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Weight gain during pregnancy and the black-white disparity in preterm birth

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Abstract

Purpose—To quantify the relationship between pregnancy weight gain with early and late preterm birth and evaluate whether associations differed between non-Hispanic (NH) black and NH white women.

Methods—We analyzed a retrospective cohort of all live births to NH black and NH white women in the U.S. 2011–2015 ($n = 10,714,983$). We used weight gain z-scores in multiple logistic regression models stratified by prepregnancy body mass index (BMI) and race to calculate population attributable risk (PAR) percentages for the contribution of high and low pregnancy weight gain to early and late preterm birth.

Results—Pregnancy weight gain was related to early and late preterm birth, but associations varied by BMI and race. For early preterm birth, the PAR percentage for high pregnancy weight gain ranged from 8–10% in NH black women and from 6–8% in NH white women. There was little

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evidence of racial differences in late preterm birth: PAR percentages ranged from 2-7% in NH black women and from 3-7% in NH white women.

Conclusions—Moderate gestational weight gain is associated with lower rate of preterm birth, with greatest reductions for early preterm birth in NH black women.

Keywords

premature birth; weight gain; health status disparities; African Americans; United States; pregnancy; obesity

Introduction

In 2015, one in every eight non-Hispanic (NH) black infants in the U.S. was born preterm (< 37 weeks' gestation) compared with one in every 11 NH white infants.¹ This difference was even greater for early preterm birth; one in every 32 NH black infants was born < 32 weeks' gestation compared with one in every 79 NH white infants.¹ The magnitude of this black-white disparity in preterm birth has persisted throughout the past decade and is not explained by socioeconomic factors.²⁻⁴

Prepregnancy body mass index (BMI) and weight gain during pregnancy may be modifiable contributors to preterm birth and racial disparities in preterm birth rates.⁵⁻⁷ Higher rates of preterm birth have been consistently observed in women who are underweight or obese before pregnancy as well as in women who gain little or no weight during pregnancy.⁶⁻¹⁰ Additionally, a higher proportion of women who identify as NH black or African American begin pregnancy obese and, if underweight or normal weight, gain below the Institute of Medicine (IOM) gestational weight gain recommendations, compared with NH white women.^{11,12} Previous studies of weight gain and preterm birth have been limited by the methods available to account for the fact that women who deliver preterm have less time to gain weight during pregnancy, and these studies have not focused on racial/ethnic differences except in very limited study samples.¹³⁻¹⁵

In this national study, we used gestational weight gain-for-gestational age z-scores to assess, by prepregnancy BMI category: (1) if gestational weight gain is associated with early and late preterm birth, and (2) if such associations differ between NH black and NH white women.

Materials and Methods

Data and Study Design

We used data from the 2011 to 2015 U.S. Birth Data Files created by the National Center for Health Statistics (NCHS). Of the 19,849,688 available birth records, we included those that used the 2003 Revision of the U.S. Standard Certificate of Live Birth ($n = 18,445,524$) and were live singletons born to NH black or NH white women ($n = 11,770,568$). We set extreme values of gestational age (< 22 or > 42 week, $n = 168,102$), birthweight-for-gestational age (following Alexander et al.,¹⁶ $n = 38,999$), and gestational weight gain z-scores (< -4 or > 4 standard deviations (SD), $n = 63,342$) to missing.^{17,18}

NCHS previously edited values outside the ranges of 100-400 lb. for maternal weight at delivery, 75-375 lb. for prepregnancy weight, and 30-78 in. for height as missing. Additional exclusions include: those missing information on prepregnancy weight or height (n = 425,474), delivery weight (n = 213,790), and infant birthweight (n = 141,660). The final study sample included 10,718,449 births. Because the data are completely de-identified and publicly available, the study did not require ethics approval from an Institutional Review Board.

Measures

We used obstetric estimates to categorize gestational age at delivery as early preterm (< 32 weeks), late preterm (≥ 32 weeks to < 37 weeks), and term (≥ 37 weeks to < 42 weeks), following the World Health Organization guidelines.¹⁹

Maternal race was self-reported as black (black or African American) or white and ethnicity was self-reported as non-Hispanic (not Spanish/Hispanic/Latino) or other. Prepregnancy BMI was calculated from self-reported prepregnancy weight and height (kg/m²) and categorized as underweight (< 18.5), normal weight (≥ 18.5 to < 25), overweight (≥ 25 to < 30), obese class I (≥ 30 to < 35), obese class II (≥ 35 to < 40), and obese class III (≥ 40). Prepregnancy BMI and race (NH black and NH white) were effect modifiers of interest.⁶

Gestational weight gain was the difference between maternal delivery weight and prepregnancy weight. We converted maternal weight gain into weight gain-for-gestational age z-scores using charts previously created by our team using serial prenatal weight measurements from women in Pennsylvania with healthy, term, singleton births.^{17,18} The charts are prepregnancy BMI-specific (separate charts for underweight through obesity class III categories) because optimal weight gain varies by prepregnancy BMI.⁶ We categorized the continuous z-scores as < -1 standard deviation (SD) (low), -1 SD to +1 SD (moderate), and > +1 SD (high) weight gain. For a normal-weight woman at 40 weeks' gestation, these categories are equivalent to < 11.2 kg, 11.2-23 kg, and > 23 kg, respectively.¹⁸ The weight gain equivalents to the categorized z-scores by week of pregnancy are provided in Supplemental Figure 1.

Confounders were selected *a priori* using theory-based causal graphs²⁰ and included sociodemographic characteristics (education level, age, marital status, acknowledgment of paternity, method of payment, and calendar year) and health characteristics (pregestational hypertension, pregestational diabetes, maternal height, trimester of entry to prenatal care, interpregnancy interval < 6 months, average number of cigarettes smoked per day in pregnancy, and parity).

Data Analysis

First, we descriptively analyzed prenatal characteristics and calculated crude rates of early and late preterm birth by maternal race. We also calculated crude rates of early and late preterm birth within each subgroup of maternal race, prepregnancy BMI, and pregnancy weight gain.

Next, we estimated associations of categorized weight gain z-scores with early and late preterm birth using multiple logistic regression models. Risk of early preterm birth was calculated over all live births and risk of late preterm birth was calculated over live births 32 weeks' gestation. We used inverse probability weighting with stabilized weights to correct for missing covariate data because 11.2% of the sample was missing information on at least one covariate.²¹ Individual covariate missingness ranged from 0-4% (median 0.7%). Population attributable risks (PAR) were calculated with the final multiple logistic regression models by the module “regpar” and PAR percentages were calculated with the same models by the module “punaf” in Stata version MP 14.1 (StataCorp, College Station, TX).^{22,23} Because of the large sample size, clinical significance was determined by the magnitude of effect estimates and width of confidence intervals in addition to p-values.²⁴

Results

The crude early preterm birth rate was 2.5 per 100 live births among NH black women, and 0.9 among NH white women. The crude late preterm birth rate was 11.6 per 100 live births in NH black women and 7.2 in NH white women. Two-thirds of NH black women and nearly three-quarters of NH white women gained weight within the moderate range (Table 1). A higher proportion of NH black women were overweight or obese prepregnancy, delivered as adolescents, did not have private health insurance, and had a high school education or less, compared to NH white women. A higher proportion of NH white women smoked during pregnancy.

Tables 2 and 3 display the crude rates of early and late preterm birth, respectively, stratified by race, prepregnancy BMI, and weight gain. The early preterm birth rate was lowest (0.6%) in NH white women who were normal weight prepregnancy and gained weight within the moderate range (equivalent to 7-15 kg at 28 weeks and 11-23 kg at 40 weeks) and highest (5.8%) in NH black women with class III obesity and high weight gain (equivalent to > 13 kg at 28 weeks and > 21 kg at 40 weeks) (Table 2). The late preterm birth rate was also lowest (6.2%) in normal-weight, NH white women with moderate weight gain and highest (17.7% and 18.5%, respectively) in obese class III, NH black women with high weight gain and in underweight, NH black women with low weight gain (equivalent to < 7 kg at either 28 or 40 weeks) (Table 3). For every combination of prepregnancy BMI and gestational weight gain, early and late preterm birth rates were higher in NH black women than in NH white women.

In adjusted analyses, the PAR and PAR percentages for early preterm birth were significant for high – but not low – weight gain during pregnancy for both NH black and NH white women with prepregnancy obesity (Table 4). High and low weight gain conferred increased population risks of early preterm birth in non-obese women, but low weight gain was most important among underweight women and high weight gain was most important among overweight women. For high weight gain in all BMI groups, the PAR and PAR percentages were higher in NH black women than in NH white women. For early preterm births among NH black women, the PAR for high gain ranged from 1.9 to 3.0 and the PAR percentage ranged from 7.8% to 10.2%. That is, if 100 NH black women gained weight during pregnancy within, instead of above, the moderate range, a reduction of 2 to 3 – or 8% to

10% of – early preterm births could be expected, depending on prepregnancy BMI. In contrast, we estimated that if 100 NH white women gained weight during pregnancy within, instead of above, the moderate range, a reduction of fewer than 1 early preterm births (6% to 8%) would be expected. For low weight gain and early preterm birth, the PAR percentage in underweight women was higher in NH black than NH white women, but the PAR percentages in normal-weight and overweight women were higher in NH white than NH black women.

Table 5 shows that low pregnancy weight gain in non-obese women and high weight gain in all women were associated with late preterm birth. For all of these associations, the PAR was higher in NH black women than in NH white women, but the black-white differences in PAR percentages were small or nonexistent. The PAR for high weight gain and late preterm birth ranged from 3.2 to 7.9 in NH black women and from 2.5 to 5.5 in NH white women, depending on prepregnancy BMI. The PAR percentage ranged from 2.4% to 6.5% in NH black women and from 2.8% to 6.8% in NH white women.

Discussion

In this national study of more than 10 million recent live births to NH black and NH white women in the U.S., moderate weight gain during pregnancy was associated with a significantly lower risk of both early and late preterm birth in all BMI groups. Preventing high pregnancy weight gain was estimated to have a greater impact on the population risk percentage of early, but not late, preterm birth in NH black women than in NH white women.

Our findings on the associations between gestational weight gain and preterm birth are difficult to compare with prior evidence because almost every study has defined weight gain differently.^{6,7} Most studies measure total weight gain, but using total gain in analysis induces a biased association between low gain and preterm birth because women who deliver preterm have less time to gain weight.¹⁵ Some studies have used various approaches to address this bias, the most common being the division of total gain by gestational age to approximate weekly rate of gain.^{6–9} However, this approach is still biased because it over-attributes gain to the first trimester, when the rate of gain is lower.^{6,15} The weight gain-for-gestational age z-scores used in this study improve upon these past approaches by standardizing weight gain for gestational age, similar to fetal weight z-scores.^{17,18,25} Overall, our results using the z-scores in the U.S. population of NH black and NH white women corroborate substantial evidence of an association between low gain and preterm birth in underweight and normal-weight women.^{6,7} In addition, our study clarifies prior mixed evidence that high weight gain is a risk factor for preterm birth in women of all BMI groups and that low weight gain is not a risk factor in obese women.^{6–10,26}

There is very limited previous knowledge on how weight gain during pregnancy may be related to differences in preterm birth between NH black and NH white women.^{13,14} Previously, one study found low weight gain was more strongly associated with preterm birth in NH white women than in NH black women,¹⁴ while another found the association to be stronger in NH black women and that high weight gain was only associated with preterm

birth in NH black women.¹³ However, both of these studies were conducted among relatively small samples of non-obese women who delivered more than 15 years ago and did not separately evaluate early and late preterm birth. Using population attributable risk percentages, our study did not find evidence that the impact of weight gain on late preterm birth differed between NH black and NH white women. We did, however, find that the estimated impact of high weight gain on early preterm birth was highest in NH black women. Early, compared to late, preterm birth may be etiologically distinct, represents a much larger black-white disparity, and accounts for a substantial proportion of infant deaths and acquired developmental disabilities.^{1,2} Although we did not have data to study biological mechanisms, current evidence suggests that multiple proximal and distal factors may interact to cause the black-white disparity in early preterm birth.²⁻⁴ Chronic stress, in particular, has been implicated in altering the endocrine and immune systems, leading to higher rates of preterm birth in NH black women than in NH white women.²⁻⁴ Such factors could compound effects of high weight gain during pregnancy or independently affect both weight gain and preterm birth. In our study, we also found PAR percentages for low pregnancy weight gain and early preterm birth to be higher in NH white than in NH black women who were normal-weight and overweight, supporting a similar finding by Hickey et al.¹⁴ in non-obese black and white women.

This observational study has several limitations. Because we only included NH black and NH white women to focus on the black-white disparity in preterm birth, our results are not generalizable to other races and ethnicities. Maternal BMI and weight gain may have different effects on spontaneous and medically indicated preterm births,^{10,13} but it was not possible to validly distinguish these births using vital records.²⁷ We were also unable to assess potential mediators of the association between weight gain and preterm birth, such as pre-eclampsia, or exclude infants with congenital anomalies because of inconsistent reporting on the birth certificates.²⁷ Missing data and reporting errors are also weaknesses of the birth certificate data and self-reported prepregnancy weight and height may have resulted in some misclassification of prepregnancy BMI and gestational weight gain. Results from a recent systematic review suggest that misclassification due to self-report may have minimal impact on study findings, but we did not test this assumption in the current study.²⁸

Birth certificate data allow the calculation of total gestational weight gain, but precluded us from assessing pattern of weight gain or using time-to-event analysis.^{14,29,30} Previous studies have reported mixed findings on the pattern of weight gain and preterm birth, which will require further study in other datasets.^{14,29,30} Recently, a multi-country, prospective study found that weight gain z-scores in healthy pregnancies were similar across populations,³¹ which suggests that the z-scores applied in our study – although developed in a U.S. subpopulation – may be appropriate to use in other populations. However, we could not test this assumption.³²

The limitations of this study are counterbalanced by a number of strengths. The study sample was drawn from all births in the U.S. from 2011 to 2015, making the results highly generalizable to the contemporary U.S. population of NH black and NH white women. The size of the study sample also provided sufficient statistical power to study the associations between a wide range of weight gain amounts and early and late preterm birth across six

categories of prepregnancy BMI in NH black and NH white women. Our use of weight gain-for-gestational age z-scores accounted for the dependence of gestational weight gain on gestational duration, which has previously prevented valid assessment of weight gain and preterm birth.¹⁵

In 2009, the IOM revised guidelines for weight gain during pregnancy to no longer recommend higher weight gain in black women, and to include a specific, relatively narrow range of recommended gain in obese women.⁶ There were limited data to guide these recommendations and the IOM report called for additional research. Our study responds to this need and may be useful for future weight gain guidelines by investigating the relationships between weight gain, maternal race, and prepregnancy BMI. Additionally, our results add to evidence that improving maternal weight gain could reduce the risk of preterm birth.^{6,7} Although behavior change is challenging, there is growing evidence that moderate weight gain can be promoted effectively.^{5,33} As a recent example, Herring et al.³⁴ found in a pilot randomized clinical trial that socioeconomically disadvantaged, African-American women who received a behavioral intervention were half as likely to gain weight above the IOM guidelines as women who received usual prenatal care. In a similar study population, Schulman and Kottke³⁵ reported that a pregnant woman's accurate knowledge of her recommended range of weight gain was associated with appropriate weight gain, but only 27% of women were aware of their recommended gain. Provider advice about gestational weight gain has been strongly associated with actual weight gain, but the majority of pregnant women – particularly those with a low BMI – do not receive accurate advice on weight gain.³⁵⁻³⁶ Moreover, the built and social environments in which women live and work are likely contributors to their ability to gain a healthy amount of weight in pregnancy.^{6,37,38} Our study findings highlight the need for continued research to determine how moderate weight gain during pregnancy can best be promoted at individual, community, and policy levels. Although our results are not from an intervention, they suggest that women achieving moderate weight gain could help meet the Healthy People 2020 goal of reducing preterm birth in the U.S. by 10%, as well as reduce the gap in early preterm birth rates between NH black and NH white women.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Abbreviations

BMI	body mass index
IOM	Institute of Medicine
NCHS	National Center for Health Statistics
NH	non-Hispanic

Characteristics of the study sample and rates of preterm birth by maternal race, U.S. singleton pregnancies in non-Hispanic black and non-Hispanic white women (2011-2015)

Table 1

Characteristic	Non-Hispanic Black (n = 2,179,626)		Non-Hispanic White (n = 8,538,823)	
	Preterm births per 100 live births		Preterm births per 100 live births	
	Column %	Early Late	Column %	Early Late
Preterm birth		2.5 11.6		0.9 7.2
Pregnancy weight gain (z-score)				
Low (< -1)	22.5	2.5 12.4	17.1	1.1 8.0
Moderate (-1 to 1)	66.4	2.3 10.9	72.6	0.8 6.6
High (> 1)	11.2	4.0 15.0	10.4	1.4 10.0
Prepregnancy BMI (kg/m ²)				
Underweight (< 18.5)	11.1	3.9 14.5	10.3	1.3 9.7
Normal-weight (18.5-24.9)				
Overweight (25-29.9)	3.6	2.9 14.5	4.0	1.3 9.6
Obese class I (30-34.9)	36.2	2.4 11.9	50.3	0.8 6.8
Obese class II (35-39.9)	26.9	2.4 11.1	23.8	0.8 7.0
Obese class III (≥ 40)	16.8	2.7 11.3	12.0	1.0 7.5
Maternal age (y)				
10-19	10.8	2.6 12.6	5.1	1.4 9.2
20-24	31.3	2.3 11.2	20.2	1.0 7.7
25-29	26.7	2.4 10.9	30.5	0.8 6.7
30-34	19.3	2.6 11.5	29.1	0.7 6.5
35	11.9	3.3 13.5	15.2	1.0 8.0
Parity				
0	61.7	2.9 10.5	58.3	1.1 7.2
1	38.3	2.3 12.3	41.8	0.7 7.2
Maternal education				
Less than high school	17.5	2.8 13.9	8.3	1.4 9.9
High school or equivalent	33.0	2.6 12.2	21.4	1.1 8.4

Characteristic	Non-Hispanic Black (n = 2,179,626)		Non-Hispanic White (n = 8,538,823)	
	Preterm births per 100 live births		Preterm births per 100 live births	
	Column %	Early	Column %	Early
Some college	34.4	2.5	31.4	0.9
College graduate	15.2	2.1	38.9	0.6
Average cigarettes smoked per day in pregnancy				
None	93.1	2.5	87.8	0.8
1-9	5.2	3.4	6.6	1.5
10 - 19	1.2	3.5	4.2	1.5
20	0.5	3.8	1.5	1.8
Marital status				
Married	28.5	2.1	71.1	0.7
Not married	71.5	2.7	28.9	1.3
Source of payment				
Private insurance	26.0	2.4	61.6	0.7
Other	74.0	2.6	38.5	1.1
Trimester of entry to prenatal care				
First	65.3	2.5	80.7	0.8
Second	25.4	2.3	15.3	1.0
Third or never	9.3	2.7	4.0	1.3

Table 2
Crude rates of early preterm birth by maternal race, prepregnancy BMI, and pregnancy weight gain z-score categories, U.S. singleton pregnancies in non-Hispanic black and non-Hispanic white women (2011-2015)

Pregnancy BMI	Weight gain category ^a	Weight gain equivalent at 28 wk (kg)	Weight gain equivalent at 40 wk (kg)	Non-Hispanic Black		Non-Hispanic White	
				Total	Cases	Per 100 live births	Per 100 live births
Underweight (<18.5 kg/m ²)	Low	< 6.6	< 6.8	16,151	691	4.3	50,422
	Moderate	6.6–14.0	6.8–21.4	50,662	1,207	2.4	240,240
	High	> 14.0	> 21.4	11,909	383	3.2	51,724
Normal weight (18.5–24.9 kg/m ²)	Low	< 6.7	< 11.2	215,441	5,800	2.7	797,776
	Moderate	6.7–14.9	11.2–23.0	475,353	9,696	2.0	3,028,308
	High	> 14.9	> 23.0	98,684	3,194	3.2	467,598
Overweight (25.0–29.9 kg/m ²)	Low	< 4.8	< 9.0	145,517	3,302	2.3	352,545
	Moderate	4.8–16.2	9.0–24.6	387,488	8,571	2.2	1,499,404
	High	> 16.2	> 24.6	53,648	2,127	4.0	181,207
Obese class I (30.0–34.9 kg/m ²)	Low	< 2.3	< 5.6	74,020	1,708	2.3	167,912
	Moderate	2.3–14.8	5.6–22.3	250,451	6,315	2.5	743,843
	High	> 14.8	> 22.3	40,744	1,768	4.3	108,450
Obese class II (35.0–39.9 kg/m ²)	Low	< -0.8	< 1.9	26,557	426	1.6	61,309
	Moderate	-0.8–12.9	1.9–21.1	146,045	3,897	2.7	393,549
	High	> 12.9	> 21.1	22,276	1,137	5.1	48,450
Obese class III (≥ 40 kg/m ²)	Low	< -3.9	< -2.3	12,848	341	2.7	26,752
	Moderate	-3.9–12.8	-2.3–20.8	136,208	3,712	2.7	293,887
	High	> 12.8	> 20.8	15,624	913	5.8	25,447

^aWeight gain categories are defined using z-score values as low (<-1 standard deviation), moderate (-1 to 1 SD), and high (>+1 SD).

Table 3
Crude rates of late preterm birth by maternal race, prepregnancy BMI, and pregnancy weight gain z-score categories, U.S. singleton pregnancies in non-Hispanic black and non-Hispanic white women (2011-2015)

Pregnanancy BMI	Weight gain category ^a	Weight gain equivalent at 28 wk (kg)	Weight gain equivalent at 40 wk (kg)	Non-Hispanic Black		Non-Hispanic White	
				Total	Cases	Per 100 live births	Per 100 live births
Underweight (<18.5 kg/m ²)	Low	< 6.6	< 6.8	16,151	2,980	18.5	50,422
	Moderate	6.6–14.0	6.8–21.4	50,662	6,685	13.2	240,240
	High	> 14.0	> 21.4	11,909	1,722	14.5	51,724
Normal weight (18.5–24.9 kg/m ²)	Low	< 6.7	< 11.2	215,441	29,231	13.6	797,776
	Moderate	6.7–14.9	11.2–23.0	475,353	51,540	10.8	3,028,308
	High	> 14.9	> 23.0	98,684	13,053	13.2	467,598
Overweight (25.0–29.9 kg/m ²)	Low	< 4.8	< 9.0	145,517	16,479	11.3	352,545
	Moderate	4.8–16.2	9.0–24.6	387,488	40,640	10.5	1,499,404
	High	> 16.2	> 24.6	53,648	8,014	14.9	181,207
Obese class I (30.0–34.9 kg/m ²)	Low	< 2.3	< 5.6	74,020	8,087	10.9	167,912
	Moderate	2.3–14.8	5.6–22.3	250,451	27,063	10.8	743,843
	High	> 14.8	> 22.3	40,744	6,046	14.8	108,450
Obese class II (35.0–39.9 kg/m ²)	Low	< -0.8	< 1.9	26,557	2,650	10.0	61,309
	Moderate	-0.8–12.9	1.9–21.1	146,045	16,068	11.0	393,549
	High	> 12.9	> 21.1	22,276	3,733	16.8	48,450
Obese class III (≥ 40 kg/m ²)	Low	< -3.9	< -2.3	12,848	1,396	10.9	26,752
	Moderate	-3.9–12.8	-2.3–20.8	136,208	14,965	11.0	293,887
	High	> 12.8	> 20.8	15,624	2,769	17.7	25,447

^aWeight gain categories are defined using z-score values as low (<-1 standard deviation), moderate (-1 to 1 SD), and high (>+1 SD).

Table 4

Population attributable risks and population attributable risk percentages for early preterm birth (< 32 wk) due to low and high pregnancy weight gain, stratified by race and prepregnancy BMI and adjusted for confounders, in U.S. singleton pregnancies in non-Hispanic black and non-Hispanic white women (2011–2015)

Pregnancy Weight Gain Category ^a	Population Attributable Risks per 100 Live Births (95% CI)			Population Attributable Risk Percentages (95% CI)		
	Non-Hispanic Black	Non-Hispanic White		Non-Hispanic Black	Non-Hispanic White	
Underweight (BMI < 18.5 kg/m²)						
Low	3.7 (2.8, 4.6)	1.3 (1.1, 1.6)		13.7 (10.4, 16.8)	11.1 (9.1, 13.0)	
Moderate	Reference	Reference		Reference	Reference	
High	1.9 (1.2, 2.6)	0.7 (0.5, 0.9)		7.8 (4.9, 10.6)	5.9 (3.9, 7.8)	
Normal Weight (BMI 18.5–24.9 kg/m²)						
Low	1.2 (1.0, 1.5)	0.8 (0.8, 0.9)		5.7 (4.5, 7.0)	11.6 (10.8, 12.3)	
Moderate	Reference	Reference		Reference	Reference	
High	2.0 (1.8, 2.2)	0.5 (0.5, 0.5)		9.3 (8.3, 10.3)	7.3 (6.7, 8.0)	
Overweight (BMI 25.0–29.9 kg/m²)						
Low	0.1 (−0.1, 0.4)	0.4 (0.3, 0.4)		0.5 (−0.7, 1.8)	5.0 (4.0, 5.9)	
Moderate	Reference	Reference		Reference	Reference	
High	2.1 (1.8, 2.3)	0.5 (0.4, 0.6)		8.8 (7.9, 9.7)	7.2 (6.4, 8.0)	
Obese Class I (BMI 30.0–34.9 kg/m²)						
Low	−0.2 (−0.5, 0.1)	0.0 (−0.1, 0.1)		−0.9 (−2.2, 0.3)	0.4 (−0.7, 1.5)	
Moderate	Reference	Reference		Reference	Reference	
High	2.3 (2.0, 2.6)	0.6 (0.5, 0.7)		8.5 (7.4, 9.7)	6.5 (5.4, 7.5)	
Obese Class II (BMI 35.0–39.9 kg/m²)						
Low	−1.2 (−1.5, −0.9)	−0.2 (−0.3, −0.1)		−5.1 (−6.2, −3.9)	−2.2 (−3.3, −1.1)	
Moderate	Reference	Reference		Reference	Reference	
High	2.9 (2.5, 3.4)	0.9 (0.7, 1.0)		10.2 (8.7, 11.7)	7.8 (6.5, 9.1)	
Obese Class III (BMI ≥ 40.0 kg/m²)						
Low	0.1 (−0.2, 0.4)	0.1 (0.0, 0.3)		0.3 (−0.7, 1.3)	1.1 (0.0, 2.1)	
Moderate	Reference	Reference		Reference	Reference	
High	3.0 (2.5, 3.4)	0.9 (0.7, 1.1)		10.0 (8.6, 11.4)	7.1 (5.8, 8.4)	

BMI, body mass index; CI, confidence interval

All results are adjusted for maternal age, education level, marital status, acknowledgement of paternity, method of payment for delivery, calendar year, pregestational hypertension, pregestational diabetes, height, trimester of entry to prenatal care, interpregnancy interval < 6 months, cigarettes smoked per day in pregnancy, and parity.

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Table 5

Population attributable risks and population attributable risk percentages for late preterm birth (32 and < 37 wk) due to low and high pregnancy weight gain, stratified by race and pre-pregnancy BMI and adjusted for confounders, in U.S. singleton pregnancies in non-Hispanic black and non-Hispanic white women (2011-2015)

Pregnancy weight gain category ^a	Population Attributable Risks per 100 Live Births (95% CI)			Population Attributable Risk Percentages (95%CI)		
	Non-Hispanic Black	Non-Hispanic White		Non-Hispanic Black	Non-Hispanic White	
Underweight (BMI < 18.5 kg/m²)						
Low	11.2 (9.4, 13.0)	5.7 (5.1, 6.3)		7.6 (6.4, 8.8)	6.1 (5.5, 6.7)	
Moderate	Reference	Reference		Reference	Reference	
High	3.2 (1.8, 4.7)	2.5 (2.0, 3.1)		2.4 (1.3, 3.4)	2.8 (2.2, 3.4)	
Normal Weight (BMI 18.5-24.9 kg/m²)						
Low	6.5 (5.9, 7.1)	3.2 (3.0, 3.3)		5.5 (5.0, 6.0)	4.9 (4.6, 5.1)	
Moderate	Reference	Reference		Reference	Reference	
High	4.5 (4.1, 5.0)	2.7 (2.6, 2.8)		4.0 (3.6, 4.4)	4.2 (4.0, 4.4)	
Overweight (BMI 25.0-29.9 kg/m²)						
Low	1.2 (0.6, 1.7)	0.7 (0.6, 0.9)		1.1 (0.5, 1.6)	1.1 (0.8, 1.4)	
Moderate	Reference	Reference		Reference	Reference	
High	5.9 (5.5, 6.3)	4.1 (4.0, 4.3)		5.3 (4.9, 5.6)	6.0 (5.8, 6.3)	
Obese Class I (BMI 30.0-34.9 kg/m²)						
Low	-0.1 (-0.7, 0.6)	-0.1 (-0.3, 0.2)		-0.1 (-0.6, 0.5)	-0.1 (-0.5, 0.3)	
Moderate	Reference	Reference		Reference	Reference	
High	6.1 (5.5, 6.7)	4.0 (3.7, 4.3)		5.3 (4.8, 5.8)	5.3 (4.9, 5.6)	
Obese Class II (BMI 35.0-39.9 kg/m²)						
Low	-1.5 (-2.2, -0.9)	-1.0 (-1.3, -0.7)		-1.4 (-2.0, -0.8)	-1.4 (-1.8, -1.0)	
Moderate	Reference	Reference		Reference	Reference	
High	7.9 (7.1, 8.6)	5.5 (5.1, 5.9)		6.5 (5.9, 7.1)	6.8 (6.4, 7.3)	
Obese Class III (BMI 40.0 kg/m²)						
Low	-0.1 (-0.7, 0.4)	-0.1 (-0.4, 0.2)		-0.1 (-0.6, 0.4)	-0.1 (-0.5, 0.3)	
Moderate	Reference	Reference		Reference	Reference	
High	7.1 (6.3, 7.8)	5.1 (4.7, 5.4)		5.9 (5.3, 6.5)	5.9 (5.5, 6.3)	

BMI, body mass index; CI, confidence interval

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All results are adjusted for maternal age, education level, marital status, acknowledgement of paternity, method of payment for delivery, calendar year, pregestational hypertension, pregestational diabetes, height, trimester of entry to prenatal care, interpregnancy interval < 6 months, cigarettes smoked per day in pregnancy, and parity.