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Prevalence and Characteristics Associated With Gestational Weight Gain Adequacy

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Abstract

Objective—To estimate the prevalence of gestational weight gain adequacy according to the 2009 Institute of Medicine recommendations and examine demographic, behavioral, psychosocial and medical characteristics associated with inadequate and excessive gain, stratified by pre-pregnancy body mass index (BMI) category.

Methods—We used cross-sectional, population-based data on women delivering full-term (≥ 37 weeks), singleton infants in 28 states who participated in the 2010 or 2011 Pregnancy Risk Assessment Monitoring System. We estimated adjusted odds ratios (aOR) and 95% Confidence Intervals (CI) for inadequate and excessive compared with adequate gain, stratified by pre-pregnancy BMI.

Results—Overall, 20.9%, 32.0% and 47.2% of women gained inadequate, adequate and excessive gestational weight, respectively. Prepregnancy BMI was strongly associated with weight gain outside recommendations. Compared with normal weight (prevalence 51.8%), underweight women (4.2%) had decreased odds of excessive gain (aOR 0.50, CI 0.40–0.61) whereas overweight and obese class I, II and III (23.6%, 11.7%, 5.4%, and 3.5%, respectively) women had increased odds of excessive gain (aOR range 2.07, CI 1.63–2.62 to aOR 2.99, CI 2.63–3.40). Underweight and obese class II and III women had increased odds of inadequate gain (aOR range 1.25, CI 1.01–1.55 to 1.86, CI 1.45–2.36). Most characteristics associated with weight gain adequacy were demographic, such as racial or ethnic minority status and education, and varied by prepregnancy BMI. Notably, one behavioral characteristic – smoking cessation – was associated with excessive gain among normal weight and obese women.

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Conclusions—Most women gained weight outside recommendations. Understanding characteristics associated with inadequate or excessive weight gain may identify potentially at-risk women and inform much-needed interventions.

Introduction

In 2009, the Institute of Medicine revised gestational weight gain recommendations by adopting body mass index (BMI) cut-off values consistent with the World Health Organization and establishing a weight gain range of 11–20 pounds for obese women (1). The recommendations balance risks associated with gaining too much or too little weight to promote optimal health for a mother and her infant. Gestational weight gain below recommendations is associated with small-for-gestational age births while weight gain above recommendations is associated with large-for-gestational age births, childhood overweight and obesity, and maternal postpartum weight retention (1, 2).

Recent studies suggest that 23% to 34% of women gained within recommendations, while 17% to 28% gained below and 41% to 51% gained above recommendations (3–5). Furthermore, overweight and obese women most frequently gained above recommendations compared with normal weight women (4–6). These prevalence estimates are mostly drawn from single state-representative samples (4–6) and all estimates use data collected before recommendations were revised (3–6). Additionally, to our knowledge, no study has used representative data to examine characteristics associated with gestational weight gain below or above the revised recommendations, which may help clinicians identify potentially at-risk women.

Our objective was to estimate the prevalence of gestational weight gain below, within and above the revised recommendations using multiple state-representative data from 2010 and 2011. We also sought to assess the relationship between demographic, behavioral, psychosocial and medical characteristics identified in the Institute of Medicine's conceptual framework and weight gain below or above recommendations, stratified by prepregnancy BMI category.

Materials and Methods

Data come from the Pregnancy Risk Assessment Monitoring System, a cross-sectional surveillance project (7). In each participating state, 100–250 mothers are systematically sampled from birth certificates 2–4 months after delivery. Sampled mothers complete a questionnaire or telephone interview to gather information on behaviors and experiences prior to, during and immediately after pregnancy. Self-reported questionnaire data are combined with demographic and medical data from the birth certificate. All data are weighted to account for survey design, non-coverage and nonresponse to be representative of the female population delivering a live birth in each state. The Pregnancy Risk Assessment Monitoring System has been reviewed and approved by the Centers for Disease Control and Prevention Institutional Review Board.

We examined demographic, behavioral, psychosocial and medical characteristics associated with gestational weight gain, as previously identified in the Institute of Medicine's

conceptual framework that was used to guide the weight gain recommendations (1). Pre-pregnancy BMI (weight in kilograms/height in meters^2) was calculated using self-reported height and weight from the questionnaire and was categorized as follows: underweight (BMI less than 18.5 kg/m^2), normal weight (BMI 18.5 – 24.9 kg/m^2), overweight (BMI 25.0 – 29.9 kg/m^2), obese (BMI 30.0 kg/m^2 or greater)(8). For some analyses, we further categorized obesity into class I (BMI 30.0–34.9 kg/m^2), class II (BMI 35.0–39.9 kg/m^2) and class III (BMI 40.0 kg/m^2 or greater)(8). From the birth certificate, we obtained demographic information including maternal age, race or ethnicity, education, parity and marital status. Maternal race or ethnicity was categorized as non-Hispanic white, non-Hispanic black, Hispanic, Asian (including Chinese, Filipino, Japanese, Pacific Islander and other Asian), American Indian, Alaska Native, Hawaiian (including part-Hawaiian), and Other (including mixed, other, or missing race). Per Vermont data use agreements, Vermont women were categorized as non-Hispanic White or other. We defined enrollment in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) or Medicaid if either the birth certificate or the questionnaire indicated enrollment in these programs. Behavioral characteristics included first trimester entrance into prenatal care and regular (three or more days) physical activity in the year before pregnancy, both from the questionnaire. The birth certificate and questionnaire were the sources for alcohol consumption and smoking during pregnancy (defined as non-smokers, quitters [smoking before pregnancy, but not in the third trimester], or smokers [smoking in the third trimester]). Psychosocial characteristics came from the questionnaire and included visiting a healthcare professional for depression before pregnancy and reporting partner abuse before or during pregnancy. Pre-pregnancy stress came from 13 questionnaire items that assess a woman's experience of stressful life events, described elsewhere (9). We summed affirmative responses and created a variable categorized by quartiles to quantify stressful events experienced: no stressful events; one stressful event; two or three stressful events; four or more stressful events. Finally, for medical conditions, we obtained information on severe nausea during pregnancy from the questionnaire. At the time of this analysis, not all states used the 2003 revision of the standard birth certificate, which distinguishes between pre-pregnancy and gestational diabetes as well as pre-pregnancy hypertension, gestational hypertension, and eclampsia. Therefore, we classified women as having diabetic disease or hypertensive conditions if the condition was indicated on either the birth certificate or questionnaire.

Total gestational weight gain was obtained from the birth certificate and was categorized based on the Institute of Medicine recommendations: 28–40 pounds for underweight women, 25–35 pounds for normal weight women, 15–25 pounds for overweight women, and 11–20 pounds for obese women (1). We considered gestational weight gain to be inadequate, adequate, or excessive if a woman gained below, within or above recommendations, respectively, for her pre-pregnancy BMI. We used 2010 and 2011 data from states that approved this analysis and met the 65% response rate threshold. In total, 28 states provided data for this analysis; 19 states provided data for both years: AR, CO, GA, HI, MD, ME, MS, NE, NJ, NY (including New York City), OK, OR, PA, RI, UT, VT, WA, WV, WY. Seven states provided data for 2010 only: AK, DE, MA, MI, MN, OH, TX. Two states provided data for 2011 only: NM, WI. Women were included if they gave birth to a

full-term (37 weeks or greater gestation), singleton infant in 2010 or 2011 (n=53,441). Plurality in Vermont was not reported to the Pregnancy Risk Assessment Monitoring System, thus all Vermont births were considered singletons. Women were excluded if they had missing gestational weight gain values (n=2,571) or missing or implausible pre-pregnancy weight (less than 75 pounds or greater than 450 pounds; n=1,186), height (less than 48″ or greater than 78″; n=1,646), or BMI (in the top or bottom 0.01 percentile of our sample, i.e. less than 12.8 kg/m^2 or greater than 69.9 kg/m^2; n=10) values. Additionally, we excluded women with incomplete data on other variables of interest (n=3,607). Our final sample size was 83.1% of our eligible population (unweighted n=44,421), which, when weighted, represents approximately 30% of births in 2010–2011.

We used Wald chi-square tests to identify statistically significant differences in proportions of women gaining inadequate, adequate or excessive weight by each characteristic. We examined associations between characteristics of interest and gestational weight gain adequacy using multinomial logistic regression to estimate odds ratios (OR) and 95% confidence intervals (CI). Each characteristic of interest has previously been associated with gestational weight gain adequacy, as described in the Institute of Medicine's conceptual framework; thus, we viewed each association as a separate confirmatory analysis and chose not to adjust analyses for multiple comparisons. Statistical significance was considered $P < 0.05$.

We present crude and adjusted associations between pre-pregnancy BMI category and gestational weight gain adequacy. Because weight gain recommendations are specific to a woman's pre-pregnancy BMI category, we stratified models to examine associations between each characteristic and weight gain adequacy within pre-pregnancy BMI categories. Associations between each characteristic and gestational weight gain adequacy did not meaningfully differ by obesity class (data not shown); therefore, we collapsed obesity into a single group. We included the same exposure variables in each multinomial model (stratified and un-stratified), regardless of statistical significance, to maintain consistency and facilitate interpretation of results. We conducted sensitivity analyses excluding Vermont women to ensure our results were not affected by misclassification of race or ethnicity or pregnancy plurality. We used SAS v9.3 with SAS-callable SUDAAN release 11 for all analyses to account for the complex sample design and weights utilized in the Pregnancy Risk Assessment Monitoring System.

Results

We found no statistically significant differences in gestational weight gain adequacy or pre-pregnancy BMI between included and excluded women; however, excluded women differed in several demographic, behavioral, psychosocial and medical characteristics (Appendix 1, available online at http://links.lww.com/xxx).

In the study population, 32.0% gained weight within guidelines, while 20.9% gained inadequate and 47.2% gained excessive weight (Figure 1). Underweight women had the highest prevalence of inadequate gain (39.3%), while overweight and obese class I women had the highest prevalences of excessive gain (64.1% and 63.5%, respectively). We found

statistically significant bivariate associations between weight gain adequacy and all demographic, behavioral, psychosocial and medical characteristics, except for prepregnancy depression (Appendix 2, available online at http://links.lww.com/xxx).

Associations between pre-pregnancy BMI and gestational weight gain adequacy did not meaningfully differ in crude and adjusted multinomial logistic regression models (crude models not shown). After adjustment, compared with normal weight women, overweight women had decreased odds of inadequate weight gain (OR 0.65, 95% CI 0.57–0.74) while underweight and obese class II and III women had increased odds of inadequate gain ranging from 1.40 (95% CI 1.18–1.67) to 1.86 (95% CI 1.45–2.36) (Table 1). Underweight women were the only group with decreased odds of excessive weight gain (OR 0.50, 95% CI 0.40–0.61); conversely, overweight, and obese class I, II and III women had increased odds of excessive gain ranging from 2.07 (95% CI 1.63–2.62) to 2.99 (95% CI 2.63–3.40).

Statistically significant associations between characteristics of interest and gestational weight gain adequacy varied by pre-pregnancy BMI (Table 2). Notable associations are highlighted here. Among underweight women, demographic characteristics, such as education less than high school, were positively associated with inadequate gain; education less than high school was also positively associated with excessive gain among underweight women. Among normal weight women, demographic and medical characteristics, including non-Hispanic Black, Hispanic and Asian races and diabetic disease, were positively associated with inadequate gain. One behavioral and one medical characteristic – smoking cessation and hypertensive conditions, respectively—were positively associated with excessive gain.

Among overweight women, demographic and medical characteristics, including black and Alaskan Native races and diabetic disease, were positively associated with inadequate gain; demographic characteristics, such as education greater than high school, were also positively associated with excessive gain. Finally, among obese women, one medical characteristic—nausea during pregnancy – was positively associated with inadequate weight gain, while behavioral and medical characteristics including smoking cessation, regular physical activity and hypertensive conditions, were positively associated with excessive gain.

In sensitivity analyses excluding Vermont mothers, we found no meaningful differences in associations between characteristics of interest and gestational weight gain adequacy (data not shown).

Discussion

In this study, 68% of women gained weight outside the 2009 Institute of Medicine recommendations. Consistent with previous research, overweight and obese class I women had the highest prevalences of excessive weight gain and were nearly three times as likely to gain excessively compared with normal weight women (4–6). Excessive gain may be more common among overweight and obese women because recommendations are lower and narrower for these women compared with normal weight women; importantly, overweight

and obese women and their infants achieve healthier outcomes at lower weight gain ranges (1).

Demographic characteristics have previously been identified as risk-factors for inadequate or excessive gestational weight gain (1, 5, 6, 10–12); our finding that some risk-factors vary by pre-pregnancy BMI may further facilitate identifying at-risk women and developing tailored interventions (13). In contrast, behavioral characteristics associated with inadequate or excessive gain may be amenable to intervention; unfortunately, we found few such characteristics. Notably, smoking cessation was associated with excessive gain among some groups of women, which is consistent with previous observations (14). Smoking cessation is encouraged to prevent adverse health outcomes for mothers and infants (15); however, these women may need additional support to achieve adequate weight gain.

Contrary to previous findings (16, 17), frequent pre-pregnancy physical activity was associated with excessive weight gain among obese women. It is possible that women who reduce physical activity during pregnancy gain excessive weight; we were unable to assess change in physical activity as these data were not collected. Obese individuals also may be more likely to over-report physical activity compared with non-obese counterparts, possibly explaining this finding among obese women only (18). Nevertheless, physical activity is recommended for women with uncomplicated pregnancies (19) and has been associated with reduced weight gain (20).

We were unable to examine dietary behaviors during pregnancy, which may be directly associated with gestational weight gain and are more amenable to intervention (21, 22). Indeed, interventions that include dietary goals and regular weight monitoring have had the most success in reducing weight gain (23). The Institute of Medicine has developed tools to promote adequate weight gain, including a pregnancy weight tracker that encourages women to self-monitor and compare weight gain to recommended ranges (24). Frequent provider contact also appears to be a successful intervention strategy for preventing excessive gain (23); this compliments recommendations for clinicians to determine a woman's pre-pregnancy BMI at the initial prenatal visit and counsel on appropriate weight gain, dietary and exercise habits throughout pregnancy (25). More work is needed to develop effective gestational weight gain interventions, albeit interventions may need to be tailored to specific population groups.

To completely capture characteristics associated with gestational weight gain adequacy, we included women with diabetic or hypertensive conditions; as a result, related findings should be interpreted with care. Diabetic disease was associated with inadequate gain, but diabetic women likely receive counseling to control glucose levels which may affect weight gain (26). Hypertensive conditions were associated with excessive weight gain, but hypertensive conditions may cause excessive gain secondary to edema, or excessive gain may cause gestational hypertension (1). Furthermore, the diabetic and hypertensive conditions we examined consist of heterogeneous subtypes. Future studies should examine both the onset of hypertensive and diabetic conditions in relation to the timing of weight gain and specific subtypes of these conditions.

Our study was strengthened by the use of a large dataset representative of 28 states. The Pregnancy Risk Assessment Monitoring System combines self-reported questionnaire with birth certificate data, the latter consisting of self-reported and medical record data; thus, we are limited by misclassification resulting from these sources. Specifically, pre-pregnancy weight may be underreported and pre-pregnancy height may be slightly over-reported, but pre-pregnancy BMI category has been found to have acceptable validity (27, 28). Conversely, gestational weight gain categories derived from the birth certificate may have as little as 50% agreement with medical record data among term births (29), and accuracy may be lower among normal weight, overweight and obese women with excessive gain compared with normal weight women with adequate gain (30). Finally, our study population may have limited generalizability because we restricted to full-term deliveries and women excluded differed from those included in the analysis.

In summary, most women gained weight outside the 2009 Institute of Medicine recommendations. Clinicians can use pre-pregnancy BMI, demographic characteristics and smoking behaviors to identify potentially at-risk women, but future work is needed to identify and evaluate other behavioral characteristics, including diet and physical activity, which may be amenable to intervention.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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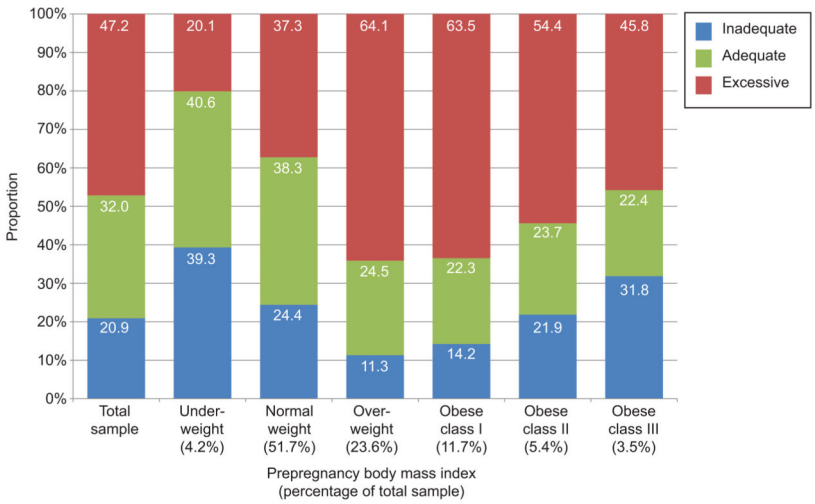

Figure 1.
Prevalence of gestational weight gain adequacy by prepregnancy body mass index.

Table 1

Adjusted[a] Odds Ratios (OR) and 95% Confidence Interval (CI) for the Association Between Pre-Pregnancy Body Mass Index (BMI) and Gestational Weight Gain

	Total (n[b], % [c])	Inadequate Gain (n=9,858[b], 20.9%[c]) OR (95%CI)	Excessive Gain (n=20,046[b], 47.2%[c]) OR (95%CI)
Pre-Pregnancy BMI			
Underweight	(2,047, 4.2)	**1.40 (1.18, 1.67)**	**0.50 (0.40, 0.61)**
Normal Weight	(22,595, 51.7)	*Referent*	*Referent*
Overweight	(10,640, 23.6)	**0.65 (0.57, 0.74)**	**2.77 (2.53, 3.03)**
Obese	(9,139, 20.6)	1.13 (0.99, 1.28)	**2.66 (2.39, 2.95)**
Obese Class I	(5,046, 11.7)	0.86 (0.72, 1.02)	**2.99 (2.63, 3.40)**
Obese Class II	(2,411, 5.4)	**1.25 (1.01, 1.55)**	**2.31 (1.94, 2.75)**
Obese Class III	(1,682, 3.5)	**1.86 (1.45, 2.36)**	**2.07 (1.63, 2.62)**

Bolded values represent statistically significant associations.

[a] Adjusted for age, race or ethnicity, education, parity, marital status, Special Supplemental Nutrition Program for Women, Infants, and Children enrollment, Medicaid enrollment, first trimester prenatal care, pre-pregnancy physical activity, alcohol consumption, smoking status during pregnancy, pre-pregnancy depression, partner abuse before or during pregnancy, number of stressful events, severe nausea during pregnancy, diabetic disease and hypertensive conditions.

[b] Based on non-weighted data.

[c] Based on weighted data

Table 2

Adjusted[a] Odds Ratios (OR) and 95% Confidence Intervals (95% CI) for the Association between Demographic, Behavioral, Psychosocial and Medical Characteristics and Inadequate or Excessive Gestational Weight Gain

	Underweight (n=2,047[c], 4.2%[d])		Normal Weight (n= 22,595 [c], 51.7%[d])		Overweight (n=10,640[c], 23.6%[d])		Obese (n=9,139[c], 20.56%[d])	
	Inadequate OR (95% CI)	**Excessive OR (95% CI)**	**Inadequate OR (95% CI)**	**Excessive OR (95% CI)**	**Inadequate OR (95% CI)**	**Excessive OR (95% CI)**	**Inadequate OR (95% CI)**	**Excessive OR (95% CI)**
Age (years)								
≤ 19	0.96 (0.46, 1.99)	0.86 (0.39, 1.87)	1.02 (0.78, 1.33)	0.93 (0.73, 1.19)	1.48 (0.83, 2.63)	**1.62 (1.10, 2.37)**	0.96 (0.51, 1.82)	0.90 (0.53, 1.54)
20–24	0.94 (0.59, 1.50)	0.99 (0.57, 1.72)	0.95 (0.79, 1.14)	0.91 (0.78, 1.06)	1.39 (0.99, 1.95)	**1.29 (1.02, 1.64)**	1.13 (0.82, 1.57)	1.14 (0.88, 1.47)
25–29	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*
30–34	0.99 (0.60, 1.62)	1.03 (0.53, 2.01)	1.01 (0.87, 1.18)	**0.86 (0.75, 0.98)**	1.01 (0.75, 1.37)	0.94 (0.77, 1.14)	1.06 (0.79, 1.43)	0.95 (0.76, 1.20)
≥ 35	1.04 (0.60, 1.83)	0.52 (0.22, 1.25)	**1.23 (1.03, 1.47)**	0.87 (0.74, 1.02)	1.12 (0.79, 1.59)	0.88 (0.70, 1.10)	0.97 (0.70, 1.36)	0.88 (0.67, 1.16)
Race or Ethnicity								
White	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*
Black	0.99 (0.54, 1.83)	0.76 (0.35, 1.63)	**1.45 (1.19, 1.77)**	0.93 (0.77, 1.12)	**1.49 (1.06, 2.09)**	1.17 (0.91, 1.50)	0.99 (0.72, 1.34)	0.84 (0.65, 1.08)
Hispanic	1.38 (0.80, 2.40)	0.71 (0.29, 1.75)	**1.29 (1.07, 1.56)**	0.84 (0.69, 1.01)	0.91 (0.64, 1.28)	0.85 (0.67, 1.08)	0.79 (0.55, 1.13)	1.02 (0.77, 1.36)
Asian	1.01 (0.62, 1.65)	0.58 (0.30, 1.10)	**1.31 (1.08, 1.58)**	**0.66 (0.54, 0.80)**	0.96 (0.62, 1.49)	0.77 (0.57, 1.04)	**0.45 (0.22, 0.90)**	0.86 (0.51, 1.48)
American Indian	--[b]	--[b]	1.42 (0.90, 2.25)	1.02 (0.67, 1.55)	0.87 (0.45, 1.69)	0.99 (0.60, 1.63)	0.69 (0.35, 1.36)	0.72 (0.37, 1.41)
Alaskan Native	--[b]	--[b]	1.46 (0.90, 2.35)	0.85 (0.54, 1.35)	**2.26 (1.08, 4.73)**	0.86 (0.45, 1.63)	**0.46 (0.22, 0.98)**	**0.57 (0.33, 0.99)**
Hawaiian	--[b]	--[b]	1.29 (0.85, 1.96)	0.96 (0.67, 1.39)	0.88 (0.37, 2.08)	0.75 (0.44, 1.30)	0.46 (0.20, 1.09)	0.78 (0.44, 1.38)
Other	0.63 (0.21, 1.95)	2.00 (0.72, 5.51)	1.35 (0.95, 1.91)	1.02 (0.75, 1.38)	1.15 (0.61, 2.17)	1.00 (0.64, 1.56)	1.00 (0.54, 1.87)	1.23 (0.76, 2.01)
Education								
< 12 years	**2.25 (1.34, 3.78)**	**2.99 (1.60, 5.60)**	**1.42 (1.14, 1.75)**	1.10 (0.89, 1.36)	1.00 (0.70, 1.43)	0.77 (0.59, 1.00)	0.95 (0.66, 1.37)	0.87 (0.64, 1.17)
12 years	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*
> 12 years	1.31 (0.83, 2.06)	1.40 (0.82, 2.40)	0.90 (0.76, 1.05)	0.96 (0.83, 1.10)	1.00 (0.74, 1.36)	**1.36 (1.11, 1.66)**	1.04 (0.80, 1.36)	1.06 (0.85, 1.32)
Parity								
0	**0.53 (0.37, 0.76)**	1.61 (1.00, 2.59)	**0.88 (0.78, 0.99)**	**1.31 (1.18, 1.46)**	0.84 (0.63, 1.10)	**1.24 (1.04, 1.48)**	**0.75 (0.58, 0.98)**	**1.26 (1.03, 1.54)**
≥ 1	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*
Marital Status								
Married	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*
Non-married	**1.67 (1.05, 2.64)**	1.34 (0.81, 2.20)	1.17 (0.99, 1.38)	1.09 (0.94, 1.27)	0.94 (0.70, 1.28)	1.00 (0.82, 1.23)	1.17 (0.90, 1.53)	**1.25 (1.01, 1.54)**

	Underweight (n=2,047[c], 4.2%[d])		Normal Weight (n= 22,595 [c], 51.7%[d])		Overweight (n=10,640[c], 23.6%[d])		Obese (n=9,139[c], 20.56%[d])	
	Inadequate OR (95% CI)	**Excessive OR (95% CI)**	**Inadequate OR (95% CI)**	**Excessive OR (95% CI)**	**Inadequate OR (95% CI)**	**Excessive OR (95% CI)**	**Inadequate OR (95% CI)**	**Excessive OR (95% CI)**
WIC Enrollment								
Yes	1.22 (0.79, 1.90)	1.55 (0.93, 2.59)	1.10 (0.93, 1.31)	0.93 (0.80, 1.09)	1.01 (0.72, 1.41)	0.98 (0.78, 1.24)	1.02 (0.75, 1.38)	0.91 (0.71, 1.16)
No	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*
Medicaid Enrollment								
Yes	1.02 (0.64, 1.62)	0.79 (0.45, 1.41)	1.02 (0.85, 1.21)	1.08 (0.92, 1.27)	**1.53 (1.09, 2.13)**	1.05 (0.84, 1.33)	0.97 (0.70, 1.34)	0.98 (0.76, 1.26)
No	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*
First Trimester Prenatal Care								
Yes	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*
No	1.50 (1.00, 2.26)	1.11 (0.67, 1.85)	**1.32 (1.12, 1.55)**	1.12 (0.96, 1.31)	1.28 (0.94, 1.74)	0.96 (0.77, 1.19)	1.20 (0.88, 1.63)	1.15 (0.90, 1.48)
Regular Pre-Pregnancy Physical Activity								
Yes	0.91 (0.64, 1.30)	0.95 (0.61, 1.47)	**0.82 (0.73, 0.92)**	1.00 (0.91, 1.11)	0.78 (0.62, 1.00)	1.14 (0.97, 1.33)	1.05 (0.83, 1.32)	**1.57 (1.31, 1.89)**
No	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*
Alcohol Consumption During Pregnancy								
Yes	**0.44 (0.23, 0.83)**	0.71 (0.33, 1.51)	0.84 (0.68, 1.03)	0.86 (0.73, 1.02)	0.82 (0.51, 1.32)	0.80 (0.60, 1.07)	0.76 (0.48, 1.21)	1.32 (0.92, 1.90)
No	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*
Smoking Status During Pregnancy								
Non-Smoker	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*
Quitter	**0.44 (0.24, 0.83)**	1.26 (0.68, 2.34)	0.93 (0.76, 1.14)	**1.41 (1.21, 1.66)**	0.95 (0.65, 1.38)	1.24 (0.96, 1.60)	1.13 (0.82, 1.57)	**1.36 (1.05, 1.77)**
Smoker	0.77 (0.43, 1.35)	1.46 (0.77, 2.78)	1.14 (0.92, 1.41)	1.14 (0.94, 1.39)	0.98 (0.67, 1.45)	1.00 (0.76, 1.31)	1.10 (0.80, 1.51)	0.89 (0.68, 1.17)
Pre-Pregnancy Depression								
Yes	0.83 (0.47, 1.46)	1.62 (0.89, 2.96)	1.05 (0.87, 1.27)	1.01 (0.86, 1.19)	0.87 (0.62, 1.22)	0.91 (0.71, 1.16)	1.14 (0.86, 1.53)	0.94 (0.73, 1.20)
No	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*
Partner Abuse Before or During Pregnancy								
Yes	0.77 (0.38, 1.56)	1.43 (0.59, 3.46)	1.00 (0.74, 1.35)	0.99 (0.74, 1.31)	0.92 (0.53, 1.58)	1.20 (0.82, 1.76)	1.04 (0.65, 1.68)	0.98 (0.65, 1.50)
No	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*
Number of Stressful Life Events								
0	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*
1	0.90 (0.57, 1.41)	1.06 (0.60, 1.88)	1.07 (0.93, 1.24)	1.10 (0.97, 1.25)	0.99 (0.72, 1.37)	1.11 (0.91, 1.36)	0.92 (0.66, 1.28)	0.98 (0.76, 1.27)
2 or 3	0.82 (0.52, 1.28)	1.19 (0.66, 2.13)	1.00 (0.86, 1.17)	**1.15 (1.01, 1.32)**	1.02 (0.76, 1.37)	1.02 (0.84, 1.24)	0.99 (0.73, 1.34)	0.96 (0.75, 1.22)
≥ 4	1.23 (0.67, 2.23)	1.01 (0.51, 2.03)	1.06 (0.85, 1.31)	1.15 (0.95, 1.38)	0.80 (0.54, 1.18)	0.92 (0.71, 1.20)	1.09 (0.77, 1.55)	1.02 (0.76, 1.36)

	Underweight (n=2,047[c], 4.2%[d])		Normal Weight (n= 22,595 [c], 51.7%[d])		Overweight (n=10,640[c], 23.6%[d])		Obese (n=9,139[c], 20.56%[d])	
	Inadequate OR (95% CI)	**Excessive OR (95% CI)**	**Inadequate OR (95% CI)**	**Excessive OR (95% CI)**	**Inadequate OR (95% CI)**	**Excessive OR (95% CI)**	**Inadequate OR (95% CI)**	**Excessive OR (95% CI)**
Severe Nausea During Pregnancy								
Yes	0.99 (0.68, 1.43)	0.91 (0.57, 1.46)	**1.15 (1.01, 1.32)**	1.01 (0.89, 1.14)	1.05 (0.81, 1.35)	**0.77 (0.65, 0.92)**	**1.38 (1.10, 1.74)**	1.03 (0.84, 1.25)
No	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*
Diabetic Disease								
Yes	0.79 (0.44, 1.41)	0.87 (0.41, 1.85)	**1.60 (1.31, 1.96)**	0.98 (0.79, 1.20)	**1.43 (1.04, 1.96)**	**0.72 (0.58, 0.90)**	1.24 (0.96, 1.61)	**0.73 (0.58, 0.91)**
No	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*
Hypertensive Conditions								
Yes	0.64 (0.31, 1.30)	0.78 (0.37, 1.65)	0.90 (0.72, 1.13)	**1.66 (1.38, 1.99)**	0.97 (0.65, 1.46)	1.26 (1.00, 1.59)	0.98 (0.74, 1.29)	**1.36 (1.09, 1.71)**
No	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*	*Referent*

Bolded values represent statistically significant associations.

[a] Adjusted for all characteristics listed.

[b] Unable to estimate association due to insufficient sample sizes.

[c] Based on non-weighted data.

[d] Based on weighted data.