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Educational attainment and gestational weight gain among US mothers

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Abstract

Background—Education is an important social determinant of many health outcomes, but the relationship between educational attainment and the amount of weight gained over the course of a woman's pregnancy (gestational weight gain (GWG)) has not been clearly established.

Methods—We used data from 1979-2010 for women in the National Longitudinal Survey of Youth 1979 cohort (n= 6344 pregnancies from 2769 women). We used generalized estimating equations to estimate the association between educational attainment and GWG adequacy (as defined by 2009 Institute of Medicine guidelines), controlling for diverse social factors from

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across the life course (e.g., income, wealth, educational aspirations and expectations) and considering effect measure modification by race/ethnicity and pre-pregnancy overweight status.

Results—In most cases, women with more education had increased odds of gaining a recommended amount of gestational weight, independent of educational aspirations and educational expectations and relatively robust to sensitivity analyses. This trend manifested itself in a few different ways. Those with less education had higher odds of inadequate GWG than those with more education. Among those who were not overweight pre-pregnancy, those with less education had higher odds of excessive GWG than college graduates. Among women who were white, those with less than a high school degree had higher odds of excessive GWG than those with more education.

Conclusion—The relationship between educational attainment and GWG is nuanced and nonlinear.

Keywords

educational status; gestational weight gain; socioeconomic factors

Introduction

Gestational weight gain (GWG) affects both maternal and child health. Inadequate GWG is associated with decreased birth weight and small for gestational age; excessive GWG is associated with increases in postpartum and long-term weight retention (Cohen, Chaffee, Rehkopf, Coyle, & Abrams, 2014; McClure, Catov, Ness, & Bodnar, 2013), birth weight (Ferraro et al., 2012), cesarean section, preeclampsia (Haugen et al., 2014), gestational diabetes (Gibson, Waters, & Catalano, 2012) and large for gestational age (Kim, Sharma, Sappenfield, Wilson, & Salihu, 2014). Additionally, such negative pregnancy and birth outcomes increase the risk of developing obesity, diabetes, and other chronic diseases in the offspring (Catalano & deMouzon, 2015; Lau, Liu, Archer, McDonald, & Liu, 2014; O'Reilly & Reynolds, 2013; Reynolds et al., 2013). Therefore, according to the life course model (Halfon & Hochstein, 2002), which posits that early-life experiences affect people's long-term health, and a 2009 Institute of Medicine (IOM) report on healthy gestational weight gain (Rasmussen & Yaktine, 2009), adequate GWG is critical to establishing a positive health trajectory for the next generation.

Although personal nutritional habits (Heery, Kelleher, Wall, & McAuliffe, 2014) and other individual behaviors (Herring et al., 2012) such as cigarette smoking (Rode, Kjærgaard, Damm, Ottesen, & Hegaard, 2013) are highly correlated with women's GWG, there are underlying social determinants that have the potential to impact women's health over the life course, including the prenatal period. One such social determinant of health is educational attainment, which is associated with numerous health outcomes across the life course (Cohen & Syme, 2013), including obesity (Cohen, Rai, Rehkopf, & Abrams, 2013a). Yet, the 2009 IOM report on pregnancy-related weight gain concluded that the relationship between educational attainment and GWG is not well-established (Rasmussen et al., 2009).

Only four American studies have examined the association between educational attainment and GWG (Chu, Callaghan, Bish, & D'Angelo, 2009; Deputy, Sharma, Kim, & Hinkle, 2015; Huynh, Borrell, & Chambers, 2013; Ventura, 1995), with mixed findings. The most recent study found that women with less than a high school education had higher odds of inadequate GWG, and for those who were underweight pre-pregnancy, lower education was also associated with higher odds of excessive GWG in comparison to adequate GWG (Deputy et al., 2015). Another U.S. study (Chu et al., 2009) found women with more education gain more weight on average. In New York City, women with high school (HS) or some college education were more likely than those with less education to gain more than 40 pounds during pregnancy, and both race/ethnicity and neighborhood socioeconomic position (SEP) modified the association for college graduates (Huynh et al., 2013). And among unmarried women (Ventura, 1995), inadequate GWG was more frequent among less educated women.

There are also two recent Swedish studies. One found that education was inversely associated with excessive GWG among healthy women having either their first or second singleton birth (Holowko et al., 2015). Another found that among women with a healthy pre-pregnancy BMI, those with an elementary or secondary education had greater odds of excessive GWG than women with higher education (Holowko, Mishra, & Koupil, 2014).

In other studies of the predictors of GWG, educational attainment has been considered solely as a confounder (e.g., Caulfield, Witter, & Stoltzfus, 1996; Chaffee, Abrams, Cohen, & Rehkopf, 2015; Drehmer, Duncan, Kac, & Schmidt, 2013; Kleinman et al., 2007; Krukowski, Bursac, McGehee, & West, 2013; J. H. Park et al., 2011a; Sridhar et al., 2014) or mediator (e.g., Morgen, Bjork, Andersen, Mortensen, & Nybo Andersen, 2008). Researchers must untangle the roles of different dimensions of SEP across the life course by assessing the independent contribution of educational attainment for GWG. We hypothesize that, after adjusting for potential confounding variables, more highly educated women will have increased odds of having a GWG within the 2009 IOM guidelines (Rasmussen et al., 2009).

Material and Methods

Study population

We use data from female participants in the 1979 National Longitudinal Survey of Youth (NLSY), who were 14-22 years old in 1979 and have been followed since through in-person and telephone interviews annually and then biennially (the data analyzed here are through 2010). Participants were sampled with a complex multistage approach that also oversampled Blacks and Hispanics (CHRR, 2008). Beginning in 1986, pregnancy data were prospectively collected; pregnancies prior to 1986 were reported retrospectively.

Variables of interest

Women self-reported their height and weight at baseline (1981) and their pre-pregnancy and delivery weights after each pregnancy. Women generally report pregnancy-related weights fairly accurately, although it is biased towards underreporting (Ferrara et al., 2006;

Hedderson, Gunderson, & Ferrara, 2010; Herring et al., 2008; Oken, Taveras, Kleinman, Rich-Edwards, & Gillman, 2007; Schieve et al., 1999). Most studies found no differences in accuracy by educational attainment (S. Park et al., 2011b; Shin, Chung, Weatherspoon, & Song, 2014; Yu & Nagey, 1992) but one did (Schieve et al., 1999). To estimate GWG adequacy, we subtracted pre-pregnancy weight from delivery weight and estimated the percentage of expected GWG per self-reported gestational age at delivery, using 2009 IOM pre-pregnancy BMI-specific recommendations (Bodnar, Siega-Riz, Simhan, Himes, & Abrams, 2010). Even though most pregnancies were pre-2009, we used this definition to ensure current clinical relevancy.

For educational attainment, we created a categorical variable by degree level (<high school (HS) degree, HS graduate but less than college degree, ≥college graduate) attained at birth year, since others found a non-linear association between educational attainment and obesity using these categories (Cohen, Rehkopf, Deardorff, & Abrams, 2013b).

Covariates

Race/ethnicity (self-reported Black, white, or Hispanic) and pre-pregnancy overweight status (body mass index (BMI)≥25) (Committee, 1995) were a priori potential effect measure modifiers. We also included several potential confounders from childhood (Cohen et al., 2013b) that were identified a priori (Cole et al., 2010; Greenland & Morgenstern, 2001; K. J. Rothman, 2008). Maternal and paternal education were categorical variables: less than a HS degree (<12 years of education), HS graduate but not a college graduate (12-15 years), and college graduation or more (≥16 years). Born in the United States, lived in the South as a child, lived in an urban setting as a child, spoke a foreign language as a child, pre-pregnancy overweight status (BMI≥25), and overweight status (BMI≥25) in 1981 (the first year for which weight and height data were available) were all binary variables that could have affected both educational attainment and gestational weight gain. We adjusted for sociodemographic characteristics (family size, married to or living with a partner at birth year, maternal age (median-centered)) and pregnancy-related characteristics (parity, consumed alcohol 3-4 days per month or more during pregnancy, smoked during pregnancy, child's birth weight, child's gender).

Statistical analysis

We included all live singleton births from all white, Black, and Hispanic NLSY79 women (due to small numbers (n=97), Asians were dropped from the sample). The [University IRB] waived the requirement for review because these data are unidentifiable and publicly available.

We separately tested the associations between education and low GWG and excessive GWG, using adequate GWG as the reference group. Our primary analyses were done for complete cases only (observations for whom we had information on all variables and covariates of interest). Out of the 11,512 pregnancies recorded in the NLSY 1979 cohort, 6,344 were complete cases included in our analyses (55%). Generalized estimating equations (GEE) with robust standard errors were used to calculate adjusted odds ratios (ORs) that accounted for clustering of multiple pregnancies per woman to provide population average estimates

(Hubbard et al., 2010) in Stata 12.0. We preferred to do two sets of regressions rather than multinomial logistic regression to make fewer assumptions about the associations between inadequate vs. adequate GWG and excessive vs. adequate GWG. All *P*-values were two-sided, reported for measures of association only (alongside 95% confidence intervals) and not also comparisons of descriptive statistics, given its limitations (Goodman, 1993; Sterne & Smith, 2001; Wasserstein & Lazar, 2016), and not adjusted for multiple comparisons (K. Rothman, 1990).

We used interaction terms to examine effect measure modification separately by pre-pregnancy overweight status and race/ethnicity. A conservative cut-off of $P \leq 0.2$ was used (Selvin, 2004). We did not consider three-way interactions due to limited power.

We conducted several sensitivity analyses to examine the robustness of our findings. First, we replaced educational attainment measured at birth year with educational attainment measured at age 25 as age 25 is considered a standard proxy for lifetime educational attainment in the United States (e.g., Barro & Lee, 2010; Cohen et al., 2013b). Next, we added additional covariates: 1) educational aspirations and expectations at baseline, to account for potential confounding by internal drive or external forces (Cohen et al., 2013b), coded these as less than HS graduate, HS graduate but not college graduate, and college graduate or more; and 2) income measured at birth year in year 2000 dollars, as a potential confounder. We then considered if overweight status at baseline was a potential effect measure modifier. Finally, to examine the extent to which missing data may have biased results, we conducted multiple imputation using Stata's “mi” with five imputations using all the covariates to impute missing data for all exposure variables in the model; the outcome (GWG) was not imputed. We repeated the primary analyses with the multiply imputed dataset.

Results

Descriptive Characteristics

We examined the characteristics of each woman and her pregnancy for the total complete case population (n=2,769) by GWG category (table 1). Our analytic sample contains 6,344 pregnancies (mean per woman: 2.0 (SD: 1.1), range: 1-10) and was racially and socioeconomically diverse. The analytic sample had fewer overweight women at baseline and more married women than the full NLSY sample. About 20% did not have a HS education, while 15% graduated from college. Women gained the recommended amount of weight in 30% of pregnancies; in 25% of pregnancies, women gained inadequately and in 45%, women gained excessively.

Inadequate GWG

Educational attainment was associated with inadequate GWG (table 2). Those who did not graduate from HS (OR: 1.64, 95%CI: 1.16-2.32) and those who graduated from high school (OR: 1.38, 95%CI: 1.06-1.80) had higher odds of inadequate GWG than college graduates. There was no interaction by pre-pregnancy overweight (Wald test $P=0.36$) or race/ethnicity (Wald test $P=0.33$).

Excessive GWG

Education was also associated with excessive GWG, and the association varied by both pre-pregnancy weight status and race/ethnicity (table 3). Among overweight women, none of the odds ratios were statistically significant. In contrast, among those not overweight pre-pregnancy, not graduating from HS (OR: 1.64, 95% CI: 1.19-2.25) and graduating from high school (OR: 1.46, 95% CI: 1.15-1.84) were both associated with higher odds of excessive GWG than college graduates. When we considered effect modification by race/ethnicity, none of the odds ratios among Hispanic women were statistically significant. Among Black/African-American women, women with less than a high school degree were less likely to gain excessively than those who graduated high school (OR: 0.58, 95% CI: 0.40- 0.85), but the opposite was true for white women (OR: 1.31, 95% CI: 1.02, 1.69). Also among whites, having less than a high school degree was associated with higher odds of excessive GWG than those with a college degree (OR: 1.59, 95% CI: 1.13, 2.24).

Sensitivity analyses

Overall, the majority of the sensitivity analyses (see supplemental tables) aligned with the main findings. The sensitivity analyses included using educational attainment at age 25 rather than at the birth year to ensure that our results were not driven by women who gave birth at younger ages in the midst of their educational trajectories. We also found similar results when we stratified by pre-pregnancy obesity (BMI≥30) rather than pre-pregnancy overweight (data available upon request).

Sensitivity analyses: Inadequate GWG

When comparing inadequate GWG to adequate GWG (supplemental table 1), similar to the main results, there was not interaction by pre-pregnancy overweight but there was by race/ethnicity. Odds ratio estimates when using educational attainment at age 25 were similar to the main findings. Adding adolescent educational aspirations and expectations did not change the point estimates, but adding income slightly attenuated the findings. In the multiple imputation results, there was interaction by pre-pregnancy overweight status such that lower education was associated with increased odds of inadequate GWG only among women not overweight pre-pregnancy.

Sensitivity analyses: Excessive GWG

Supplemental table 2 compares excessive GWG to adequate GWG. Like the main results, there was interaction by pre-pregnancy overweight status and race/ethnicity, and results were similar when using educational attainment at age 25 and when doing multiple imputation. However, the effect estimates sometimes differed. Adding adolescent educational aspirations and expectations to the main model attenuated the odds ratios. Adding income to the main model resulted in statistically significant results among both pre-pregnancy overweight categories, Black women, and white women that were similar to the main findings.

Sensitivity analyses: Overweight status at baseline

When the results were stratified by overweight status at baseline rather than at pre-pregnancy (supplemental table 3), there was a statistically significant interaction.

Associations between educational attainment and inadequate GWG were only statistically significant among those not overweight at baseline. When comparing excessive GWG among those with no high school degree to those with a college degree, the direction of the statistically significant association was opposite depending on baseline overweight status.

Discussion

The relationship between educational attainment and gestational weight gain is nuanced and non-linear, and adds to the current body of mixed evidence. Overall, these findings suggest that increased education plays a role in healthier GWG for some, but not all, groups of women. In this cohort, higher education was associated with lower odds of inadequate GWG. Educational attainment was also associated with excessive GWG; however, pre-pregnancy overweight status and race/ethnicity both modified this association, sometimes in different directions. Sensitivity analyses suggest that these relationships were independent of the type of people who attain more education due to internal drive (reflected by educational aspirations) or external social forces (reflected by educational expectations), as others have found for obesity (Cohen et al., 2013b).

Our finding that increased educational attainment was associated with lower odds of inadequate GWG is consistent with evidence that highly educated pregnant women are more likely to comply with health recommendations (e.g., physical activity (Amezcua-Prieto et al., 2011) and folic acid (Rasmussen & Clemmensen, 2010)). Since inadequate GWG is associated with poor fetal growth, women with low education might particularly benefit from additional prenatal services to help them gain adequately during pregnancy.

The relationship between education and excessive GWG was more nuanced. Among women who were not overweight before pregnancy, less education increased the odds of excessive gain. This aligns with findings from Sweden, in which women with a normal weight pre-pregnancy BMI and HS degree or less had higher odds of excessive GWG than women with a college education (Holowko et al., 2014). The inverse, but not statistically significant, association found among overweight women may be due to several following reasons. First, overweight women who are less educated are given different health recommendations: overweight women are more likely to receive advice to overgain, and lower income women are less likely to receive advice at all (Phelan et al., 2011). Second, they may differentially comply with those recommendations: the prevalence of knowledge of GWG recommendations was lower than the proportion of women who reported receiving advice from clinicians among a primarily low-income overweight sample of pregnant women (Ledoux, Van Den Berg, Leung, & Berens, 2015). And/or, third, their obesity set points, which would likely be different from normal weight women, (Speakman et al., 2011) might play a role. Further studies should explore these different potential mechanisms, perhaps qualitatively. Additionally, less education appeared to protect against excessive GWG among Black women but was associated with increased odds of excessive GWG among White women.

Women often seek weight gain advice during pregnancy (Olander, Atkinson, Edmunds, & French, 2012), and the advice received is associated with the amount of weight they gain

(Cogswell, Scanlon, Fein, & Schieve, 1999; Taffel, Keppel, & Jones, 1993). However, there may be educational disparities in advice received. Women with higher education may be more likely to receive advice during pregnancy (Ferrari & Siega-Riz, 2012). Then, among women who receive advice, evidence is mixed: some found education was associated with quality of advice (Bodnar et al., 2010; Stotland et al., 2005; Taffel et al., 1993; Taffel & Keppel, 1986), but other studies found no association (Cogswell et al., 1999; Phelan et al., 2011). Since some social and nutritional programs (e.g., USDA's Special Supplemental Nutrition Program for Women, Infants, and Children) target pregnant women based on SEP (which educational attainment partially determines), understanding these phenomena could inform future interventions.

Overall, the sensitivity analyses were similar to our main findings, but some differences emerged. In our sensitivity analysis using educational attainment at age 25 instead of educational attainment at the birth year, the results remained similar, even though a substantial number of women who had their first child before age 25 changed their educational attainment category (20.6% of black women, n=374; 15.0% of Hispanic women, n=276, 10.4% of white women, n=951). Other studies of NLSY women found that teenage childbearing is associated with less education, and the magnitude of this association differs by race/ethnicity (Klepinger, Lundberg, & Plotnick, 1995; Mott & Marsiglio, 1985). Among women who had their first child before age 25, the correlation coefficient between educational attainment at the first child's birth year and the educational attainment at age 25 is 0.88. (In comparison, the correlation coefficient for all women is 0.93, suggesting that educational attainment changes between first birth and age 25 more frequently for those who have their first child before age 25.)

Major study strengths include the detailed lifetime SEP data, national sample, and racial/ethnic diversity. To the best of our knowledge, this is the first study of educational attainment and GWG to adjust for a wide range of potential confounders from across the life course (Figure 1). Previous studies controlled for fewer covariates (Chu et al., 2009; Ventura, 1995) and/or had a geographically restricted population (Huynh et al., 2013). Since we more comprehensively controlled for confounders, our results are likely closer to an unbiased estimate of the underlying education-GWG association. We also considered all of a woman's pregnancies, using GEE to account for clustering, rather than restricting our analyses to one pregnancy per woman.

Limitations included self-reported measures and low power for sub-analyses. In particular, we had self-reported pre-pregnancy weight and delivery weight to estimate GWG. Due to small subgroup size, we could not estimate any potential Asian-specific education-GWG associations, and we combined normal weight and underweight women into one group when considering interaction by pre-pregnancy weight. Although the NLSY is a nationally representative sample, by limiting our analytic sample to those for whom we had complete data, this study is no longer officially nationally representative, but remains relevant for American populations. Additionally, we chose to consider the associations between inadequate and adequate separately from excessive and adequate, even though this reduced power, to avoid making the more restrictive assumptions required for ordinal or multinomial logistic regression.

Implications for Practice and/or Policy

This study increases our understanding of education as an upstream determinant of GWG. With respect to the life course model, this research provides potential points of intervention based on the mother's education in order to increase adequate GWG as well as promote health over the life course of the child. Yet many questions remain before an intervention program can be developed. We encourage future researchers to conduct studies with similar strengths—including rich SEP data—and also collect anthropometric measures of weight and be powered to detect three-way interaction between race/ethnicity, pre-pregnancy BMI, and educational attainment. Future researchers could also assess if mechanisms for the education-inadequate GWG association differ from the mechanisms for the education-excessive GWG association, including, potentially, differences in medical advice and health literacy. As researchers and practitioners seek to improve GWG outcomes, educational attainment may be an important entry for population-level intervention.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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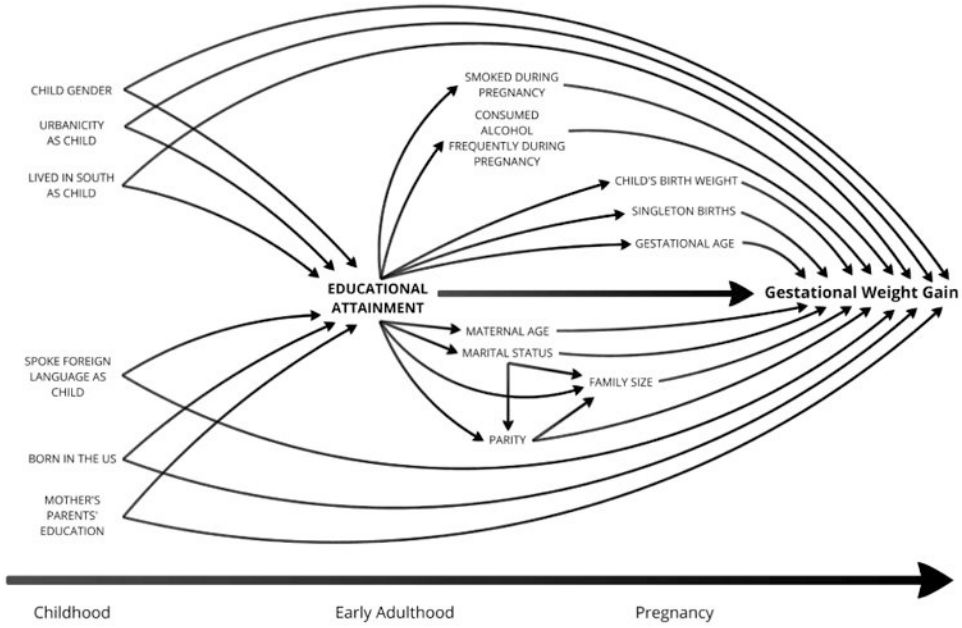

Figure 1.

A life course approach to examining the association between educational attainment and gestational weight gain.

Table 1

Descriptive Characteristics for Complete Case Analysis of Pregnancies (n =6344), National Longitudinal Survey of Youth 1979 Cohort, United States of America, 1979-2010.

	Inadequate Gestational Weight Gain (n=1615, 25.5% of all cases)	**Adequate Gestational Weight Gain (n=1904, 30.0% of all cases)**	**Excessive Gestational Weight Gain (n=2825, 44.5% of all cases)**	**Total Analytic Sample (n=6344)**
Variables of Primary Interest				
Gestational Weight Gain (kg)	Mean(SD): 6.8(4.9)	Mean(SD): 12.3(2.5)	Mean(SD): 19.4(5.7)	Mean(SD): 14.0(7.0)
Less Than High School Graduate at Birth Year	27.9%	18.5%	17.8%	20.6%
High School Graduate or Some College at Birth Year	62.5%	62.4%	66.7%	64.3%
College Graduate at Birth Year	9.6%	19.1%	15.5%	15.1%
A Priori Potential Effect Measure Modifiers				
White/Other	56.4%	66.8%	64.7%	63.2%
Black/African-American	27.7%	18.8%	21.5%	22.2%
Hispanic/Latino	16.0%	14.5%	13.8%	14.6%
Overweight (BMI≥25) at Pre-Pregnancy	14.4%	18.4%	36.1%	25.3%
Sociodemographic characteristics				
Father Had Less Than High School Education	51.0%	44.4%	46.3%	46.9%
Father Graduated High School or Some College	40.7%	41.2%	41.9%	41.4%
Father Graduated College	8.3%	14.4%	11.8%	11.7%
Mother Had Less Than High School Education	48.9%	40.9%	45.0%	44.7%
Mother Graduated High School or Some College	46.7%	51.9%	48.7%	49.2%
Mother Graduated College	4.5%	7.2%	6.3%	6.1%
Born in the United States	92.8%	94.3%	93.8%	93.7%
Spoke a Foreign Language as a Child	23.6%	21.0%	22.0%	22.1%
Lived in the South as Child	35.4%	35.6%	33.5%	34.6%
Lived in an Urban (City or Town) Setting as Child	78.8%	77.7%	79.3%	78.7%
Overweight (BMI≥25) in 1981	12.4%	12.9%	23.9%	17.7%
Characteristics at Time of Pregnancy				
Maternal age	Mean (SD): 24.4 (5.0)	Mean(SD): 25.6 (5.1)	Mean(SD): 25.8 (5.1)	Mean(SD): 25.4 (5.1)
Parity	Mean(SD): 2.0(1.1)	Mean(SD): 1.9(1.1)	Mean(SD): 1.8(1.0)	Mean(SD): 1.9(1.1)
1st child	38.5%	41.7%	47.7%	43.5%
2nd child	34.9%	35.5%	31.6%	33.6%
3rd child	17.0%	15.4%	14.5%	15.4%

	Inadequate Gestational Weight Gain (n=1615, 25.5% of all cases)	**Adequate Gestational Weight Gain (n=1904, 30.0% of all cases)**	**Excessive Gestational Weight Gain (n=2825, 44.5% of all cases)**	**Total Analytic Sample (n=6344)**
4th child or more	9.6%	7.4%	6.2%	7.5%
Family Size at Birth Year	Mean(SD): 3.9(1.9)	Mean(SD): 3.7(1.7)	Mean(SD): 3.7(1.7)	Mean(SD): 3.7(1.8)
Married or Living with Long Time Partner at Birth Year	63.6%	75.4%	71.8%	70.8%
Consumed Alcohol 3-4 Days/ Month or More During Pregnancy	9.7%	8.1%	8.2%	8.5%
Smoked During Pregnancy	33.8%	26.8%	26.4%	28.4%
Child's Birth Weight (kg)	Mean(SD): 3.1(0.6)	Mean(SD): 3.3(0.6)	Mean(SD): 3.4(0.6)	Mean(SD): 3.3(0.6)
Child is Female	50.8%	49.0%	48.0%	49.0%

Note: Many of the parents of the study participants attended high school in the 1950s; educational attainment has increased in subsequent generations.

Table 2

Educational Attainment at Birth Year and Inadequate Gestational Weight Gain: Adjusted Odds Ratios (95% Confidence Interval).

	Inadequate Gestational Weight Gain (n=3519)
Less than high school degree vs. high school degree	1.19 (0.97, 1.47)
Less than high school degree vs. college degree	1.64 ** (1.16, 2.32)
High school vs. college degree	1.38 * (1.06, 1.80)

* p<0.05,

** p<0.01,

*** p<0.001

Adequate gestational weight gain is reference group. Main effects for excessive GWG vs. adequate GWG are not reported given the presence of effect measure modification (see table 3). Adjusted for paternal educational attainment, maternal educational attainment, born in the United States, living in the South as a child, living in an urban area as a child, speaking a foreign language as a child, family size at birth year, marital status or living with a long time partner at birth year, overweight status in 1981, parity, consuming alcohol 3-4 days a month or more during pregnancy, smoking during pregnancy, child's birth weight, child's gender, pre-pregnancy overweight status, maternal age, and race/ethnicity. Wald test for effect measure modification by both pre-pregnancy BMI and race/ethnicity each had p>0.2.

Table 3

Educational Attainment at Birth Year and Excessive Gestational Weight Gain by Pre-Pregnancy Overweight Status and Race/Ethnicity: Adjusted Odds Ratios (95% Confidence Interval).

	Pre-Pregnancy Overweight Status[1]		Race/Ethnicity[2]		
	Not Overweight	**Overweight**	**Black/African-American**	**Hispanic**	**White**
	(n=3357)	**(n=1372)**	**(n=964)**	**(n=665)**	**(n=3100)**
Less than high school vs. high school degree	1.12 (0.91, 1.39)	0.71 (0.49, 1.04)	0.58 ** (0.40, 0.85)	0.88 (0.59, 1.29)	1.31 * (1.02, 1.69)
Less than high school vs. college degree	1.64 ** (1.19, 2.25)	0.60 (0.35, 1.01)	0.91 (0.50, 1.63)	1.30 (0.64, 2.64)	1.59 ** (1.13, 2.24)
High school vs. college degree	1.46 ** (1.15, 1.84)	0.84 (0.56, 1.27)	1.56 (0.95, 2.55)	1.48 (0.77, 2.87)	1.21 (0.96, 1.54)

* p<0.05,

** p<0.01,

*** p<0.001

[1] Wald test for pre-pregnancy overweight status interaction P-value: 0.002

[2] Wald test for race/ethnicity interaction P-value: 0.009

Adequate gestational weight gain is the reference group. These estimates are calculated based on overweight pre-pregnancy BMI-by-education interaction terms (first two columns) and race-by-education interaction terms (last three columns). These models also include the following covariates: paternal educational attainment, maternal educational attainment, born in the United States, living in the South as a child, living in an urban area as a child, speaking a foreign language as a child, family size at birth year, marital status or living with a long time partner at birth year, overweight status in 1981, parity, consuming alcohol 3-4 days a month or more during pregnancy, smoking during pregnancy, maternal age, child's birth weight, and child's gender. The model stratified by pre-pregnancy overweight status includes race/ethnicity as a covariate. The model stratified by race/ethnicity includes pre-pregnancy overweight status as a covariate.