

# Excessive Weight Gain among Obese Women and Pregnancy Outcomes

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## ABSTRACT

We evaluated pregnancy outcomes in obese women with excessive weight gain during pregnancy. A retrospective study was performed on all obese women. Outcomes included rates of preeclampsia (PEC), gestational diabetes, cesarean delivery (CD), preterm delivery, low birth weight, very low birth weight, macrosomia, 5-minute Apgar score of <7, and neonatal intensive care unit (NICU) admission and were stratified by body mass index (BMI) groups class I (BMI 30 to 35.9 kg/m<sup>2</sup>), class II (36 to 39.9 kg/m<sup>2</sup>), and class III ( $\geq$ 40 kg/m<sup>2</sup>). Gestational weight change was abstracted from the mother's medical chart and was divided into four categories: weight loss, weight gain of up to 14.9 pounds, weight gain of 15 to 24.9 pounds, and weight gain of more than 25 pounds. A total 20,823 obese women were eligible for the study. Univariate analysis revealed higher rates of preeclampsia, gestational diabetes, Cesarean deliveries, preterm deliveries, low birth weight, macrosomia, and NICU admission in class II and class III obese women when compared with class I women. When different patterns of weight gain were used as in the logistic regression model, rates of PEC and CD were increased. Excessive weight gain among obese women is associated with adverse outcomes with a higher risk as BMI increases.

**KEYWORDS:** Obesity, pregnancy outcomes, weight gain during pregnancy

Obesity has become an epidemic in the United States,<sup>1</sup> and its negative impact on maternal and neonatal health is well known. Over the past 15 years, the prevalence of obesity in women of reproductive age has been increasing, ranging between 19 and 38%.<sup>2</sup> Obese women have an increased risk of complications during pregnancy, which include hypertension (CHTN), preeclampsia (PEC), gestational diabetes (GDM), stillbirth, abnormal labor and cesarean delivery (CD), and postpartum infection.<sup>3-6</sup> Neonatal complications include congenital malformations, macrosomia, late fetal death,

and early neonatal death.<sup>3-5,7</sup> Despite knowing the potential impact of carrying excessive weight during pregnancy, many obstetricians continue to disseminate advice on weight changes during pregnancy based on the guidelines set forth by the Institute of Medicine (IOM) in the 1990s.<sup>8</sup> Although the IOM guidelines advise that obese women should gain at least 15 pounds, they do not account for differing levels of obesity.

There is a growing body of evidence demonstrating that not all obese pregnant women with a body mass index (BMI) of greater than 29 have the same weight

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gain requirements or pregnancy outcomes. In a large Swedish population cohort study, Cedergren<sup>9</sup> found the optimal gestational weight gain in women with a prepregnancy BMI  $\geq 30$  kg/m<sup>2</sup> was less than 13 pounds. Helms et al<sup>10</sup> found a decreased risk of pregnancy complications when class I obese women gained 10 to 25 pounds, class II obese women gained 0 to 9 pounds, and class III obese women lost 0 to 9 pounds during pregnancy.

As no consensus has been reached on what the optimal weight change in pregnancy should be for patients with a prepregnancy BMI  $\geq 30$ , we conducted a retrospective cohort study to examine how different intrapartum weight changes among women with different classes of obesity influenced maternal and neonatal morbidity. We hypothesize that excessive weight gain may be associated with adverse obstetric outcomes, particularly in women in the severe obesity group. The objective of this study was to evaluate maternal and neonatal outcomes in obese women stratified into four categories of intrapartum weight changes: those who lost weight during pregnancy, those who gained up to 14.9 pounds, those who gained between 15 and 24.9 pounds, and those who gained 25 or more pounds over the course of pregnancy.

## MATERIALS AND METHODS

We reviewed prenatal and delivery records at Jackson Memorial Hospital/University of Miami from January 2000 to December 2005 and identified 21,823 singleton pregnancies in obese women. Maternal obesity was stratified into three different classes based on BMI at delivery as follows: class I (BMI 30 to 35.9 kg/m<sup>2</sup>), class II (BMI 36 to 39.9 kg/m<sup>2</sup>), and class III (BMI  $\geq 40$  kg/m<sup>2</sup>). Women with multiple gestations, missing data on weight gain, and pregnancies complicated by fetal lethal anomalies were excluded.

Gestational weight change was abstracted from the mother's medical chart and was divided into four categories as follows: weight loss, weight gain of up to 14.9 pounds, weight gain of 15 to 24.9 pounds, and weight gain of 25 or more pounds. We chose these weight categories based on the IOM guidelines for pregnant women to gain at least 15 pounds and the lesser categories based on what cutoffs might be clinically relevant. Maternal BMI at delivery was calculated as reported weight in kilograms divided by height in meters squared.

Outcome variables included PEC, GDM, CD, PTD (<37 weeks, <32 weeks, and <28 weeks), low birth weight (LBW), very low birth weight (VLBW), macrosomia ( $\geq 4500$  g), 5-minute Apgar score of <7, and neonatal intensive care unit (NICU) admissions. Potential confounders for this analysis included maternal age, race/ethnicity, trimester at first prenatal visit, pre-

vious CD, previous preterm delivery, chronic hypertension, and preeclampsia.

The three classes of obese women were assessed for homogeneity with respect to demographic and medical characteristics using the chi-square test for categorical variables and analysis of variance test for continuous variables. Univariate analysis assessing the association between obesity class and pregnancy outcome was conducted with a chi-square or Fisher exact test, where appropriate. Within each obesity class, the absolute risk for each pregnancy outcome was calculated and stratified by gestational weight gain category to assess the effect of gestational weight gain for each pregnancy outcome. The following weight patterns during pregnancy were used in the analysis: weight loss, weight gain of  $\leq 14.9$  pounds, and excessive weight gain as defined as  $\geq 15$  pounds. Logistic regression, controlling for potential confounders, was used to examine how weight change during pregnancy impacted pregnancy outcomes on each obesity class. All analyses were performed with SPSS 15 (SPSS Inc., Chicago, IL) software. This research was approved by the University of Miami/Jackson Memorial Hospital institutional review board.

## RESULTS

Of the total 20,823 obese women eligible for the study, 71.2% ( $n = 14,827$ ) were class I obese, 15.5% ( $n = 3246$ ) were class II obese, and 13.3% were class III obese ( $n = 2750$ ). Overall, the maternal characteristics were similar with respect to age, gestational age at delivery, gravidity, and trimester at first prenatal visit (Table 1). As seen in the general population, the prevalence of obesity was found to be higher among minorities. Those in class II and class III had higher rates of previous cesarean deliveries, PTD, CHTN, and preeclampsia. A majority of our study population began prenatal care in the first trimester.

Univariate analysis (Table 2) demonstrated the frequency of PEC was significantly higher in the class II and class III obese women compared with class I obese women (6.3% versus 8.9% versus 4.8%;  $p < 0.001$ ). Class II and class III obese women had significantly higher frequencies of GDM (7.7% versus 10.4% versus 4.9%;  $p < 0.001$ ) and CD (51.7% versus 62.2% versus 41.4%;  $p < 0.001$ ) compared with class I obese women. Approximately 15% of class III obese women delivered preterm infants compared with 14.5% of class II and 12.5% of class I obese women ( $p < 0.01$ ). Class III obese women also delivered a significantly higher frequency of macrosomic infants (5.4% versus 3.2% versus 1.9%;  $p < 0.001$ ) and infants admitted to the NICU (21.3% versus 19.2% versus 17.1%;  $p < 0.01$ ) than class II or class I obese women. The frequency distribution of obese women delivering infants with LBW and VLBW was also

**Table 1 Demographic and Medical Characteristics of Obese Women**

Characteristics	Obese Class I (BMI 30–35.9), n = 14,827	Obese Class II (BMI 36–39.9), n = 3246	Obese Class III (BMI ≥ 40), n = 2750
Age (y)	28.0 ± 6.6	28.3 ± 6.6	28.0 ± 6.5
GA at delivery (wk)	38.1 ± 3	38.0 ± 3.7	37.7 ± 3.9 <sup>†</sup>
Gravidity	2.8 ± 1.9	3.02 ± 2.0*	3.1 ± 2.2 <sup>†</sup>
Race/ethnicity			
Non-Hispanic White	3.9	4.4*	4.0 <sup>†</sup>
Hispanic	17.3	26.6*	39.0 <sup>†</sup>
African-American	57.5	48.9	37.7 <sup>†</sup>
Others	21.3	20.1	23.3 <sup>†</sup>
Initiation of care			
1st trimester	73.7	73.0	73.8
2nd trimester	19.9	20.0	19.3
3rd trimester	4.7	4.1	4.5
None	1.7	2.0	2.4
Previous cesarean	17.4	21.4*	28.0 <sup>†</sup>
Previous preterm	10.4	13.1*	14.8 <sup>†</sup>
CHTN	6.7	12.1*	19.5 <sup>†</sup>
Pregestational DM	1.5	2.6*	5.4 <sup>†</sup>

\* $p < 0.01$  denotes statistical significance with respect to class I and class II obese women.

<sup>†</sup> $p < 0.001$  denotes statistical significance with respect to class I and class III obese women.

Age and GA at delivery are presented as mean ± SD and the remaining variables as percentages. BMI, body mass index; CHTN, hypertension; DM, diabetes mellitus; GA, gestational age.

higher in class II and class III women. Five-minute Apgar score <7 was not significantly different among different classes of obesity. Table 3 describes pregnancy outcomes by weight gain patterns among obese women.

After univariate analysis, a logistic regression model was created adjusting for the following comorbidities: CHTN, pregestational diabetes mellitus, previous CD, and previous PTD. Using as reference the group with weight gain of 15 to 24.9 pounds, it was found that when weight gain and even weight loss were placed into the model, the risk for PEC was significantly elevated in the class I obese women who gained 25 or more pounds, and CD was significantly increased in all classes in the same weight gain category. The rates of

LBW and VLBW were not significantly increased (Table 4).

## DISCUSSION

Our study revealed that obese women have increased risk of adverse obstetric outcomes, particularly if weight gain is excessive. Target weight gain during pregnancy remains a controversial issue. Cogswell et al<sup>11</sup> found that 27% of women reported they did not receive medical advice about pregnancy weight gain and another 22% had been advised to gain more than recommended according to the IOM guidelines. Another study among pregnant women in North Carolina found the propor-

**Table 2 Association between Obesity Class and Pregnancy Outcome**

Characteristics (%)	Obese Class I (BMI 30–35.9), n = 14,827	Obese Class II (BMI 36–39.9), n = 3246	Obese Class III (BMI ≥ 40), n = 2750	p Value*
Preeclampsia	4.8	6.3	8.9	<0.001
Gestational diabetes	4.9	7.7	10.4	<0.001
Cesarean delivery	41.4	51.7	62.2	<0.001
Preterm delivery	12.5	14.5	14.8	<0.01
Low birth weight	12.5	13.8	14.1	0.01
Very low birth weight	4.3	5.7	6.3	<0.001
Macrosomia	1.9	3.2	5.4	<0.001
5-minute Apgar <7	4.1	4.6	5.2	0.090
NICU admission	17.1	19.2	21.3	<0.01

\*p value calculated using Fisher exact test or chi-square test, where appropriate.

BMI, body mass index; NICU, neonatal intensive care unit.

**Table 3 Pregnancy Outcomes by Weight Loss, Weight Gain 0–14 Pounds, and Weight Gain ≥15 Pounds among Class I, II, and III Obese Women**

Variables	Class I (BMI 30–35.9), n = 14,827	Class II (BMI 36–39.9), n = 3246	Class III (BMI ≥ 40), n = 2750	
Preeclampsia	5.2	6.8	8.3	
	4.3	5.6*	7.5†	
	4.8	6.3*	8.9†	
Gestational diabetes	4.8	6.3	4.7†	
	8.4	11.5	12.4†	
	4.9	7.1	10.3†	
Premature rupture of membranes	3.4	4.0	3.9	
	5.5	3.8	6.2	
	1.6	2.2	2.0	
Chorioamnionitis	2.7	1.7	4.4	
	2.3	1.7	1.9	
	2.8	2.9	2.6	
Cesarean delivery	34.4	43.2	51.9†	
	36.1	43.8	53.4†	
	40.5	50.8	61.4†	
Preterm delivery (wk)				
	<37	25.5	26.9	25.6†
		28.6	24.3	31.9†
<37	13.9	15.8*	16†	
	25.5	26.9	25.6†	
	28.6	24.3	31.9†	
<32	13.9	15.8*	16†	
	12.9	12.9	10.3	
	16.0	11.8	18.4	
<28	3.3	4.2*	4.6†	
	10.0	7.0	10.3	
	11.7	10.1	18.4	
Low birth weight	1.6	2.2*	4.6†	
	22.5	21.5	21.5	
	25.5	21.4	27.2	
Very low birth weight	10.8	12.6	11.5	
	12.6	11.0	10.3	
	14.8	12.5	17.3	
5-minute Apgar <7	2.9	4.6	4.3	
	11.3	11.0	7.9	
	12.1	12.5	13.1	
NICU admission	3.0	4.6*	3.8†	
	25.2	25.2	29.9	
	22.9	22.9	26.8	
Fetal death	17.6	20.4	21.6†	
	3.6	4.4	2.3	
	3.1	2.4	2.1	
	1.0	0.7*	1.0†	

\*p < 0.01 denotes statistical significance with respect to class I and class II obese women.

†p < 0.01 denotes statistical significance with respect to class I and class III obese women.

These outcomes are presented as percentages for each weight category (weight loss, weight gain 0–14 pounds, and weight gain ≥15 pounds). BMI, body mass index; NICU, neonatal intensive care unit.

tion of pregnant women gaining excessive weight increased from 15.5% in 1988 to 19.5% in 2003.<sup>10</sup> Overweight and obesity are themselves factors associated with excessive weight gain during pregnancy,<sup>8,12</sup> and even

adolescents often gain more weight than is recommended by the IOM guidelines.<sup>5</sup> In light of existing imprecise medical advice on the topic and the rising prevalence of obesity in the U.S. population, studies

**Table 4 Adjusted Odd Ratios and 95% Confidence Intervals for Selected Outcome Variables by Weight Changes for Each Obesity Class\***

Variables	Class I	Class II	Class III
Preeclampsia			
Weight loss	1.35 (0.92–2.04)	1.12 (0.54–2.29)	1.16 (0.61–2.20)
Weight gain 0–14 pounds	1.05 (0.73–1.51)	0.90 (0.47–1.72)	0.99 (0.56–1.76)
Weight gain ≥25 pounds	1.41 (1.15–1.81)	1.15 (0.76–1.75)	1.33 (0.87–2.02)
Cesarean delivery			
Weight loss	1.02 (0.08–1.26)	0.78 (0.50–1.23)	0.87 (0.58–1.31)
Weight gain 0–14 pounds	0.97 (0.81–1.16)	1.06 (0.74–1.51)	0.99 (0.70–1.41)
Weight gain ≥25 pounds	1.46 (1.31–1.63)	1.54 (1.33–1.94)	1.58 (1.21–2.05)
Low birth weight			
Weight loss	1.05 (0.73–1.52)	0.84 (0.36–1.93)	1.32 (0.61–2.8)
Weight gain 0–14 pounds	1.23 (0.91–1.67)	1.16 (0.57–2.34)	1.43 (0.65–2.75)
Weight gain ≥25 pounds	0.78 (0.64–0.95)	0.92 (0.57–1.46)	0.92 (0.53–1.60)
Very low birth weight			
Weight loss	1.25 (0.63–2.45)	1.06 (0.26–4.28)	1.09 (0.25–4.64)
Weight gain 0–14 pounds	1.11 (0.63–1.91)	0.81 (0.19–3.43)	1.20 (0.37–3.86)
Weight gain ≥25 pounds	0.67 (0.44–1.02)	0.85 (0.33–2.20)	0.79 (0.29–2.12)

\*Women with weight gain between 15 and 24.9 pounds were used as reference in the logistic regression analyses.

concerning pregnancy weight gain recommendations in obese women are timely and informative.

The results of this study are consistent with others found in the literature demonstrating more severe classes of obesity portend worse pregnancy outcomes.<sup>1,3,6,13–15</sup> We found adverse maternal and fetal outcomes are more pronounced in class III obese women compared with class I obese or class II obese women.

Even studies of women with normal pregnancy BMI indicate that women who gain weight beyond the recommended IOM guidelines have an increased risk for PEC, failed induction, CD, and large-for-gestational-age (LGA) infants.<sup>16</sup> Bianco et al<sup>13</sup> found that morbidly obese women were more likely to experience pregnancy complications compared with nonobese women; however, the frequency of these complications was not affected by gestational weight gain. On the contrary, we found a dose-response relationship between gestational weight gain and PEC, GDM, CD, and LGA infants. The Bianco study had small numbers of obese women enrolled relative to our study and likely lacked the power necessary to reach statistical significance.

Obesity prevention among obstetrician-gynecologists should be addressed prepregnancy to maximize maternal and neonatal health outcomes,<sup>4</sup> as initial studies examining weight gain restriction for obese pregnant women suggest mere weight control does not affect delivery or neonatal outcome.<sup>17</sup> Claesson et al<sup>17</sup> only sought to control weight gain; however, they did not examine women who lost weight. Our results suggest there may be an added health benefit for class III obese women who lose weight during pregnancy. New weight

gain guidelines have been recently published, and future prospective studies validating them are needed.

#### NOTES

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