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## Indications for primary cesarean delivery relative to body mass index

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### Abstract

**Background**—Obesity is a known risk factor for cesarean delivery. Limited data are available regarding the reasons for the increased rate of primary cesarean in obese women. It is important to identify the factors leading to an increased risk of cesarean to identify opportunities to reduce the primary cesarean rate.

**Objective**—We evaluated indications for primary cesarean across body mass index kg/m<sup>2</sup> classes to identify the factors contributing to the increase rate of cesarean among obese women.

**Study design**—In the Consortium of Safe Labor study between 2002 and 2008, we calculated indications for primary cesarean including failure to progress or cephalopelvic disproportion, non-reassuring fetal heart tracing, malpresentation, elective, hypertensive disease, multiple gestation, placenta previa or vasa previa, failed induction, human immunodeficiency virus or active herpes simplex virus, history of uterine scar, fetal indication, placental abruption, chorioamnionitis, macrosomia, and failed operative delivery. For women with primary cesarean for failure to progress or cephalopelvic disproportion, dilation at the last recorded cervical examination was evaluated. Women were categorized according to body mass index on admission: normal weight (18.5-24.9), overweight (25.0-29.9), obese class I (30.0-34.9), II (35.0-39.9), and III (≥ 40). Cochran-Armitage Trend Test and Chi-square tests were performed.

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We would like to choose Table 2 in the print issue of the Journal.

**Results**—Of 66,502 nulliparous and 76,961 multiparous women in the study population, 19,431 nulliparous (29.2%) and 7,329 multiparous women (9.5%) underwent primary cesarean. Regardless of parity, malpresentation, failure to progress or cephalopelvic disproportion, and non-reassuring fetal heart tracing were the common indications for primary cesarean. Regardless of parity, the rates of primary cesarean for failure to progress or cephalopelvic disproportion increased with increasing body mass index (normal weight, class I, II and III obesity in nulliparous: 33.2%, 41.6%, 46.4%, 47.4%, and 48.9% [ $P<.01$ ] and multiparous women: 14.5%, 20.3%, 22.8%, 27.2%, and 25.3% [ $P<.01$ ]), whereas the rates for malpresentation decreased (normal weight, class I, II and III obesity in nulliparous: 23.7%, 17.2%, 14.6%, 12.0%, and 9.1% [ $P<.01$ ] and multiparous women: 35.6%, 30.6%, 26.5%, 24.3%, and 22.9% [ $P<.01$ ]). Rates of primary cesarean for non-reassuring fetal heart tracing were not statistically different for nulliparous ( $P>.05$ ) or multiparous women ( $P>.05$ ). Among nulliparous women who had a primary cesarean for failure to progress or cephalopelvic disproportion, rates of cesarean prior to active labor (6 cm) increased as body mass index increased, accounting for 39.3% of women with class I, 47.1% of women with class II and 56.8% of women with class III obesity compared to 35.2% for normal weight women ( $P<.01$ ).

**Conclusion**—Similar to normal weight women, the indication of cesarean for failure to progress or cephalopelvic disproportion was the major factor contributing to the increase in primary cesarean in obese women, but was even more prevalent with increasing obesity class. The rates of intrapartum primary cesarean prior to achieving active labor increased with increasing obesity class in nulliparous women.

## Keywords

Cesarean delivery; Indication; Obesity

## Introduction

Obesity is epidemic in the United States. In 2011-2012, 32% of women of reproductive age (20 to 39 years old) were obese (body mass index [BMI]  $\geq 30$  kg/m<sup>2</sup>).<sup>1</sup> Obese women have an increased risk of cesarean delivery even after adjusting for maternal comorbidities as well as a lower rate of vaginal birth after cesarean compared with normal weight women.<sup>2, 3</sup> Although the rate of primary cesarean delivery declined from 22.1% in 2009 to 21.5% in 2012, the overall rate is still high.<sup>4</sup> Limited data are available regarding the reasons for the increased rate of primary cesarean delivery in obese women. Small studies have demonstrated that failure to progress/cephalopelvic disproportion and non-reassuring fetal heart tracing were the most common indications for primary cesarean delivery in obese women.<sup>5, 6, 7, 8</sup> In a retrospective study of 2,251 obese women undergoing non-elective cesarean delivery, increasing BMI was associated with increased risks for cesarean delivery due to hypocontractility and non-reassuring fetal heart tracing (defined by ICD O62 and ICD O68, respectively).<sup>9</sup> However, in that study, failure to progress/cephalopelvic disproportion was not increased in obese women. It is important to identify the factors leading to an increased risk of cesarean delivery because obese women also have a higher risk of postoperative complications including endometritis, wound infection and separation and venous thromboembolism.<sup>10, 11, 12</sup> To identify opportunities to reduce the primary cesarean

delivery rate, it is important to examine the contributors for increased risk of primary cesarean delivery in obese women who constitute one-third of the U.S. delivery population. Therefore, we investigated the factors contributing to the increase rate of cesarean delivery among obese women in a large U.S. multicenter cohort study.

## Materials and methods

The Consortium on Safe Labor (CSL) was a retrospective cohort study of all women delivering at 23 weeks of gestation or greater between 2002 and 2008 in 12 clinical centers with 19 hospitals across 9 American Congress of Obstetricians and Gynecologists (ACOG) US districts.<sup>13</sup> All participating institutions obtained Institutional Review Board (IRB) approval.

The CSL included a total of 228,562 deliveries with 233,736 newborns delivered at 23 weeks of gestation after excluding 106 deliveries due to errors in identification. Data from the electronic medical record were abstracted and mapped to predefined classes at the data coordinating center. The data coordinating center performed data cleaning and logic checks. Sites validated four diagnoses including cesarean delivery for non-reassuring fetal heart rate tracing, neonatal asphyxia, neonatal intensive care unit (NICU) admission due to a respiratory diagnosis and shoulder dystocia. The variables were highly concordant with the medical records (greater than 95% for 16 out of 20 variables and greater than or equal to 91.9% for all).<sup>13</sup> We included singleton and multiple pregnancies in the present analysis. We excluded women with previous cesarean deliveries, fetus with a major congenital anomaly or chromosomal abnormality, antepartum stillbirth, and women with BMI unknown or <18.5 kg/m<sup>2</sup>. The final analysis was limited to 143,463 deliveries (Figure S1).

We chose to use the maternal BMI on admission because this variable takes into account weight gain during pregnancy and was also recorded in labor and delivery on the majority of women. Information on maternal demographics and pregnancy outcomes was collected for evaluation based on maternal BMI at admission. Maternal BMI was categorized as normal weight for 18.5 to 24.9 kg/m<sup>2</sup>, overweight for 25.0 to 29.9 kg/m<sup>2</sup>, obese class I for 30.0 to 34.9 kg/m<sup>2</sup>, class II for 35.0 to 39.9 kg/m<sup>2</sup>, and class III for 40 kg/m<sup>2</sup>.

We compared percentages of indications for primary cesarean delivery across BMI classes. A sensitivity analysis was performed for the three most common indications stratified by gestational age category at delivery (23 to 32, 33 to 36 and greater than or equal to 37 weeks of gestation). Indications were recorded in the medical record including failure to progress or cephalopelvic disproportion (FTP/CPD), non-reassuring fetal heart tracing (NRFHT), malpresentation, elective, hypertensive disease, multiple gestation, placenta previa or vasa previa, failed induction, human immunodeficiency virus (HIV) or active herpes simplex virus, history of uterine scar, fetal indication, placental abruption, chorioamnionitis, macrosomia, and failed operative delivery. Percentages of each indication were calculated as the number of the cesarean deliveries performed for each indication. The rates could add up to > 100% if more than one indication was recorded.

Because some women had more than one indication and we could not identify which indication was the primary indication, we also grouped the indications for primary cesarean delivery into the following three hierarchical, mutually exclusive classes using criteria previously described by Zhang et al.<sup>13</sup>: clinically indicated; mixed; and truly elective. Clinically indicated was defined as non-reassuring fetal heart rate tracing, failure to progress, cephalopelvic disproportion, failed induction, failed trial of forceps or vacuum, placenta abruption, placenta previa, and history of shoulder dystocia. Mixed included indications where adequate information was not available such as previous uterine scar, malpresentation, fetal macrosomia, HIV infection, multiple gestation, preeclampsia/eclampsia, and other (ie. HIV infection without known viral load). Suspected macrosomia and multiple gestation are not absolute indications for primary cesarean delivery unless the estimated fetal weight is greater than 4500 grams for diabetic women, greater than 5000 grams for non-diabetic women, or non-cephalic presentation in twins.<sup>14</sup> Since estimated fetal weight or presentation of the twins were unknown in our study, we classified these as mixed indications. “Truly elective” was defined as cesarean for elective delivery as recorded in the medical record with no other indications recorded as well as non-medically indicated reasons including maternal request, multiparity, women desiring a tubal ligation, advanced maternal age, diabetes mellitus, human papilloma virus, postterm or postdates, pregnancy remote from term, group B streptococcus, polyhydramnios, fetal death, and social or religious concerns. In cases in which more than one reason for cesarean delivery was given, and when there were reasons in more than one class, the delivery was placed in the higher ranking class in which clinically indicated outranked mixed, which, in turn outranked truly elective.

We further examined the timing of delivery relative to the first and second stage of labor. For this analysis, we excluded multiple gestation. For women with cesarean indication for failure to progress or cephalopelvic disproportion, dilation at the last recorded cervical examination was evaluated. For women with cesarean indication for arrest of descent, the time between full dilation and birth of the neonate was evaluated. Those women with unrecorded last cervical examination were excluded from this analysis.

Descriptive statistics were calculated for all study variables. Chi-square test was used to compare maternal characteristics. Cochran-Armitage Trend Test was used to calculate the association between cesarean indications and BMI classes. All statistical analyses were performed using SAS 9.3 (SAS Institute Inc., Cary, NC).

## Results

Of 143,463 women, there were 21,929 (15.3%) normal weight women, 55,997 (39.0%) overweight women, 38,007 (26.5%) obese class I women, 16,743 (11.7%) obese class II women, and 10,787 (7.5%) obese class III women (supplementary Figure S1).

Demographic characteristics differed by BMI class (Table 1). Obese women (classes I, II, and III) were more likely to be older, multiparous, non-Hispanic black, smokers, to have public insurance or self pay, and have multiple gestations compared to normal weight women. Obese women also were more likely to have chronic medical conditions and

pregnancy complications including diabetes (pregestational and gestational diabetes) and hypertension (chronic hypertension, preeclampsia or syndrome of hemolysis, elevated liver enzymes, and low platelets [HELLP syndrome], chronic hypertension with superimposed preeclampsia) compared to normal weight women (all  $P < .01$ ; data not shown). Obese women with chronic conditions delivered at a later gestational age and their neonates had a heavier birth weight on average ( $P < .01$ ). In addition, rates of fetal scalp electrode, intrauterine pressure catheter use were increased in obese women compared to normal weight and overweight women ( $P < .01$ ). Oxytocin use increased with increasing BMI classes ( $P < .01$ ), whereas no clear trend was seen in epidural use. Obese women (classes I, II, and III) had lower rates of prelabor cesarean delivery and higher rates of labor induction compared with normal weight and overweight women ( $P < .01$ ).

Indications for primary cesarean delivery in nulliparous women are presented in Table 2. Primary cesarean rates increased with increasing maternal BMI class. In nulliparous women who were normal weight, overweight, obesity class I, obesity class II, and obesity class III, the primary cesarean delivery rates were 18.5%, 24.5%, 32.3%, 40.8%, and 50.8%, respectively. The rate of nulliparous women who had more than one indication was 10.8%. In all BMI classes, failure to progress or cephalopelvic disproportion was the most common indication for primary cesarean delivery and the percentages increased with increasing BMI classes ( $P < .01$ ). Malpresentation was the second most common indication for primary cesarean delivery in normal weight women, but the percentages decreased with increasing BMI classes ( $P < .01$ ). Non-reassuring fetal heart tracing and elective cesarean were the third and fourth most common indications for primary cesarean delivery but the percentages did not increase with increasing BMI ( $P = .11$  and  $P = .71$ , respectively). Macrosomia as an indication for primary cesarean increased with increasing BMI class. In grouped indications, clinically indicated cesarean deliveries decreased while clinically mixed cesarean deliveries increased with increasing BMI class. Truly elective primary cesarean delivery essentially was consistent across BMI class ( $P < .01$ ).

Indications for primary cesarean delivery in multiparous women are presented in Table 3. Primary cesarean rates increased with increasing maternal BMI class. In multiparous women who were normal weight, overweight, obesity class I, obesity class II, and obesity class III, the primary cesarean delivery rates were 6.4%, 7.3%, 10.1%, 13.3%, and 18.5%, respectively. The rate of multiparous women who had more than one indication was 12.0%. Failure to progress or cephalopelvic disproportion, non-reassuring fetal heart tracing, and malpresentation were the most common indications for primary cesarean delivery. Malpresentation was the most common indication for primary cesarean delivery in normal weight, but the percentages decreased with increasing BMI classes ( $P < .01$ ). Non-reassuring fetal heart tracing was the second most common indication for primary cesarean delivery in normal weight women, and the percentages did not increase with increasing BMI ( $P = .93$ ). Failure to progress or cephalopelvic disproportion was the third most common indication for primary cesarean delivery in normal weight women, and the percentages increased with increasing BMI classes ( $P < .01$ ). Macrosomia as an indication for primary cesarean increased with increasing BMI class, and was the fourth most common indication for obesity classes II and III. Elective was the fifth common indication for primary cesarean delivery and the percentages increased with increasing BMI classes ( $P < .01$ ). An increasing trend across the

BMI classes was observed in failure to progress or cephalopelvic disproportion, elective, hypertensive disease, failed induction, and macrosomia (all for  $P < .01$ ). In grouped indications that were mutually exclusive, the rates of clinically indicated, mixed and truly elective primary cesarean delivery were not different across BMI classes ( $P = .75$ ).

When examining indications of primary cesarean by gestational age, there were differences by gestational age category. Between 23 0/7 and 32 6/7 weeks' gestation in both nulliparous and multiparous women, malpresentation, non-reassuring fetal heart tracing, and hypertensive disease were the most common indications. Similar to the main results, in nulliparous women between 33 0/7 and 36 6/7 weeks' gestation, and nulliparous and multiparous women at term, the percentages of failure to progress/cephalopelvic disproportion increased with increasing BMI classes, whereas the percentages of malpresentation decreased with increasing BMI classes.

Among nulliparous women who had a primary cesarean delivery for failure to progress or cephalopelvic disproportion, more women had a cesarean delivery before progressing into the active phase of labor beyond 6 cm cervical dilation as BMI classes increased, accounting for 39.3% of women with class I, 47.1% of women with class II and 56.8% of women with class III obesity compared to 35.2% for normal weight women ( $P < .01$ ) (Table 4). Among multiparous women who had a primary cesarean delivery for failure to progress or cephalopelvic disproportion, there was also a significant association between dilation level and BMI classes ( $P = .04$ ); however, no clear trend was seen.

Among all with a primary cesarean delivery who reached the second stage of labor, there was no significant difference in the second stage duration among BMI classes regardless of parity ( $P = .47$  and  $.76$  in nulliparous and multiparous, respectively) (Table 5). Among nulliparous women with a primary cesarean delivery who reached the second stage of labor, 21.8% and 32.2% of women had a second stage of labor lasting for 3-3.9 hours and 4 hours or more, respectively. Among multiparous women with a primary cesarean delivery who reached the second stage of labor, only 16.2% and 18.2% of women had a second stage of labor lasting for 3-3.9 hours and 4 or more hours.

## Comment

Rates of primary cesarean delivery increased with increasing maternal BMI class, regardless of parity. Failure to progress or cephalopelvic disproportion and fetal macrosomia were the major indications for primary cesarean delivery that increased with increasing obesity class. Percentages of non-reassuring fetal heart tracing did not increase with increasing obesity. Among nulliparous women who had primary cesarean delivery for failure to progress or cephalopelvic disproportion, a greater percentage of women had a cesarean delivery before progressing into the active phase of labor beyond 6 cm cervical dilation as BMI classes increased.

In an analysis of Consortium on Safe Labor data, Boyle et al. reported the most common indications for primary cesarean delivery overall were failure to progress, non-reassuring fetal heart tracing, and fetal malpresentation.<sup>15</sup> Consistent with the previous analysis we

found that these were the most common indications in obese women, although the association with increasing maternal BMI differed. Of these, failure to progress contributed most to the increase in primary cesarean delivery both in nulliparous and multiparous women with increasing rates observed with increasing BMI classes. Previous studies have demonstrated a longer duration of labor in obese women.<sup>16, 17</sup> This longer duration of labor might be due to soft tissue dystocia<sup>18, 19</sup> and uterine hypocontractility.<sup>5, 9</sup> In our study, among nulliparous women who had primary cesarean delivery for failure to progress or cephalopelvic disproportion, more women had a cesarean delivery before 6 cm cervical dilation as BMI classes increased. In multiparous women, a third of primary cesarean deliveries were performed in the latent phase of labor regardless of obesity classes. A previous CSL study found that the active phase of labor starts at 6cm cervical dilation.<sup>20</sup> Our findings that rates of cesarean delivery in the latent phase of labor increased with increasing maternal obesity class in nulliparous women indicate that allowing longer labor may be particularly important for this group of women. In our study, among women who underwent primary cesarean delivery for arrest of descent, the majority of nulliparous women had at least 3 hours of second stage of labor, whereas the majority of multiparous women did not. A previous CSL study showed relatively high vaginal delivery rate in women with a second stage of labor beyond 3 hours.<sup>21</sup> The percentages of fetal malpresentation decreased with increasing BMI. This decrease may be because the overall incidence of cesarean delivery increased with increasing BMI but the incidence of malpresentation was stable across the BMI classes.

In our study, the percentages of primary cesarean delivery for non-reassuring fetal heart tracing did not increase with increasing BMI classes. Maternal body habitus in obese women may make fetal heart monitoring more difficult. Of note, in our study, fetal scalp electrode was more frequently used in obese women. The diagnosis of non-reassuring fetal heart tracing is highly subjective and influenced by providers' obstetric practice.<sup>15</sup> Methods for improved and objective intrapartum evaluation of fetal status that is closely correlated with neonatal outcomes is needed in order to reduce the percentage of cesarean deliveries due to non-reassuring fetal heart rate tracings.

In our study, the percentages of primary cesarean delivery for macrosomia increased with increasing BMI classes regardless of parity. Indeed, mean birth weight was higher with increasing BMI classes, which is consistent with increased rates of macrosomia in obese women. In a study of obese women, limiting the amount of weight gain during pregnancy decreased the risk of cesarean delivery and macrosomia.<sup>22</sup> Elective cesarean delivery was one of the major factors contributing to the increase in primary cesarean delivery in nulliparous and multiparous women with increasing percentages in obese multiparous women. Elective cesarean deliveries are an obvious target to reduce the primary cesarean delivery in obese women.

There are some limitations in our study. We chose to use the maternal BMI on admission rather than the prepregnancy weight because this variable takes into account weight gain during pregnancy. Studies comparing third trimester BMI with prepregnancy BMI have found that third trimester BMI was more associated with increasing cesarean delivery rate.<sup>3, 23</sup> In addition, BMI on admission to labor and delivery was recorded in more women

than prepregnancy BMI. Another limitation includes the retrospective nature of our analysis. Obesity itself may have influenced providers' labor and delivery management. In our study, 10.8% of nulliparous and 12.0% of multiparous women had more than one cesarean indication. Due to the retrospective nature of the study, we could not identify which indication was the primary indication. To account for this limitation, we performed hierarchical grouped categories, which were mutually exclusive. Also, there were women excluded due to unknown BMI, although this is unlikely to have biased our results since they were most likely missing completely at random. The recommendation that active phase of labor starts at 6 cm cervical dilation were based on data from the CSL study.<sup>14, 20</sup> Our findings might not be as generalizable to current practice which has incorporated this definition of active phase.<sup>14</sup> The major strength of this study is the large cohort from 12 clinical centers with 19 hospitals across 9 ACOG US districts that makes our study more generalizable.

In summary, similar to normal weight women, the indication for cesarean delivery of failure to progress/cephalopelvic disproportion was the major factor contributing to the increase in primary cesarean delivery in obese women, but was even more prevalent with increasing obesity class. Without considering maternal and neonatal morbidity, we cannot make recommendations for labor management in obese women. Given that the rates of intrapartum primary cesarean delivery prior to achieving active labor increased with increasing obesity class in nulliparous women, accounting for 39% of women with class I, 47% of women with class II and 57% of women with class III obesity, our findings have implications on a population level in light of the obesity epidemic. In order to decrease the rate of primary cesarean delivery safely, randomized controlled trials investigating the benefits and risks of avoiding cesarean delivery for failure to progress/cephalopelvic disproportion would need to be conducted.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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**Condensation**

Nearly half of obese nulliparous and a quarter of obese multiparous women had primary cesarean delivery for failure to progress or cephalopelvic disproportion.

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Table 1

Demographic data of women with primary cesarean delivery.

	Normal weight (n=2,712)	Overweight (n=8,659)	Obesity class I (n=7,603)	Obesity class II (n=4,222)	Obesity class III (n=3,564)	P-value <sup>a</sup>
Maternal age, year mean (SD)	27.6 (66.9)	28.6 (6.8)	28.2 (6.7)	27.8 (6.5)	27.3 (6.3)	<.01
Nulliparous women	1,993 (73.5)	6,529 (75.4)	5,482 (72.1)	2,965 (70.2)	2,462 (69.1)	<.01
Race/ethnicity						<.01
Non-Hispanic white	1,332 (49.1)	4,199 (48.5)	3,445 (45.3)	1,853 (43.9)	1,476 (41.4)	
Non-Hispanic black	545 (20.1)	1,616 (18.7)	1,842 (24.2)	1,231 (29.2)	1,331 (37.4)	
Hispanic	462 (17.0)	1,715 (19.8)	1,595 (21.0)	828 (19.6)	526 (14.8)	
Asian/Pacific islander	204 (7.5)	585 (6.8)	246 (3.2)	69 (1.6)	38 (1.1)	
Other, unknown	169 (6.2)	544 (6.3)	475 (6.3)	241 (5.7)	193 (5.4)	
Health insurance						<.01
Private	1,306 (48.2)	4,589 (53.0)	3,984 (52.4)	2,192 (51.9)	1,762 (49.4)	
Public or self-pay	1,084 (40.0)	3,087 (35.7)	3,021 (39.7)	1,804 (42.7)	1,655 (46.4)	
Other, unknown	322 (11.9)	983 (11.4)	598 (7.9)	226 (5.4)	147 (4.1)	
Multiple gestation	120 (4.4)	566 (6.5)	529 (7.0)	242 (5.7)	188 (5.3)	<.01
Smoking	199 (7.3)	442 (5.1)	444 (5.8)	271 (6.4)	299 (8.4)	<.01
Gestational age at delivery, weeks, mean (SD)	37.3 (3.6)	38.3 (2.8)	38.4 (2.8)	38.4 (2.7)	38.3 (2.6)	<.01
Gestational age category						<.01
23 0/7 - 27 6/7	101 (3.7)	124 (1.4)	101 (1.3)	54 (1.3)	39 (1.1)	
28 0/7 - 32 6/7	194 (7.2)	323 (3.7)	298 (3.9)	144 (3.4)	112 (3.1)	
33 0/7 - 36 6/7	460 (17.0)	1,079 (12.5)	924 (12.2)	512 (12.1)	461 (12.9)	
37 0/7 -	1,957 (72.2)	7,133 (82.4)	6,280 (82.6)	3,512 (83.2)	2,952 (82.8)	
Birth weight gram, mean (SD)	2,827.5 (774.2)	3,139.3 (695.5)	3,240.6 (735.4)	3,303.0 (753.2)	3,331.6 (756.1)	<.01
Type of labor						<.01
Prelabor cesarean delivery	844 (31.1)	2,156 (24.9)	1,744 (22.9)	847 (20.1)	749 (21.0)	
Spontaneous labor	1,063 (39.2)	3,233 (37.3)	2,691 (35.4)	1,394 (33.0)	1,025 (28.8)	
Induction of labor	805 (29.7)	3,270 (37.8)	3,168 (41.7)	1,981 (46.9)	1,790 (50.2)	
Fetal scalp electrode	506 (19.2)	1,897 (22.6)	1,763 (24.0)	1,149 (28.3)	1,092 (31.9)	<.01
Intrauterine pressure catheter	579 (22.0)	2,355 (28.0)	2,295 (31.3)	1,370 (33.7)	1,203 (35.2)	<.01
Oxytocin use	1,173 (43.3)	4,509 (52.1)	4,333 (57.0)	2,518 (59.6)	2,196 (61.6)	<.01

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	Normal weight (n=2,712)	Overweight (n=8,659)	Obesity class I (n=7,603)	Obesity class II (n=4,222)	Obesity class III (n=3,564)	P-value <sup>d</sup>
Epidural use	1,732 (63.9)	5,999 (69.3)	5,190 (68.3)	2,885 (68.3)	2,333 (65.5)	<.01

Abbreviations: SD, standard deviation; HELLP syndrome, Hemolysis Elevated Liver enzyme, Low Platelet syndrome

<sup>d</sup>Chisquare-test

**Table 2**

Indications for primary cesarean delivery in nulliparous women.

	Normal weight	Overweight	Obesity class I	Obesity class II	Obesity class III	P-value <sup>a</sup>
Total number of delivery (N=66,502)	10,765	26,635	16,988	7,270	4,844	NA
Total number of primary cesarean delivery (n=19,431)	1,993 (18.5)	6,529 (24.5)	5,482 (32.3)	2,965 (40.8)	2,462 (50.8)	NA
Indication for primary cesarean delivery, n (%)						NA
Failure to progress or cephalopelvic disproportion	661 (33.2)	2,714 (41.6)	2,541 (46.4)	1,406 (47.4)	1,203 (48.9)	<.01
Non-reassuring fetal heart tracing	457 (22.9)	1,479 (22.7)	1,161 (21.2)	629 (21.2)	540 (21.9)	.11
Malpresentation	472 (23.7)	1,121 (17.2)	801 (14.6)	357 (12.0)	225 (9.1)	<.01
Elective	175 (8.8)	508 (7.8)	389 (7.1)	225 (7.6)	222 (9.0)	.71
Hypertensive disease	48 (2.4)	174 (2.7)	207 (3.8)	108 (3.6)	118 (4.8)	<.01
Multiple gestation	41 (2.1)	180 (2.8)	148 (2.7)	44 (1.5)	30 (1.2)	<.01
Placenta previa or vasa previa	40 (2.0)	71 (1.1)	35 (0.6)	10 (0.3)	9 (0.4)	<.01
Failed induction	34 (1.7)	131 (2.0)	136 (2.5)	97 (3.3)	117 (4.8)	<.01
HIV, active herpes simplex virus lesions	30 (1.5)	63 (1.0)	38 (0.7)	18 (0.6)	12 (0.5)	<.01
Uterine scar	26 (1.3)	81 (1.2)	51 (0.9)	26 (0.9)	24 (1.0)	.07
Fetal indication or anomaly	24 (1.2)	81 (1.2)	58 (1.1)	44 (1.5)	40 (1.6)	.12
Placental abruption	19 (1.0)	37 (0.6)	14 (0.3)	5 (0.2)	6 (0.2)	<.01
Chorioamnionitis	14 (0.7)	58 (0.9)	45 (0.8)	40 (1.4)	17 (0.7)	.46
Macrosomia	11 (0.6)	108 (1.7)	159 (2.9)	124 (4.2)	146 (5.9)	<.01
Failed trial of forceps or vacuum	3 (0.2)	21 (0.3)	14 (0.3)	7 (0.2)	3 (0.1)	.36
Grouped Indications, per 100 cesarean delivery						<.01 <sup>b</sup>
Clinically indicated	40.3	43.0	42.5	38.8	37.1	
Mixed	43.6	42.0	43.0	46.2	48.3	
Truly elective <sup>c</sup>	16.1	15.0	14.5	15.0	14.6	

Abbreviations: NA, not available; HIV, human immunodeficiency virus

<sup>a</sup>P-value for percentage per 100 cesarean delivery; calculated by Cochran-Armitage trend test unless otherwise indicated.

<sup>b</sup>Chi-square test

<sup>c</sup>Elective indications include maternal request, multiparity, women desiring a tubal ligation, advanced maternal age, diabetes mellitus, human papilloma virus, postterm or postdates, pregnancy remote from term, group B streptococcus, polyhydramnios, fetal death, and social or religious concerns.

**Table 3**

Indications for primary cesarean delivery in multiparous women.

	Normal weight	Overweight	Obesity class I	Obesity class II	Obesity class III	P-value <sup>d</sup>
Total number of delivery (N=76,961)	11,164	29,362	21,019	9,473	5,943	NA
Total number of primary cesarean delivery (n=7,329)	719 (6.4)	2,130 (7.3)	2,121 (10.1)	1,257 (13.3)	1,102 (18.5)	NA
Indication for primary cesarean delivery, n (%)						NA
Failure to progress or cephalopelvic disproportion	104 (14.5)	433 (20.3)	484 (22.8)	342 (27.2)	279 (25.3)	<.01
Non-reassuring fetal heart tracing	169 (23.5)	493 (23.2)	501 (23.6)	286 (22.8)	262 (23.8)	0.93
Malpresentation	256 (35.6)	651 (30.6)	563 (26.5)	305 (24.3)	252 (22.9)	<.01
Elective	29 (4.0)	126 (5.9)	119 (5.6)	89 (7.1)	84 (7.6)	<.01
Hypertensive disease	13 (1.8)	30 (1.4)	63 (3.0)	46 (3.7)	38 (0.4)	<.01
Multiple gestation	12 (1.7)	115 (5.4)	110 (5.2)	61 (4.9)	38 (3.5)	.89
Placenta previa or vasa previa	38 (5.3)	101 (4.7)	58 (2.7)	20 (1.6)	11 (1.0)	<.01
Failed induction	2 (0.3)	10 (0.5)	14 (0.7)	12 (1.0)	25 (2.3)	<.01
HIV, active herpes simplex virus lesions	15 (2.1)	48 (2.3)	41 (1.9)	17 (1.4)	11 (1.0)	<.01
Uterine scar	11 (1.5)	35 (1.6)	34 (1.6)	16 (1.3)	10 (0.9)	0.12
Fetal indication or anomaly	9 (1.3)	38 (1.8)	41 (1.9)	31 (2.5)	24 (2.2)	0.08
Placental abruption	21 (2.9)	32 (1.5)	27 (1.3)	12 (1.0)	4 (0.4)	<.01
Chorioamnionitis	1 (0.1)	6 (0.3)	8 (0.4)	5 (0.4)	2 (0.2)	0.82
Macrosomia	5 (0.7)	36 (1.7)	87 (4.1)	64 (5.1)	92 (8.4)	<.01
Failed trial of forceps or vacuum	2 (0.3)	6 (0.3)	3 (0.1)	2 (0.2)	1 (0.1)	.20
Grouped Indications, percentage						.75 <sup>b</sup>
Clinically indicated	38.8	40.8	39.7	40.8	37.5	
Mixed	44.9	44.1	44.0	43.6	46.3	
Truly elective <sup>c</sup>	16.3	15.1	16.4	15.6	16.2	

Abbreviations: NA, not available; HIV, human immunodeficiency virus

<sup>a</sup>P-value for percentage per 100 cesarean delivery; calculated by Cochran-Armitage trend test unless otherwise indicated.

<sup>b</sup>Chi-square test

<sup>c</sup>Elective indications include maternal request, multiparity, women desiring a tubal ligation, advanced maternal age, diabetes mellitus, human papilloma virus, postterm or postdates, pregnancy remote from term, group B streptococcus, polyhydramnios, fetal death, and social or religious concerns.

Last recorded cervical dilation among women undergoing primary cesarean delivery for failure to progress or cephalopelvic disproportion.

**Table 4**

Cervical dilation	Nulliparous women							P-value <sup>a</sup>
	Total (n=8,427)	Normal weight (n=657)	Overweight (n=2,681)	Obesity class I (n=2,505)	Obesity class II (n=1,393)	Obesity class III (n=1,191)		
Full Dilation	1,816	174 (26.5)	710 (26.5)	561 (22.4)	241 (17.3)	130 (10.9)	<.01	
6-9 cm	2,509	203 (30.9)	820 (30.6)	815 (32.5)	383 (27.1)	293 (24.6)		
Less than 6 cm	3,531	231 (35.2)	983 (36.7)	984 (39.3)	656 (47.1)	677 (56.8)		
Not recorded	571	49 (7.5)	168 (6.3)	145 (5.8)	118 (8.5)	91 (7.6)		
Multiparous women								
Cervical dilation	Total (n=1,612)	Normal weight (n=99)	Overweight (n=425)	Obesity class I (n=477)	Obesity class II (n=336)	Obesity class III (n=275)	P-value <sup>a</sup>	
Full Dilation	302	14 (14.1)	100 (23.5)	92 (19.3)	55 (16.4)	41 (14.9)	.04	
6-9 cm	625	34 (34.3)	160 (37.7)	184 (38.6)	144 (42.9)	103 (37.5)		
Less than 6 cm	519	37 (37.4)	119 (28.0)	150 (31.5)	114 (33.9)	99 (36.0)		
Not recorded	166	14 (14.1)	46 (10.8)	51 (10.7)	23 (6.9)	32 (11.6)		

Numbers are shown as n (%).

<sup>a</sup> Chi-square test. Not recorded was excluded for the analysis. Women with unrecorded last cervical exam were excluded for the analysis.



Duration of second stage of labor among women with a primary cesarean delivery for arrest of descent.

Table 5

Duration (hours)	Nulliparous women							P-value <sup>a</sup>
	Total (n=1,816)	Normal weight (n=174)	Overweight (n=710)	Obesity class I (n=561)	Obesity class II (n=241)	Obesity class III (n=130)		
Less than 2	304 (16.7)	33 (19.0)	113 (15.9)	101 (18.0)	35 (14.5)	22 (16.9)		.47
2-2.9	409 (22.5)	45 (25.9)	154 (21.7)	119 (21.2)	58 (24.1)	33 (25.4)		
3-3.9	396 (21.8)	38 (21.8)	158 (22.3)	118 (21.0)	48 (19.9)	34 (26.2)		
4 or more	584 (32.2)	46 (26.4)	239 (33.7)	184 (32.8)	84 (34.9)	31 (23.9)		
Not recorded	123 (6.8)	12 (6.9)	46 (6.5)	39 (7.0)	16 (6.6)	10 (7.7)		
Multiparous women								
Duration (hours)	Total (n=302)	Normal weight (n=14)	Overweight (n=100)	Obesity class I (n=92)	Obesity class II (n=55)	Obesity class III (n=41)		P-value <sup>a</sup>
Less than 2	95 (31.5)	6 (42.9)	26 (26.0)	35 (38.0)	16 (29.1)	12 (29.3)		.76
2-2.9	81 (26.8)	5 (35.7)	31 (31.0)	18 (19.6)	16 (29.1)	11 (26.8)		
3-3.9	49 (16.2)	2 (14.3)	18 (18.0)	14 (15.2)	11 (20.0)	4 (9.8)		
4 or more	55 (18.2)	1 (7.1)	18 (18.0)	17 (18.5)	11 (20.0)	8 (19.5)		
Not recorded	22 (7.3)	0 (0.0)	7 (7.0)	8 (8.7)	1 (1.8)	6 (14.6)		

Numbers are shown as n (%)

<sup>a</sup>Chi-square test. Not recorded was excluded for the analysis. Women with unrecorded last cervical exam were excluded for the analysis.