The second graph in the first row shows that having more children was associated with increased BMI change overall in Hispanics (Main term $P < 0.001$) and this association varied by gender with BMI change increasing in men and decreasing in women with child count (Interaction $P = 0.001$). In the Black and White populations, we observed no relationship between number of children and BMI change and this finding did not vary by gender.

The second and third rows of Fig. 4 contain graphs of the estimates from models stratified by gender, race/ethnicity and socioeconomic position. For Hispanic parents, the observed gendered difference in association between each biological child and weight gain was strongest in the low-income group (Interaction $P = 0.001$). For high income Black parents, there was marginal evidence that child count was associated with BMI gain (Main term $P = 0.09$), but insignificant evidence of a gendered difference (Interaction $P = 0.19$). There was no evidence of an association between having children and weight change in high-income Whites (Main term $P = 0.55$), and insignificant evidence of differing associations by gender among low-income Whites (Interaction $P = 0.19$).

Fig. 5 displays the same stratified analyses for models predicting the

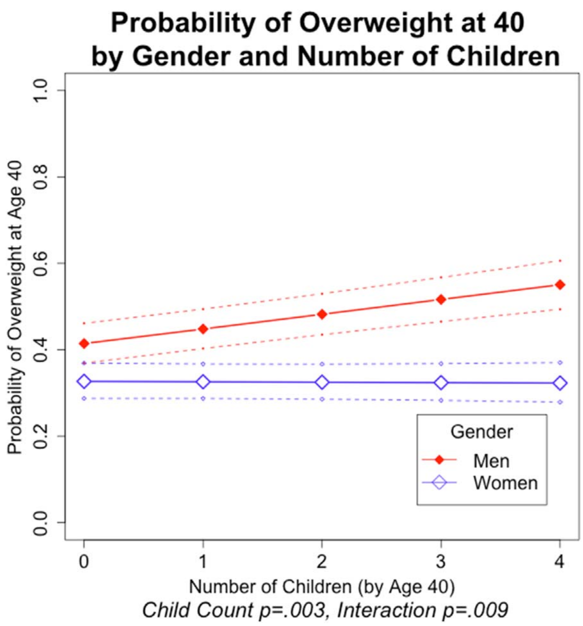

Fig. 3. Predicted probabilities and 95% confidence intervals of overweight/obese status at age 40 by gender and number of children. P-values below the graph are those associated with the model parameters for linear number of children and the interaction between number of children and gender. Solid lines indicate the probability of overweight and dashed lines the 95% confidence intervals around it.

probability of overweight/obese status at age 40. Among Hispanics, having more biological children was associated with a larger increase in odds of being overweight/obese at age 40 in both men and women (Main term $P = 0.02$), and insignificant evidence that this differs by gender (Interaction $P = 0.11$). There was stronger evidence of a gender difference in the low-income Hispanics (Interaction $P = 0.04$) and marginal evidence among high-income Hispanics (Interaction $P = 0.07$). For Whites, having more children was associated with increased overweight/obesity overall (Main term $P = 0.01$) and there was evidence of an interaction (Interaction $P = 0.02$), with men having a higher risk of overweight associated with each child. Black parents showed no evidence that having more children was associated with increased probability of overweight/obese status in any of the subcohorts.

The size and direction of the associations between number of children and obese status (> 30 BMI) at age 40 were similar to those we found for overweight/obese status (> 25 BMI) (results not shown).

Discussion

We found no evidence in this nationally representative US cohort that having more children was associated with greater weight gain in women compared to men. In contrast, the analysis demonstrated, among some subgroups defined by race/ethnicity and income, a pattern of higher weight gain in men associated with children than seen in women. We found a gendered difference in BMI change at age 40 that was most marked in Hispanics, driven by an association among low-income Hispanics, but little evidence among Blacks and Whites, regardless of income. We observed a 32% higher odds of overweight/obese status associated with number of children in men and a 15% higher odds of overweight/obese status in women. We observed significantly higher associations of overweight/obese status in men compared to women in low-income Hispanics and Whites overall, but not in Black parents. Our findings suggest that the association between having children and weight at midlife in both women and men may differ by race and socioeconomic position. The greatest burden of overweight/obesity and increased BMI with increased number of children may be experienced by Hispanics, in particular Hispanic men.

Our analysis can not determine the reasons for these differences, so we can only speculated based on other literature about potential causes of these patterns. While women's weight gain is in part due to biological pathways, through changes due to pregnancy, breastfeeding, postnatal retention of gestational weight gain (Mannan, Doi & Mamun, 2013), a primary finding of our analysis is that these gains are even greater for men, suggesting that the pathways underlying the connection between weight and number of children are not solely driven by the biology of child-bearing itself. Child-related weight gain thus may be more likely to be a function of behavioral changes such as reduction in parental physical activity, changing dietary intake and also potentially a reduction in substance use associated with weight gain (LaRoche et al., 2012; Rhodes et al., 2014; Greaves, Oliffe, Ponic, Kelly & Bottorff, 2010). While there are a substantial number of studies of the effects of parental physical activity and diet on children's diet and physical activity (Moore et al., 1991; Yao & Rhodes, 2015; Patrick & Nicklas, 2005), we identified few studies examining how the number of children impacts the physical activity and diet of their parents, which may be a fruitful area of future inquiry. Overall, however, the evidence that both men and women were more likely to be overweight if they had more children suggests that child bearing and child-rearing may increase parental weight gain through shared social and environmental pathways, as opposed to solely pregnancy-related biological ones.

The stratified analyses provided evidence for a role of race/ethnicity and socio-economic position in the relationship between number of children and midlife weight. In several analytical strata, we observed evidence of male weight gain increasing with number of children, while female weight gain stayed constant or decreased. This association was strongest in the Hispanic low-income cohort, but similar, albeit statistically insignificant, patterns were observed in the Black high income and White low-income cohorts. We also observed evidence of higher odds of overweight/obese status among parents with more children among Whites and Hispanics of both income strata.

Our findings suggest that low-income Hispanic men may be uniquely at risk for parenting-related weight gain. While we are not able to identify the social mechanisms for this difference, other literature offers suggestion on why this may be the case. First, prior work has shown that acculturation plays a larger role in obesity for Hispanic men as compared to Hispanic women (Bowie, Juon, Cho & Rodriguez, 2007), and it is possible that this may also interact with number of children to produce greater impacts among men. In addition, our results show that these differences for Hispanic men were strongest among low income Hispanics, which further suggests potential specific social mechanisms. This finding is consistent with mechanisms related to work, poverty and place of residence, where lower income Hispanic men may face further decreased financial resources with additional children based on living in areas with fewer resources for a healthy diet and physical activity (Day, 2006). In addition, prior work has shown that stress from occupation or economic factors plays a greater role in depression for Mexican American men as compared to Mexican American women, which may link to greater obesity for men as compared to women (Aranda, Castaneda, Lee & Sobel, 2001). Further study of mechanisms in these populations are important to understanding the reasons for these differences and the extent to which they may contribute to racial/ethnic and socioeconomic inequalities in BMI and overweight/obesity.

Prior work has demonstrated that child–bearing is a risk for short and long-term weight gain in women (Gunderson & Abrams, 1999; Brown et al., 1992; Abrams et al., 2013), although some studies have found no association (Robinson, Cheng, Hoggatt, Stürmer & Siega-Riz, 2014). Previous studies (Weng et al., 2004; LaRoche et al., 2013; Skilton et al., 2009; Umberson et al., 2011; Garfield et al., 2015; Davis et al., 2009) have had mixed findings on the relationship between short-term weight gain and number of children in fathers; none of these stratified analyses by both race and socioeconomic position. It may be that part of this inconsistency in findings for both genders is due to differences in study demographics.

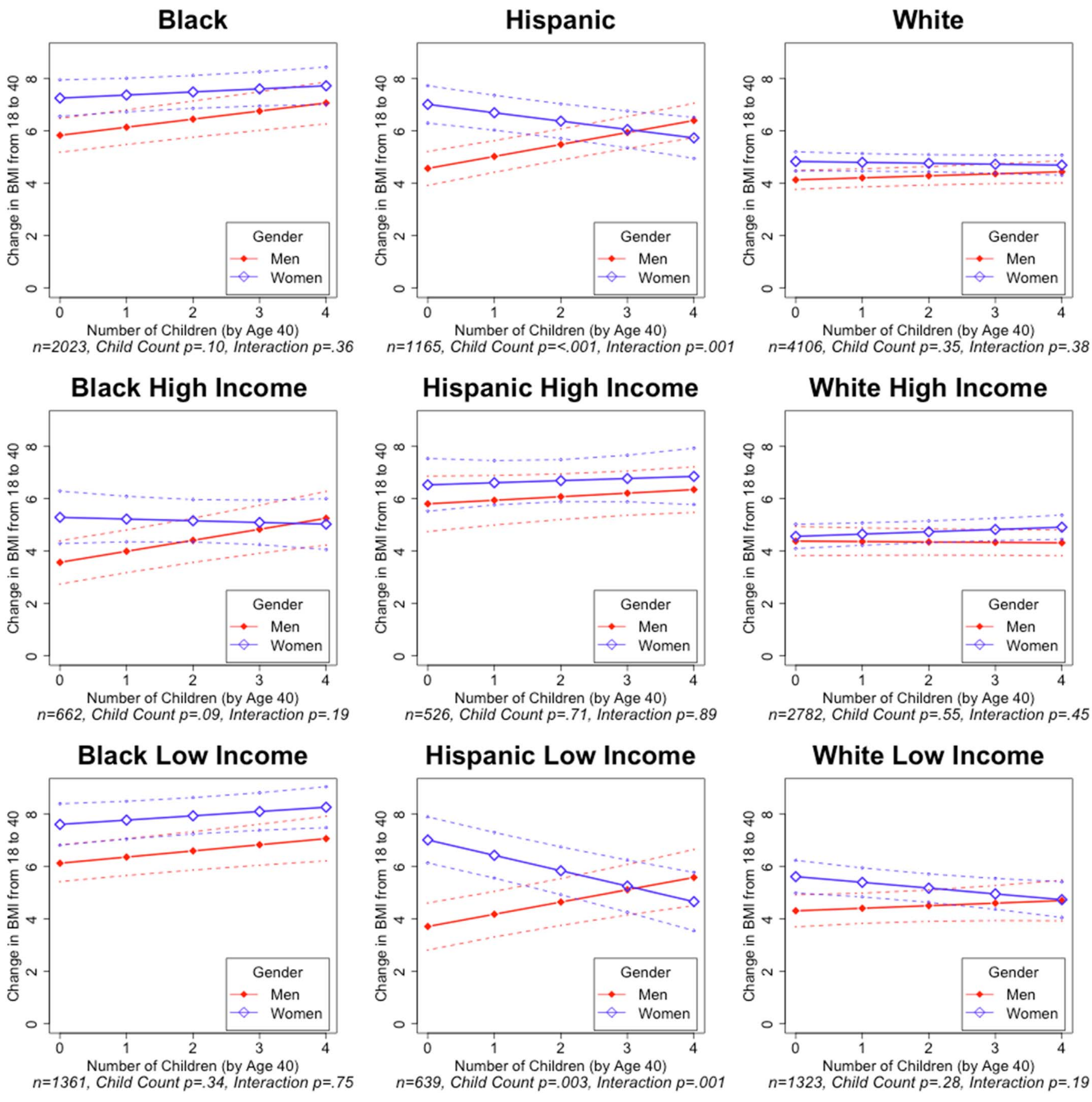

Fig. 4. Predicted change in BMI at age 40 by gender and number of children, stratified by race and average household income. Changes are estimated by applying the stratified models to an example data set. This data set varies gender and child count, but holds all other variables constant at the population mean value (mode for categorical variables). Data sizes for each strata are reported under each graph. P-values below each graph are those associated with the model parameters for linear number of children and the interaction between number of children and gender. Solid lines indicate the predicted BMI change and dashed lines the 95% confidence intervals around it.

Our findings support the suggestion that future work to determine the pathways creating these differences in association should be explored. One interesting area that deserves study is how female and male parents change their use of their time, for example, the role of child related activities, and how this differs by racial/ethnic group and socioeconomic strata. A sample with an number of blacks and Latinos and representation of a range of socioeconomic levels would be needed. While these measures are not available in the NLSY data, other studies such as the Panel Study of Income Dynamics may be able to address this.

Our reported findings were robust to a number of sensitivity analyses in which we varied the form and components of the model. When number of children was modeled as a categorical variable in the whole cohort, we observed a dose-response along the categories for both outcomes, indicating that the linear approximation was reasonable. The findings were also robust to the exclusion of any of the specific covariates that we included in the models, and to alternate approaches towards survey non-response. Our results for all models in all strata were unchanged when we included an indicator for being born in the United States in our adjustment set. Results were not changes after adding additional exclusion criteria that removed people who had children within one year of their age 40 weight measurement nor by

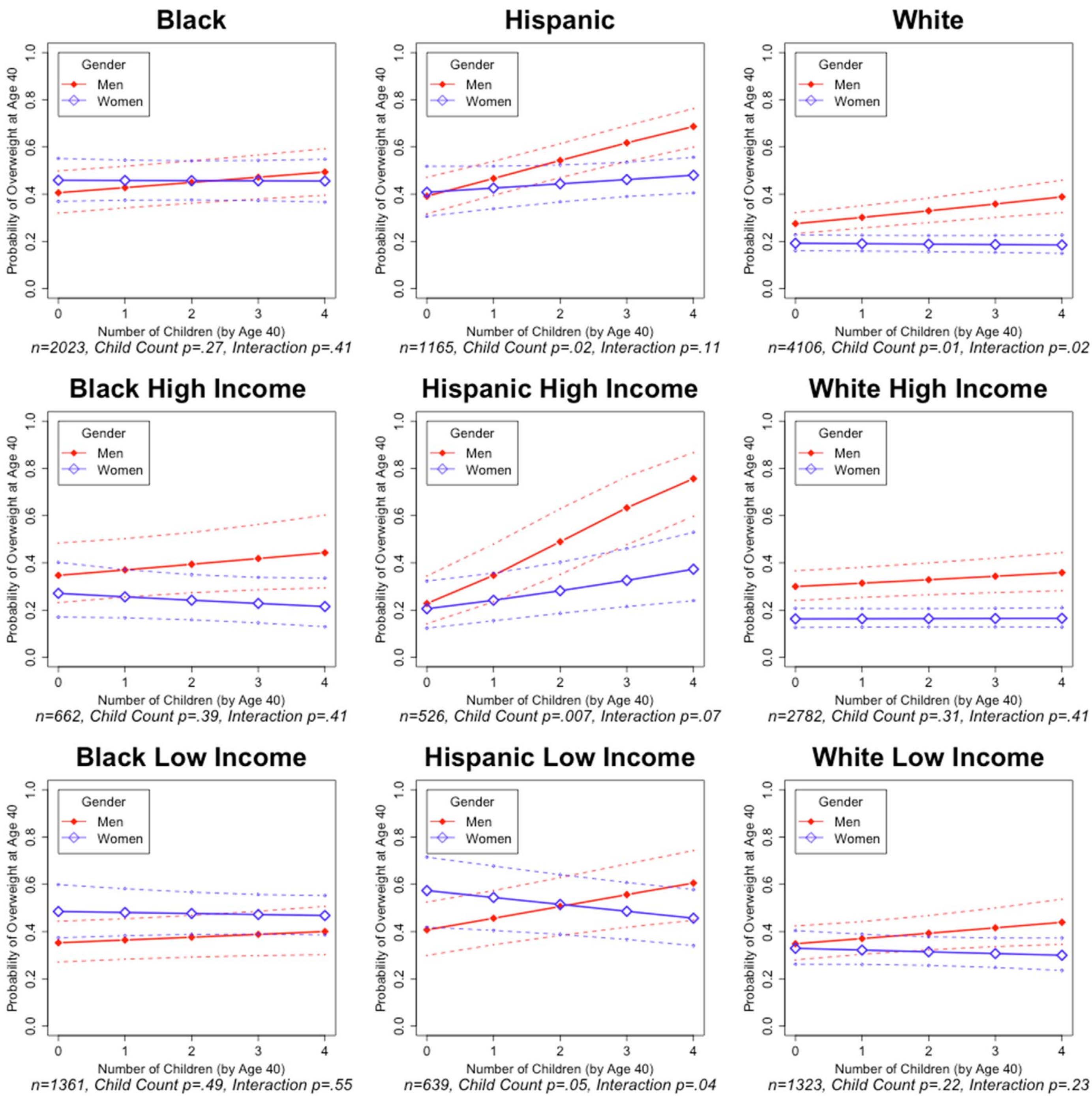

Fig. 5. Predicted probability of being overweight/obese at age 40 by gender and number of children, stratified by race and average household income. Probabilities are estimated by applying stratified models to an example data set. This data set varies gender and child count, but holds all other variables constant at the population mean value (mode for categorical variables). Data sizes for each strata are reported under each graph. P-values below each graph are those associated with the model parameters for linear number of children and the interaction between number of children and gender. Solid lines indicate the predicted BMI change and dashed lines the 95% confidence intervals around it.

controlling for the age at first birth.

This study had several limitations. The findings must be interpreted as descriptive, rather than causal, due at least in part to possible unmeasured and incompletely controlled confounding. People who choose to have more children may differ from those having fewer in many attributes beyond those that we controlled for. We relied on self-reported weight as the outcome, although we did incorporate adjustment factors to limit differential reporting bias by gender, race/ethnicity, height and weight. There was substantial and non-random non-response, which we adjusted for using inverse probability weighting. We did not have information on the lifestyle and diet of the cohort members, so could not determine their role as mechanisms of the observed weight gain. We included only biological children in this analysis, so could not evaluate the associations of weight gain and the raising of non-biological children.

We fit our models on 10 different stratified cohorts, and these multiple comparisons increase the probability that some of our statistically significant findings occurred due to chance. These separate tests are not independent so we did not adjust for these comparisons, but our findings should be cautiously interpreted and confirmed in independent data. A strength of this study is the nationally representative sample that allowed us to generate stratified estimates by race and socioeconomic position that generalize to the U.S. population.

Current obstetric guidelines contain recommendations aimed at both supporting women to gain a healthy amount of weight during their pregnancy and subsequently return to their previous weight (Yaktine & Rasmussen, 2009). Our results, while descriptive, suggest that parenthood poses a particularly great risk to the father's maintenance of a healthy weight as well. Recent research has highlighted the role that becoming parents and raising children has on the social, economic and lifestyle mediators of weight gain (Gruber & Haldeman, 2009; Hagobian et al., 2016) in both genders. Public health and clinical interventions are needed to help both mothers and fathers maintain a healthy weight into midlife. The group in most need of attention, based on our findings, is lower income Latino men.

Institutional review

The Committee for Protection of Human Subjects at the University of California, Berkeley approved this study.

Disclosure

All views expressed in this paper are those of the author and do not reflect the views or policies of the U.S. Bureau of Labor Statistics. The authors have no competing financial interests or other conflicts of interest relating to this work.

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