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Maternal Super-obesity and Perinatal Outcomes

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Abstract

OBJECTIVE—To determine the effect of maternal super-obesity (BMI ≥50 kg/m^2) compared to morbid obesity (BMI 40–49.9 kg/m^2) or obesity (BMI 30–39.9 kg/m^2) on perinatal outcomes.

STUDY DESIGN—Retrospective cohort study of birth records linked to hospital discharge data for all live born singleton term infants born to obese Missouri residents from 2000–2006. We excluded major congenital anomalies and women with diabetes or chronic hypertension.

RESULTS—There were 64,272 births meeting study criteria, including 1,185 (1.8%) super-obese mothers. Super-obese women were significantly more likely than obese women to have preeclampsia (aRR 1.7, 95% CI 1.4, 2.1), macrosomia (aRR 1.8, 95% CI 1.3, 2.5), and cesarean delivery (aRR 1.8, 95% CI 1.5, 2.1). Almost half (49.1%) of all super-obese women delivered via cesarean, and 33.8% of super-obese nulliparous women underwent scheduled primary cesarean.

CONCLUSION—Women with a BMI ≥50 kg/m^2 are at significantly increased risk for perinatal complications compared to obese women of lower BMI.

Keywords

pregnancy outcomes; super-obesity

Introduction

The obesity epidemic remains unabated in the United States. In 2007–2008, 34% of American women ages 20–39 years met obesity criteria (body mass index (BMI) ≥30 kg/m^2), [1] and obesity is now an increasingly common and harmful pregnancy complication. Super-obesity, as coined in the gastric bypass literature to describe patients weighing

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≥225% of ideal body weight, [2] represents individuals with a BMI ≥50 kg/m^2. The number of super obese individuals is growing 5 times faster than other obesity categories,[3] meaning that healthcare providers will be increasingly challenged to accommodate their health care needs.

Obese women are more likely than normal weight women to suffer preeclampsia, diabetes, cesarean, fetal growth abnormalities, and stillbirth.[4] Although several studies compare obese women to normal weight women, to date, there have been limited studies on super-obesity in pregnancy.[5–7] As the number of super-obese pregnant women continues to rise, it is important to determine whether there is a "dose-response" relationship between the severity of maternal obesity and perinatal complications.

The objective of this study was to determine the effect of maternal super-obesity on perinatal outcomes compared to maternal obesity (BMI 30–39.9 kg/m^2) and morbid obesity (BMI 40–49.9 kg/m^2). We hypothesized that pregnancy in super-obese women, compared to obese and morbidly-obese women, is associated with 1) increased risk of maternal complications of pregnancy, 2) greater risk of fetal growth abnormalities, and 3) greater risk of infant complications.

Materials and Methods

This is a population-based retrospective cohort study of all live born singleton, full-term infants born to Missouri residents between January 1, 2000 and December 31, 2006 (N=502,452). Data was obtained from Missouri vital records, which includes birth certificate records linked to hospital discharge information, for the available period of 2000–2006. Women with pre-pregnancy BMI ≥30 kg/m^2 were included. Exclusion criteria were: 1) fetuses with major congenital anomalies (n= 872, 1.3%), and 2) women with diabetes (n= 5,830, 8.3%) or chronic hypertension (n = 1,773, 2.7%) as documented in the birth certificate or hospital discharge data. Women with either pregestational or gestational diabetes were excluded due to the inability to reliably classify the type of diabetes based on the birth certificate or ICD-9 coding. Inclusion was limited to term infants to avoid confounding of neonatal outcomes due to complications associated with prematurity.

The primary predictor of interest was maternal BMI. BMI was calculated by self-reported pre-pregnancy weight in kilograms divided by height in meters squared. The World Health Organization (WHO) separates obesity (BMI ≥ 30 kg/m^2) into three classes – class I (30–34.9 kg/m^2), class II (35.0–39.9 kg/m^2) and class III (≥ 40 kg/m^2).[8] As the objective of this study was to determine the impact of super obesity on perinatal outcomes and whether there was a dose-response to increasing obesity, we combined class I and II as obese (30–39.9 kg/m^2), and separated class III into morbid obesity (40–49.9 kg/m^2) and super-obesity, defined as BMI ≥ 50 kg/m^2.[2]

The primary outcomes of interest were preeclampsia, method of delivery, macrosomia (birth weight >4500 grams), and composite neonatal morbidity, which included low Apgar score (<7 at 5 minutes), birth trauma, neonatal infection, neonatal hypoglycemia, respiratory distress syndrome, neonatal seizures, neonatal length of stay > 5 days, and/or meconium aspiration syndrome. Low birth weight was defined as <2500 grams. If a diagnosis such as preeclampsia, birth trauma, or respiratory distress syndrome was documented in either the birth certificate or the hospital discharge data, then the condition was considered present. Use of the combined birth certificate and hospital discharge data has been found to be more accurate for perinatal outcomes compared to birth certificate data alone.[9, 10]

Various maternal socio-demographic characteristics have been shown to be associated with maternal obesity and were evaluated as potential confounders in this study. Maternal education was categorized as high, average, or low based on age and years of education.[11] Corrected for maternal age, average education included women within 2 grades of their expected level, and low education was 2 or more grades below expected grade. Greater than 12 years of education was considered high, regardless of maternal age. The R-GINDEX was used to categorize prenatal care as no care, inadequate, adequate, intermediate, intensive, or missing based on initiation of prenatal care, total number of visits, and gestational age at delivery.[12,13] Smoking status was determined by maternal self report on birth certificate records.

Bivariate analyses were completed using the chi-square (χ^2) , Fisher exact test, and t-test, as appropriate. Outcomes were assessed using Cochrane-Armitage test for linear trend and multivariable regression for adjusted risk. Multivariable logistic regression models were used to evaluate outcomes, controlling for maternal age, race, parity, smoking status, marital status, Medicaid use, prenatal care, level of education, primary scheduled cesarean and repeat cesarean. Mode of delivery was categorized by birth certificate designation as vaginal, operative vaginal, vaginal birth after cesarean (VBAC), primary emergent cesarean, primary elective cesarean, and repeat cesarean. For clarity, primary elective cesarean is referred to as primary scheduled cesarean. Comparisons were made among BMI groups (obese, morbidly-obese, and super-obese). Adjusted relative risk (aRR) and 95% confidence interval (CI) were calculated. A value of $P<0.05$ on two-tailed tests was considered significant.

All analyses were completed using SAS version 9.2 (SAS Institute Inc., Cary, NC). Approval for human subject research and a waiver of informed consent were received from the Institutional Review Board at Saint Louis University and the Missouri Department of Health and Senior Services, Section for Epidemiology for Public Health Practice.

Results

There were 64,272 births meeting study criteria. 53,032 (82.5%) women were obese, 10,055 (15.6%) were morbidly obese and 1,185 (1.8%) were super-obese. Increasing BMI was associated with increased parity, single status, Medicaid use, African-American race, intensive prenatal care utilization, and prior cesarean (table 1). Lower BMI was associated with smoking and higher education levels.

Increasing maternal BMI was associated with a statistically significant increase in all studied perinatal outcomes, including preeclampsia, macrosomia, and composite neonatal morbidity, except for birth trauma (table 2). Super-obese women were significantly more likely than obese women to have preeclampsia (aRR 1.7), macrosomia (aRR 1.9) and neonatal hypoglycemia (aRR 2.0) (table 3). Compared to morbidly-obese women, super-obese women remained at increased risk for composite neonatal morbidity (aRR 1.2, p-value 0.02). There was no difference between morbidly-and super-obese women regarding risk for preeclampsia, macrosomia, or neonatal length of stay >5 days. Compared to obese women, morbidly-obese women were at increased risk for these outcomes along with neonatal hypoglycemia and composite neonatal morbidity.

Increasing maternal obesity was significantly associated with an elevated risk of cesarean delivery and a decreased incidence of vaginal delivery, regardless of parity (table 4). Among nulliparous women, 31% of super-obese women delivered vaginally compared to 53% of obese women. 33.8% of nulliparous super-obese women underwent scheduled cesarean. Of the 196 nulliparous super-obese women who attempted a vaginal delivery, 94 (48%) had a spontaneous vaginal birth, 24 (12%) had an operative vaginal delivery, and 78 (40%) were delivered via cesarean. For multiparous women, prior vaginal birth was associated with a significantly decreased risk of emergency cesarean, but most women with a prior cesarean underwent a repeat cesarean with only 2% of women in each obesity class having a VBAC.

Nulliparous super-obese women were significantly less likely than nulliparous obese women to have a vaginal delivery (aRR 0.4) and significantly more likely to undergo a scheduled cesarean (aRR 2.4) or emergency cesarean (aRR 1.6) (table 5). Similar results were seen in multiparous women. Super-obese women remained at increased risk compared to morbidly-obese women for cesarean delivery (aRR 1.2, p-value 0.03) and had decreased rates of vaginal delivery for nulliparous (aRR 0.6, p-value <.0001) and multiparous women (aRR 0.8, p-value .001).No significant difference in VBAC rates was seen between BMI groups, which were universally low.

Comment

Super-obese women are at significantly increased risk of pregnancy complications, even compared to other obese and morbidly-obese women. Our results support a dose-response relationship between worsening obesity and cesarean, macrosomia, neonatal hypoglycemia, and preeclampsia. This study provides information regarding the increased risk of perinatal complications with increasing BMI within obesity classes including super-obese women and builds upon the few published studies on super-obesity in pregnancy which primarily examined single outcomes and limited comparisons to normal weight women[5, 6] or combined obesity classes.[7]

Super-obese women are at significantly increased risk of delivery via cesarean compared to morbidly-obese and obese women. Although the overall cesarean rate in the United States in 2007 was 31.8%,[14] 49.1% of all super-obese women were delivered via cesarean, including 12.1% who underwent primary scheduled cesarean. Among nulliparous super-obese women, 33.8% underwent primary scheduled cesarean, and 40% of the women who attempted vaginal delivery were delivered via cesarean. Previous studies have shown that in addition to potential difficulties with regional anesthesia placement, super-obese women are at increased risk for airway problems, deep venous thrombosis, and wound infection.[15–17] Super-obese women need to be counseled about these increased risks and providers need to be prepared for the likelihood of a surgical delivery and increased probability of repeat cesareans as <3% of super-obese women delivered via VBAC. The rates of primary scheduled cesarean are much higher than in other populations. Future prospective studies are needed to examine the indication for cesarean in super-obese women and determine the influence of provider type and attitudes, including unwillingness to attempt a vaginal delivery or decreased patience during labor.

In addition to the medical risks associated with cesarean, there are also increased costs associated with the surgical procedure and prolonged hospital stay compared to a vaginal delivery. Super-obese women were more likely to utilize intensive prenatal care compared to obese and morbidly-obese women which again reflects an increase in medical costs.

This study supports the importance of preconception counseling and the potentially beneficial effect of weight loss prior to pregnancy, as has been shown in women following gastric bypass surgery with decreased rates of gestational diabetes, preeclampsia, and macrosomia compared to other obese women and to previous pregnancies.[4, 18–20] Our findings suggest that women who are able to lower their pre-pregnancy BMI, even if it is only from super-obese to morbidly-obese, may decrease their risk of cesarean, neonatal hypoglycemia, and composite neonatal morbidity. For a 5'4" woman, a change in weight of 5.9 lbs corresponds with a 1 unit change in BMI. For a 300 lb woman, losing 20 lbs will decrease her BMI from 51.5 to 48.1, and losing 40 lbs will drop her BMI to 44.6. Many super-obese women may find the idea of losing enough weight to become normal weight inconceivable, but by highlighting the potential benefits of even modest weight loss, obstetric providers can help patients set reasonable, achievable goals that will hopefully improve perinatal and life-long health outcomes for women and infants. Clinical studies are urgently needed to determine the impact of prepregnancy weight loss, effective perinatal interventions, and track long-term health outcomes for both mothers and their children.

Limitations of this study include this use of birth certificate and hospital discharge data, which are dependent upon the original quality of the data entered. This data set has been studied extensively and is considered very reliable[21] with a low percentage of records with missing information.[14] As we depended on birth certificate data, we were unable to evaluate stillbirth or miscarriage rates. We chose to focus on term deliveries to better evaluate infant birth weight and neonatal complications, and therefore are not able to address preterm birth data. The potential for undercoding remains a concern for diagnoses such as birth trauma or preeclampsia, as severe undercoding of birth trauma (5%) and minimal undercoding of preeclampsia (85%) was found in an audit of Missouri birth certificate with hospital discharge data (Schramm WS. Data quality: new certificates. Proceedings of the AVRHS/ VSCP project directors meeting. San Francisco, California; 1991). However, there is no reason to expect that undercoding would be biased by maternal BMI, particularly across the elevated BMI categories examined in these analyses. Patients who were not coded properly would lead to an underrepresentation of the true incidence of these conditions, thus suggesting that the true differences were even larger than stated. An additional limitation was use of self-reported prepregnancy weight, which may be over- or under-reported by participants. A prior integrated review of 34 studies found that women in all studies underestimated weight[22], and a 2006 study of reproductive age women reported that although women underestimated weight by an average of 4.6 lbs, 84% remained classified in the appropriate BMI categories.[23] Bonder et al. examined the impact of exposure misclassification between prepregnancy BMI and adverse pregnancy outcomes, and found that although pregnancy outcomes were slightly overestimated, the dose-dependent associations persisted.[24] Interestingly, they reported that the severely-obese women (BMI $\geq$35 kg/m^2) had the best predictive value (0.93) between self-reported and measured BMI, which would support the accuracy of our BMI classifications and perinatal outcomes. Use of birth certificate data contributed to one of our primary strengths, the ability to analyze perinatal outcomes on over 1,000 super-obese, 10,000 morbidly-obese, and 50,000 obese women.

Super-obese women are at significantly increased risk of pregnancy complications including cesarean, preeclampsia, macrosomia, and neonatal hypoglycemia compared to obese women with lower BMI. While we support the role of preconception weight loss to improve perinatal outcomes, this study suggests that interventions to reduce excess morbidity in super-obese women need to be examined, especially mode of delivery, which is highly affected by physician influence. An analysis of the indication for primary cesarean, and specifically elective cesarean, in morbid- and super-obese women is urgently needed. By better understanding why super-obese women are being delivered via cesarean, it may be possible to decrease patient morbidity due to operative delivery by increasing provider education and awareness. Further, the economic implication of increasing levels of obesity requires study.

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Table 1

Population Characteristics (n=64,272)

	Maternal Obesity Class BMI (kg/m^2)		
	Obese 30–39.9 N(%)	**Morbid 40–49.9 N(%)**	**Super ≥50 N(%)**
Maternal Race [a]			
African American	9,222 (17.4)	2,178 (21.7)	376 (31.8)
Caucasian	41,143 (77.7)	7,512 (74.9)	760 (64.3)
Hispanic	1,962 (3.7)	259 (2.6)	30 (2.5)
Asian/other	621 (1.2)	86 (0.9)	16 (1.4)
Maternal Age [a]			
< 18	896 (1.7)	81 (0.8)	5 (0.4)
18–34	46,806 (88.3)	8,972 (89.2)	1,053 (88.9)
≥ 35	5,330 (10.0)	1,001 (10.0)	127 (10.7)
Education [a]			
High	25,482 (48.3)	4,619 (46.1)	506 (42.9)
Average	19,683 (37.3)	3,971 (39.7)	489 (41.5)
Low	7,563 (14.3)	1,418 (14.2)	184 (15.6)
Married [a]	34,458 (65.0)	6,370 (63.4)	664 (56.1)
Parity [a]			
0	17,013 (32.2)	2,993 (30.0)	296 (25.1)
1	18,470 (35.0)	3,574 (35.8)	437 (37.0)
2	10,510 (19.9)	2,020 (20.2)	256 (21.7)
≥3	6,773 (12.8)	1,398 (14.0)	192 (16.3)
Smoking status [b]			
Yes	9,378 (17.7)	1,685 (16.8)	167 (14.1)
No	43,368 (81.8)	8,319 (82.7)	1,013 (85.5)
Unknown	286 (0.5)	51 (0.5)	5 (0.4)
Medicaid [a]	25,331 (47.9)	5,341 (53.3)	743 (63.1)
Prenatal care utilization [a]			
Missing	774 (1.5)	151 (1.5)	18 (1.6)
None	258 (0.5)	46 (0.5)	7 (0.6)
Inadequate	2,327 (4.5)	417 (4.2)	54 (4.7)
Adequate	27,928 (53.7)	5,307 (53.9)	611 (52.9)
Intermediate	16,808 (32.3)	3,056 (31.0)	344 (29.8)
Intensive	3,891 (7.5)	877 (8.9)	121 (10.5)
Male infant	27,122 (51.1)	5,127 (51.0)	594 (50.1)
Gestational age (w)	38.8±1.0	38.7±1.0	38.7±1.0
Birth weight (g) [c]	3460.6 ±476.3	3490.1 ±499.5	3517.6 ±514.8

[a] $p<.0001$;

[b] $p<.001$;

[c] $p<.05$

Table 2

Trend analysis for perinatal outcomes by obesity class (BMI = kg/m^2)

	Obese 30–39.9 N(%)	Morbid 40–49.9 N(%)	Super ≥50 N(%)	*p-value*[a]
Preeclampsia Neonatal length of stay	3,842 (7.2)	980 (9.8)	129 (10.9)	<.0001
> 5 days	1,629 (3.1)	381 (3.8)	53 (4.5)	<.0001
Low Apgar	343 (0.7)	67 (0.7)	15 (1.3)	0.05
Macrosomia	979 (1.9)	262 (2.6)	40 (3.4)	<.0001
Low birth weight	1,074 (2.0)	223 (2.2)	31 (2.6)	0.04
Neonatal hypoglycemia	1,035 (2.0)	274 (2.7)	45 (3.8)	<.0001
Birth trauma	1,716 (3.2)	348 (3.5)	41 (3.5)	0.12
Composite neonatal	4,924 (9.3)	1,097 (10.9)	153 (12.9)	<.0001

BMI = Body Mass Index

[a]Cochran-Armitage trend

Table 3

Perinatal outcome comparison between obesity groups

	Morbid vs. Obese		Super vs. Obese		Super vs. Morbid	
	aRR[a] (95% CI)	***p-value***	***aRR[a] (95% CI)***	***p-value***	***aRR[a] (95% CI)***	***p-value***
Preeclampsia	1.4 (1.3, 1.5)	<.0001	1.7 (1.4, 2.1)	<.0001	1.2 (1.0, 1.4)	0.11
Neonatal length of stay > 5 days	1.2 (1.1, 1.3)	0.003	1.3 (1.0, 1.8)	0.04	1.2 (0.9, 1.6)	0.36
Low Apgar	1.0 (0.8, 1.4)	0.75	1.9 (1.1, 3.2)	0.02	1.9 (1.0, 3.4)	0.04
Macrosomia (≥4500 g)	1.4 (1.2, 1.6)	<.0001	1.8 (1.3, 2.5)	0.0006	1.3 (0.9, 1.8)	0.16
Low birth weight	1.1 (0.9, 1.3)	0.24	1.3 (0.9, 1.9)	0.16	1.3 (0.9, 1.9)	0.22
Neonatal Hypoglycemia	1.4 (1.2, 1.6)	<.0001	2.0 (1.5, 2.7)	<.0001	1.4 (1.0, 1.9)	0.05
Birth trauma	1.2 (1.0, 1.3)	0.008	1.3 (1.0, 1.8)	0.09	1.1 (0.8, 1.6)	0.44
Composite neonatal morbidity	1.2 (1.1, 1.3)	<.0001	1.5 (1.2, 1.8)	<.0001	1.2 (1.0, 1.5)	0.02

[a]Adjusted for: smoking, Medicaid, age (18–34), education (average), prenatal care (adequate), married, nulliparous, repeat cesarean, scheduled primary cesarean, and race

Table 4

Trend analysis for mode of delivery by obesity class (BMI kg/m2)

	BMI (kg/m^2)			
	30 – 39.9	*40 – 49.9*	*≥ 50*	*p-value*[a]
Nulliparous				
Vaginal delivery	9,042 (53.2)	1,331 (44.5)	94 (31.8)	<.0001
Operative vaginal	1,747 (10.3)	268 (9.0)	24 (8.1)	0.0471
Primary scheduled cesarean	3,033 (17.8)	654 (21.9)	100 (33.8)	<.0001
Primary emergency cesarean	3,163 (18.6)	735 (24.6)	78 (26.4)	<.0001
Multiparous				
Vaginal delivery	22,334 (62.5)	3,690 (52.8)	421 (47.6)	<.0001
Operative vaginal	1,343 (3.8)	272 (3.9)	39 (4.4)	0.3187
Vaginal birth after cesarean	735 (2.1)	150 (2.2)	23 (2.6)	0.3073
Primary scheduled cesarean	1,382 (3.9)	328 (4.7)	46 (5.2)	0.0003
Primary emergency cesarean	1,400 (3.9)	323 (4.6)	49 (5.5)	0.0004
Repeat scheduled cesarean	8,559 (23.9)	2,229 (31.9)	307 (34.7)	<.0001
Total				
Vaginal delivery	31,534 (59.5)	5,053 (50.3)	517 (43.6)	<.0001
Operative vaginal	3,108 (5.9)	548 (5.5)	63 (5.3)	0.0837
Total cesarean	17,653 (33.3)	4,304 (42.8)	582 (49.1)	<.0001
Primary scheduled cesarean	4,452 (8.4)	992 (9.9)	147 (12.4)	<.0001
Primary emergency cesarean	4,580 (8.6)	1,067 (10.6)	127 (10.7)	<.0001

[a]Cochran-Armitage χ^2 trend test

Table 5

Mode of delivery comparison between obesity groups[a]

	Morbid vs. Obese		Super vs. Obese		Super vs. Morbid	
	aRR[b] (95% CI)	*p-value*	*aRR[b] (95% CI)*	*p-value*	*aRR[b] (95% CI)*	*p-value*
Nulliparous						
Vaginal delivery	0.69 (0.64, 0.75)	<.0001	0.40 (0.31, 0.51)	<.0001	0.58 (0.45, 0.75)	<.0001
Operative vaginal	0.88 (0.77, 1.01)	0.06	0.81 (0.53, 1.23)	0.32	0.92 (0.59, 1.42)	0.69
Primary scheduled cesarean	1.31 (1.19, 1.45)	<.0001	2.41 (1.88, 3.09)	<.0001	1.85 (1.43, 2.40)	<.0001
Primary emergency cesarean	1.42 (1.30, 1.56)	<.0001	1.59 (1.22, 2.07)	0.001	1.09 (0.83, 1.44)	0.53
Multiparous						
Vaginal delivery	0.66 (0.62, 0.69)	<.0001	0.52 (0.45, 0.60)	<.0001	0.79 (0.68, 0.91)	0.001
Operative vaginal	1.06 (0.93, 1.21)	0.41	1.25 (0.90, 1.73)	0.19	1.17 (0.83, 1.65)	0.38
Vaginal birth after cesarean	1.05 (0.88, 1.26)	0.57	1.19 (0.76, 1.84)	0.45	1.08 (0.68, 1.73)	0.73
Primary scheduled cesarean	1.24 (1.09, 1.40)	0.001	1.42 (1.05, 1.93)	0.02	1.18 (0.86, 1.63)	0.30
Primary emergency cesarean	1.19 (1.05, 1.35)	0.01	1.35 (1.00, 1.83)	0.048	1.13 (0.83, 1.56)	0.44
Repeat scheduled cesarean	1.52 (1.43, 1.61)	<.0001	1.80 (1.56, 2.07)	<.0001	1.19 (1.02, 1.38)	0.03
Total						
Vaginal delivery	0.67 (0.64, 0.70)	<.0001	0.50 (0.44, 0.56)	<.0001	0.75 (0.66, 0.84)	<.0001
Operative vaginal	0.95 (0.87, 1.04)	0.28	0.97 (0.75, 1.25)	0.81	1.01 (0.77, 1.32)	0.94
Total cesarean	1.42 (1.32, 1.53)	<.0001	1.82 (1.48, 2.22)	<.0001	1.27 (1.03, 1.56)	0.02
Primary scheduled cesarean	1.23 (1.14, 1.32)	<.0001	1.66 (1.39, 1.98)	<.0001	1.37 (1.14, 1.66)	0.001
Primary emergency cesarean	1.26 (1.18, 1.36)	<.0001	1.28 (1.06, 1.55)	0.01	0.99 (0.81, 1.21)	0.93

[a]Example: Women who were morbidly obese were 1.31 times more likely to deliver by primary scheduled cesarean than women who were obese.

[b]Adjusted for: smoking, insurance status, race/ethnicity, maternal age, education, prenatal care, and marital status.