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Non-medically indicated induction in morbidly obese women is not associated with an increased risk of cesarean delivery

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Abstract

Background—The prevalence of morbid obesity (body mass index [BMI] ≥ 40 kg/m² in women aged 20–39 years was 7.5% in 2009–2010. Morbid obesity is associated with an increased risk of stillbirth compared with normal BMI, especially after 39 weeks' gestation. The data regarding an increased risk of cesarean delivery associated with non-medically indicated induction of labor compared to expectant management in morbidly obese women are limited.

Objective—To compare the cesarean delivery rate of non-medically indicated induction of labor with expectant management in morbidly obese women without other comorbidity.

Study design—This was a retrospective cohort study from the Consortium on Safe Labor of morbidly obese women with singleton, cephalic gestations without previous cesarean, chronic hypertension, gestational and pregestational diabetes between 37 0/7 and 41 6/7 weeks' gestation. We examined maternal outcomes including cesarean delivery, operative delivery, third or fourth degree laceration, postpartum hemorrhage, and composite maternal outcome (any of transfusion, intensive care unit admission, venous thromboembolism). We also examined neonatal outcomes including shoulder dystocia, macrosomia (>4000 g), neonatal intensive care unit (NICU) admission, and composite neonatal outcome (5-min Apgar score <5 , stillbirth, neonatal death, or asphyxia or hypoxic–ischemic encephalopathy). Adjusted odds ratios (aOR) with 95% confidence intervals (95%CI) were calculated, controlling for maternal characteristics, hospital type, and

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simplified Bishop score. Analyses were conducted at early and full term (37 0/7-38 6/7 and 39 0/7-40 6/7 weeks' gestation, respectively). Women who delivered between 41 0/7 and 41 6/7 weeks' gestation were included as expectant management group.

Results—Of 1,894 nulliparous and 2,455 multiparous morbidly obese women, 429 (22.7%) and 791 (32.2%) had non-medically indicated induction, respectively. In nulliparas, non-medically indicated induction was not associated with increased risks of cesarean delivery and was associated with decreased risks of macrosomia (2.2% vs. 11.0%; aOR=0.24; 95%CI=0.05-0.70) at early term and decreased NICU admission (5.1% vs. 8.9%; aOR=0.59; 95%CI=0.33-0.98) at full term compared with expectant management. In multiparas, non-medically indicated induction compared with expectant management was associated with a decreased risk of macrosomia at early term (4.2% vs. 14.3%; aOR=0.30; 95%CI=0.13-0.60), cesarean delivery at full term (5.4% vs. 7.9%; aOR=0.64; 95%CI=0.41-0.98), and composite neonatal outcome (0% vs. 0.6%; aOR=0.10; 95%CI=<.01-0.89) at full term.

Conclusion—In morbidly obese women without other comorbidity, non-medically indicated induction was not associated with an increased risk of cesarean delivery.

Keywords

body mass index; composite neonatal morbidity; dinoprostone; expectant management; foley balloon catheter; macrosomia; misoprostol; morbid obesity; neonatal intensive care unit admission; non medically indicated induction of labor; stillbirth; spontaneous labor

Introduction

A third of women of reproductive age (20 to 39 years old) were obese (body mass index [BMI] ≥ 30 kg/m²) in 2011-2012.¹ Obese women have an increased risk of cesarean delivery even after adjusting for maternal comorbidities compared with normal weight women.^{2, 3} Considering the high rate of cesarean delivery and morbidities associated with cesarean delivery, the high prevalence of class II obesity (BMI 35-39.9 kg/m²; 17.2%) and class III obesity (morbid obesity; BMI ≥ 40 kg/m²; 7.5%) in women aged 20–39 years in 2009–2010 is concerning.⁴

Although obesity alone is not an indication for induction of labor,⁵ obesity is a risk factor for stillbirth.⁶ A recent study showed that BMI ≥ 40 kg/m² was associated with 3 fold increase in stillbirth compared with normal BMI, especially after 39 weeks' gestation.⁶ Obese women are also likely to have prolonged pregnancy, resulting in induction of labor.⁷

Women with morbid obesity have an increased risk of failure of induction (29%) compared with women of normal BMI (13%).⁸ Multiple observational studies of induction of labor in the general population showed an increased risk of cesarean delivery compared to spontaneous labor.⁹⁻¹³ Because women cannot choose to enter spontaneous labor, the ideal comparison group for labor induction is women undergoing expectant management. A previous retrospective study of obese women (BMI ≥ 30 kg/m²) showed elective induction of labor between 39 and 40 weeks was associated with an increased risk of cesarean delivery (40% vs. 26%) and neonatal intensive care unit (NICU) admission (18% vs. 6%) compared to expectant management.¹⁴ Data on the rate of cesarean delivery associated with non-

medically indicated induction of labor compared with expectant management in morbidly obese women are very limited. The primary aim of our study is to evaluate cesarean delivery rate associated with non-medically indicated induction of labor compared to expectant management in morbidly obese women without other comorbidities at term. We also analyzed severe maternal outcomes and neonatal outcomes as secondary outcomes.

Materials and Methods

This was a secondary analysis of data from the Consortium on Safe Labor (CSL), which was conducted between 2002 and 2008 (87% of births between 2005 and 2007) in 12 clinical centers with 19 hospitals across 9 ACOG districts.¹⁵ All participating institutions obtained Institutional Review Board (IRB) approval. IRB approval from MedStar IRB was obtained for this analysis.

After exclusion of 106 deliveries due to errors in identification, the CSL included 228,562 deliveries with 233,736 newborns delivered at 23 weeks of gestation. Data were extracted from the electronic medical record, including maternal characteristics, maternal antenatal medical history, labor and delivery outcomes, postpartum outcomes, and neonatal outcomes. Data were mapped to predefined codes at the data-coordinating center. The abstracted data of key variables were compared with the medical records. High concordance was noted between the abstracted data and the medical records (greater than 95% for 16 out of 20 variables and greater than or equal to 91.9% for all).¹⁵ We limited the current analysis to morbidly obese women (BMI ≥ 40 kg/m² at the time of admission to labor and delivery) with singleton gestations with cephalic presentation delivered between 37 0/7 and 41 6/7 weeks' gestation. Women delivering beyond 41 6/7 weeks' gestation were excluded because they were post term, which would have been an indication for induction. We excluded women with BMI <40 kg/m², history of previous cesarean delivery or uterine scar, congenital anomaly, chromosomal abnormalities, placenta accreta, placenta previa, human immunodeficiency virus, herpes simplex virus infection, cardiac disease, and unknown cervical exam at admission, which were all derived from the medical record. Cardiac disease was supplemented by International Classification of Disease, Ninth revision, Clinical Modification (ICD-9-CM: 390-398, 410-429, 648.5, 648.6). We also excluded women who had scheduled non-medically indicated cesarean delivery. Because expectant management may not be recommended when pregnancy is complicated by medical comorbidities, we generated the low risk cohort by excluding all women with chronic maternal medical conditions that may necessitate induction of labor, including chronic hypertension, gestational and pregestational diabetes mellitus. Because expectant management itself (continuing to be pregnant) is a risk for development of pregnancy associated hypertensive disease (gestational hypertension, preeclampsia, hemolysis, elevated liver enzyme, low platelet [HELLP], and eclampsia) or fetal compromise, these women were retained in the cohort.

Non-medically indicated inductions of labor were defined as following: 1) indication for induction was recorded as elective or no indication was recorded and there were no pregnancy conditions that necessitated induction, including premature rupture of membranes, pregnancy related hypertensive disease, fetal condition (such as fetal growth

restriction or abnormal antenatal testing), and abruption; 2) indication for induction was recorded as post dates or post term with no other indications listed but before 41 weeks' gestation and there were no pregnancy conditions.¹⁶ We compared non-medically induced women with women who were expectantly managed (those who did not have non-medically indicated induction) at early term (between 37 0/7 and 38 6/7 weeks' gestation) and full term (between 39 0/7 and 40 6/7 weeks' gestation) after stratifying by parity.¹⁷ Women who delivered between 41 0/7 and 41 6/7 weeks' gestation were included as expectant management group. Induction of labor beyond 41 0/7 weeks' gestation was not examined in this analysis. The expectant management group included women who subsequently went on to have spontaneous labor or indicated induction/cesarean delivery for a complication (e.g. development of preeclampsia or non-reassuring fetal status) or a non-medically indicated induction at a later gestational age. For example, the expectant management group at early term included women who underwent spontaneous labor at early term or full term, indicated induction of labor or cesarean delivery at early term or full term, and non-medically indicated induction at full term.

Maternal age, race/ethnicity, insurance, marital status, BMI (kg/m²), pregnancy associated hypertensive disease and birth weight were examined at early term and full term according to parity. Simplified Bishop score including cervical dilation, effacement, and station were evaluated at admission.¹⁸ Unfavorable cervix was defined as simplified Bishop score ≤ 4 , which has similar sensitivity and specificity to the original Bishop score ≤ 6 .¹⁸

We examined cesarean delivery rate as well as other maternal outcomes including operative delivery, third or fourth degree laceration, postpartum hemorrhage, hysterectomy, maternal death, and composite maternal outcome. Composite maternal outcome was defined as any of the following: transfusion, intensive care unit admission, or venous thromboembolism (deep venous thrombosis and pulmonary embolism). We also examined neonatal outcomes including shoulder dystocia, macrosomia (birth weight >4000 g), neonatal intensive care unit (NICU) admission, and composite neonatal outcome. Composite neonatal outcome was defined as any of the following: 5-minute Apgar score less than 5, stillbirth, neonatal death, or the clinical diagnoses of asphyxia or hypoxic-ischemic encephalopathy. Maternal and neonatal outcomes were derived from medical record. Postpartum hemorrhage was defined as recorded in the medical record by an estimated blood loss greater than 500 ml for vaginal delivery and greater than 1,000 ml for cesarean delivery. Maternal and neonatal outcomes were compared between non-medically indicated induction and expectant management at early term and full term.

Descriptive statistics were calculated for all study variables. Chi-square test, Fisher's exact test, or Wilcoxon rank-sum test were performed. A P-value $<.05$ was considered significant. Multivariable logistic regression models were performed to calculate adjusted odds ratios (aOR) with corresponding 95% confidence intervals (95% CI), controlling for maternal age, race/ethnicity, marital status, insurance type, hospital type, body mass index (kg/m²) at admission, and simplified Bishop score (expectant management group as referent). Firth's penalized maximum likelihood estimation was applied to remedy the problem of rare events in our logistic regression models.¹⁹ Post hoc power analysis to detect 2-fold increase in

cesarean delivery rate with alpha of 0.05 was performed. All statistical analyses were performed using SAS 9.4 (SAS Institute Inc., Cary, NC).

Results

Our study included 1,894 nulliparous and 2,455 multiparous morbidly obese women (Figure S1 and Figure S2). Of 1,801 nulliparous women who underwent expectant management at early term, 173 women (9.6%) underwent medically indicated induction of labor. Of 1,073 nulliparous women who underwent expectant management at full term, 257 women (24.0%) underwent medically indicated induction of labor. Of 2,289 multiparous women who underwent expectant management at early term, 160 women (6.7%) underwent medically indicated induction of labor. Of 1,053 multiparous women who underwent expectant management at full term, 156 women (14.8%) underwent medically indicated induction of labor. Demographic data of nulliparous women are presented in Table 1. There were 93 and 336 nulliparous women who underwent non-medically indicated induction of labor at early and full term, respectively. Nulliparous women undergoing non-medically indicated induction of labor at early term were more likely to be younger gestational age, non-Hispanic black, have lower birth weight, and an unfavorable cervix compared with nulliparous women who underwent expectant management ($P < .01$). Nulliparous women undergoing non-medically indicated induction of labor at full term were more likely to be younger gestational age and less likely to have private insurance, and a favorable cervix compared with nulliparous women who underwent expectant management ($P < .01$). Demographic data of multiparous women are presented in Table 2. There were 166 and 625 multiparous women who underwent non-medically indicated induction of labor at early and full term, respectively. Multiparous women undergoing non-medically indicated induction of labor at early term were more likely to be older ($P = .03$), younger gestational age, have lower birth weight, and less likely to have a favorable cervix compared with multiparous women who underwent expectant management ($P < .01$ except age). Multiparous women undergoing non-medically indicated induction of labor at full term were more likely to be older ($P = .03$), younger gestational age, lower BMI category ($P = .03$), non-Hispanic white, and married, and less likely to have public insurance, and a favorable cervix compared with multiparous women who underwent expectant management ($P < .01$ except age and BMI category).

Maternal and neonatal outcomes of nulliparous women are presented in Table 3. Non-medically indicated induction of labor both at early and full term was not associated with increased risk of cesarean delivery compared with expectant management. Maternal complications of non-medically indicated induction of labor were comparable to those of expectant management. There was no hysterectomy or maternal death in this cohort. Non-medically indicated induction of labor compared with expectant management was associated with decreased risks of macrosomia (2.2% vs. 11.0%; $aOR = 0.24$; 95% $CI = 0.05-0.70$) at early term and decreased NICU admission (5.1% vs. 8.9%; $aOR = 0.59$; 95% $CI = 0.33-0.98$) at full term. Other neonatal outcomes of non-medically indicated induction of labor were comparable to those of expectant management.

Maternal outcomes of multiparous women are presented in Table 4. In multiparous women, non-medically indicated induction of labor both at early term was not associated with an

increased risk of cesarean delivery compared with expectant management. In multiparous women, non-medically indicated induction of labor at full term was associated with a decreased risk of cesarean delivery (5.4% v.s 7.9%; aOR=0.64; 95%CI=0.41-0.98) compared with expectant management. Maternal complications of non-medically indicated induction of labor were comparable to those of expectant management. There was no hysterectomy or maternal death. Non-medically indicated induction of labor compared with expectant management was associated with decreased risks of macrosomia (4.2% vs. 14.3%; aOR=0.30; 95%CI=0.13-0.60) at early term, and composite neonatal outcome (0% vs. 0.6%; aOR=0.10; 95%CI=<.01-0.89) at full term. Out of six women with the composite neonatal outcome in the expectant management group at full term, there were 2 stillbirths and 1 neonatal death. However, the number was not large enough to analyze each outcome separately. Other neonatal complications of non-medically indicated induction of labor were also comparable to those of expectant management.

Post hoc power analysis showed that to detect a 2-fold increase in the cesarean delivery rate with an alpha of 0.05, the power was 66.1%, 94.4%, 74.7%, and 96.8% in early term nulliparas, full term nulliparas, early term multiparas, and full term multiparas, respectively.

Comment

Principal findings

In this multi-institutional retrospective cohort study of morbidly obese women without chronic hypertension, gestational and pregestational diabetes mellitus, we found that non-medically indicated induction of labor at early and full term was not associated with an increased risk of cesarean delivery compared with expectant management in nulliparous women. In multiparous women, non-medically indicated induction of labor at full term was associated with a decreased risk of cesarean delivery compared with expectant management. Non-medically indicated induction of labor at full term compared to expectant management was associated with decreased risks of NICU admission in nulliparous women and composite neonatal outcome in multiparous women.

Meaning of the study

Previous studies comparing induction of labor with spontaneous labor in the general population showed an increased risk of cesarean delivery associated with induction of labor.⁹⁻¹³ However, recent studies showed that induction of labor compared with expectant management did not show an increased risk of cesarean delivery in the general population.^{20, 21, 22} In obese women, data regarding the association between cesarean delivery and non-medically indicated induction of labor are conflicting.^{14, 23} Wolfe et al. in 2014 conducted a retrospective study of 410 obese nulliparous women (BMI ≥ 30 kg/m²) with an unfavorable cervix, which showed elective induction of labor between 39 and 40 weeks' gestation was associated with an increased risk of cesarean delivery compared with expectant management.¹⁴ However, Lee et al in 2015 conducted a retrospective study of 74,725 obese women (BMI ≥ 30 kg/m²) using an administrative database, which showed elective induction of labor at 39 weeks' gestation was associated with a decreased risk of cesarean delivery compared with expectant management in both nulliparous and

At that time, the definition of active phase was reaching a cervical dilation of 4 cm. Therefore, the cesarean delivery rate may be lower with current labor management in both women undergoing non-medically indicated induction and expectant management. Finally, we assumed that induction was non-medically indicated if a woman did not have any pregnancy conditions that necessitated induction, which may have lead to misclassification.

Proposals for future research

In conclusion, non-medically indicated induction of labor at early term and full term was not associated with increased risk of cesarean delivery compared with expectant management in morbidly obese nulliparous and multiparous women. Given that morbid obesity is a risk factor for stillbirth, a prospective study that compares the maternal outcomes including the cesarean delivery rate, perinatal mortality (stillbirths and neonatal deaths) and neonatal morbidity between non-medically indicated induction and expectant management would be useful.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Demographic and obstetric characteristics of nulliparous women.

	Early term			Full term		
	Non-medically indicated induction (N=93)	Expectant management (N=1801)	P-value	Non-medically indicated induction (N=336)	Expectant management (N=1073)	P-value
Age (yr)	24.7 ± 5.5	24.0 ± 5.1	.20	24.4 ± 5.2	23.8 ± 5.2	.05
Gestational age (weeks)	38.3 (37.3 to 38.9)	39.7 (38.0 to 41.0)	<.01	40.0 (39.0 to 40.7)	40.0 (39.0 to 41.0)	<.01
BMI (kg/m ²)			.10			.55
40-49.9	86 (92.5)	1595 (88.6)		303 (90.2)	952 (88.7)	
50-59.9	5 (5.4)	191 (10.6)		32 (9.5)	111 (10.3)	
60 or greater	2 (2.2)	15 (0.8)		1 (0.3)	10 (0.9)	
Birth weight (gram)	3219.7 ± 384.3	3444.5 ± 464.4	<.01	3505.4 ± 405.0	3510.2 ± 457.7	.85
Race/ethnicity			<.01			.51
Non-Hispanic white	28 (30.1)	848 (47.1)		155 (46.1)	501 (46.7)	
Non-Hispanic black	43 (46.2)	560 (31.1)		111 (33.0)	332 (30.9)	
Hispanic	19 (20.4)	256 (14.2)		50 (14.9)	151 (14.1)	
Other, unknown	3 (3.2)	137 (7.6)		20 (6.0)	89 (8.3)	
Married (n:91, 1756, 333, 1036) *	35 (38.5)	722 (41.1)	.66	148 (44.4)	396 (38.2)	.05
Health insurance			.60			<.01
Private	46 (49.5)	946 (52.5)		151 (44.9)	574 (53.5)	
Public, self-pay, unknown	47 (50.5)	855 (47.5)		185 (55.1)	499 (46.5)	
Nonmedically indicated induction of labor	93 (100)	336 (18.7)	<.01	336 (100)	0 (0)	<.01
Simplified Bishop	3 (1 to 6)	5 (2 to 7)	<.01	4 (2 to 7)	5 (2 to 7)	<.01
Simplified Bishop score 4	58 (62.4)	784 (43.5)	<.01	174 (51.8)	426 (39.7)	<.01

Abbreviation: body mass index (BMI)

Data shown as mean ± standard deviation, n (%), or median (10th to 90th percentile)

Significant findings are Bolded.

* due to missing number

Table 2

Demographic and obstetric characteristics of multiparous women.

	Early term		Full term			
	Non-medically indicated induction (N=166)	Expectant management (N=2289)	P-value	Non-medically indicated induction (N=625)	Expectant management (N=1053)	P-value
Age (yr)	28.8 ± 4.6	27.9 ± 5.1	.03	28.3 ± 5.1	27.7 ± 5.2	.03
Gestational age (weeks)	38.4 (37.6 to 38.9)	39.3 (38.0 to 40.7)	<.01	39.4 (39.0 to 40.4)	40.0 (39.0 to 41.0)	<.01
BMI (kg/m ²)			.74			.03
40-49.9	152 (91.6)	2073 (90.6)		579 (92.6)	944 (89.7)	
50-59.9	12 (7.2)	194 (8.5)		37 (5.9)	99 (9.4)	
60 or greater	2 (1.2)	22 (1.0)		9 (1.4)	10 (0.9)	
Birth weight (gram)	3335.1 ± 362.4	3500.5 ± 460.5	<.01	3565.7 ± 418.3	3574.8 ± 451.8	.67
Race/ethnicity			.28			<.01
Non-Hispanic white	65 (39.2)	1028 (44.9)		344 (55.0)	379 (36.0)	
Non-Hispanic black	62 (37.3)	708 (30.9)		144 (23.0)	385 (36.6)	
Hispanic	30 (18.1)	389 (17.0)		91 (14.6)	197 (18.7)	
Other, unknown	9 (5.4)	164 (7.2)		46 (7.4)	92 (8.7)	
Married (n: 150, 2198, 612, 999) *	79 (52.7)	1231 (56.0)	.45	427 (69.8)	464 (46.4)	<.01
Health insurance			.81			<.01
Private	81 (48.8)	1142 (49.9)		363 (58.1)	474 (45.0)	
Public, self-pay, unknown	85 (51.2)	1147 (50.1)		262 (41.9)	579 (55.0)	
Nonmedically indicated induction of labor	166 (100)	625 (27.3)	<.01	625 (100)	0 (0)	<.01
Simplified Bishop	4 (2 to 6)	5 (2 to 8)	<.01	5 (2 to 7)	6 (3 to 8)	<.01
Simplified Bishop score	108 (65.1)	853 (37.3)	<.01	312 (49.9)	330 (31.3)	<.01

Abbreviation: body mass index (BMI)

Data shown as mean ± standard deviation, n (%), or median (10th to 90th percentile)

Significant findings are Bolded.

* due to missing number

Table 3

Maternal and neonatal outcomes of non-medically indicated induction of labor compared with expectant management in nulliparous women.

	Non-medically indicated Induction, n (%)	Expectant management, n (%) (ref)	Adjusted OR (95%CI)
Early term	N=93	N=1801	
Cesarean delivery	40 (43.0)	613 (34.0)	1.26 (0.81-1.96)
Operative delivery	5 (5.4)	124 (6.9)	1.22 (0.44-2.75)
Third or fourth degree laceration (n=53, n=1118) *	1 (1.9)	76 (6.4)	0.45 (0.05-1.72)
Postpartum hemorrhage	3 (3.2)	92 (5.1)	0.72 (0.20-1.89)
Composite maternal outcome (n=71, n=1350) *	1 (1.4)	56 (4.2)	0.86 (0.10-3.41)
Shoulder dystocia	1 (1.1)	38 (2.1)	0.68 (0.08-2.65)
Macrosomia (n=92, n=1789) *	2 (2.2)	197 (11.0)	0.24 (0.05-0.70)
NICU	4 (4.3)	150 (8.3)	0.50 (0.16-1.19)
Composite neonatal outcome (n=93, n=1795)	1 (1.1)	15 (0.8)	2.73 (0.29-12.16)
Full term	N=336	N=1073	
Cesarean delivery	128 (38.1)	368 (34.3)	1.06 (0.81-1.39)
Operative delivery	21 (6.3)	77 (7.2)	0.85 (0.50-1.39)
Third or fourth degree laceration (n=208, n=705) *	13 (6.3)	51 (7.2)	0.83 (0.43-1.52)
Postpartum hemorrhage	15 (4.5)	55 (5.1)	0.91 (0.49-1.60)
Composite maternal outcome (n=266, n=777) *	6 (2.3)	36 (4.6)	0.53 (0.21-1.19)
Shoulder dystocia	5 (1.5)	23 (2.1)	0.78 (0.27-1.89)
Macrosomia (n=332, n=1069) *	34 (10.2)	144 (13.5)	0.73 (0.48-1.08)
NICU	17 (5.1)	95 (8.9)	0.59 (0.33-0.98)
Composite neonatal outcome (n=335, n=1068)	2 (0.6)	10 (0.9)	0.85 (0.16-3.09)

Abbreviation: Odds ratio (OR); confidence interval (CI), neonatal intensive care unit (NICU)

Composite maternal outcome was defined as: transfusion, intensive care unit admission, venous thromboembolism (deep venous thrombosis and pulmonary embolism).

Composite neonatal outcome was defined as: 5-minute Apgar score less than 5, neonatal death, or the clinical diagnoses of asphyxia or hypoxic-ischemic encephalopathy.

Models were adjusted for maternal age, race/ethnicity, marital status, insurance type, hospital type, body mass index (kg/m²), and simplified Bishop at admission.

Significant findings are Bolded.

* due to missing number

Table 4

Maternal and neonatal outcomes of non-medically indicated induction of labor compared with expectant management in multiparous women.

	Non-medically indicated Induction, n (%)	Expectant management, n (%) (ref)	Adjusted OR (95%CI)
Early term	N=166	N=2289	
Cesarean delivery	14 (8.4)	154 (6.7)	0.87 (0.47-1.51)
Operative delivery	4 (2.4)	73 (3.2)	0.92 (0.30-2.21)
Third or fourth degree laceration (n=152, n=2135) *	0 (0)	9 (0.4)	0.71 (0.01-5.84)
Postpartum hemorrhage	3 (1.8)	81 (3.5)	0.58 (0.16-1.50)
Composite maternal outcome (n=137, n=1790) *	7 (5.1)	68 (3.8)	2.30 (0.94-4.94)
Shoulder dystocia	2 (1.2)	56 (2.4)	0.60 (0.12-1.81)
Macrosomia (n=166, n=2287) *	7 (4.2)	328 (14.3)	0.30 (0.13-0.60)
NICU	6 (3.6)	105 (4.6)	0.80 (0.32-1.68)
Composite neonatal outcome (n=165, n=2285)	1 (0.6)	10 (0.4)	1.65 (0.17-7.40)
Full term	N=625	N=1053	
Cesarean delivery	34 (5.4)	83 (7.9)	0.64 (0.41-0.98)
Operative delivery	23 (3.7)	31 (2.9)	0.99 (0.54-1.78)
Third or fourth degree laceration (n=541, n=970) *	5 (0.8)	2 (0.2)	3.96 (0.89-23.47)
Postpartum hemorrhage	20 (3.2)	45 (4.3)	0.85 (0.47-1.50)
Composite maternal outcome (n=541, n=751) *	24 (4.4)	26 (3.5)	1.04 (0.55-1.96)
Shoulder dystocia	15 (2.4)	31 (2.9)	0.78 (0.39-1.48)
Macrosomia (n=624, n=1039) *	107 (17.2)	178 (16.9)	0.89 (0.67-1.19)
NICU	18 (2.9)	51 (4.8)	0.62 (0.34-1.08)
Composite neonatal outcome (n=637, n=1050)	0 (0)	6 (0.6)	0.10 (<0.01-0.89)

Abbreviation: Odds ratio (OR); confidence interval (CI), neonatal intensive care unit (NICU)

Composite maternal outcome was defined as: transfusion, intensive care unit admission, venous thromboembolism (deep venous thrombosis and pulmonary embolism).

Composite neonatal outcome was defined as: 5-minute Apgar score less than 5, neonatal death, or the clinical diagnoses of asphyxia or hypoxic-ischemic encephalopathy.

Models were adjusted for maternal age, race/ethnicity, marital status, insurance type, hospital type, body mass index (kg/m²), and simplified Bishop at admission.

Significant findings are Bolded.

* due to missing number