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Racial and Ethnic Differences in Utilization of Labor Management Strategies Intended to Reduce Cesarean Delivery Rates

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Abstract

Objective—To examine whether racial and ethnic differences exist in the frequency of and indications for cesarean delivery and to assess whether application of labor management strategies intended to reduce cesarean delivery rates is associated with patient's race and ethnicity.

Methods—This is a secondary analysis of a multicenter observational obstetric cohort. Trained research personnel abstracted maternal and neonatal records of >115,000 pregnant women from 25 hospitals (2008–2011). Term women with singleton, nonanomalous, vertex, liveborn neonates were included in two cohorts: 1) nulliparous women (n=35,529) and 2) multiparous women with

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prior vaginal deliveries only (n=39,871). Women were grouped as non-Hispanic black, non-Hispanic white, Hispanic, and Asian. Multivariable logistic regression was used to evaluate the following outcomes: overall cesarean delivery frequency, indications for cesarean delivery, and utilization of labor management strategies intended to safely reduce cesarean delivery.

Results—A total of 75,400 women were eligible for inclusion, of whom 47% (N=35,529) were in the nulliparous cohort and 53% (N=39,871) in the multiparous cohort. The frequencies of cesarean delivery were 25.8% among nulliparous women and 6.0% among multiparous women. For nulliparous women, the unadjusted cesarean frequencies were 25.0%, 28.3%, 28.7%, and 24.0% for non-Hispanic white, non-Hispanic black, Asian, and Hispanic women, respectively. Among nulliparous women, the adjusted odds of cesarean were higher in all racial and ethnic groups compared with non-Hispanic white women (non-Hispanic black aOR 1.47, 95% CI 1.36–1.59; Asian aOR 1.26, 95% CI 1.14–1.40; Hispanic aOR 1.17, 95% CI 1.07–1.27), due to greater odds of cesarean delivery both for nonreassuring fetal status and labor dystocia. Nonapplication of labor management strategies regarding failed induction, arrest of dilation, arrest of descent, or cervical ripening did not contribute to increased odds of cesarean delivery for non-Hispanic black and Hispanic women. Compared with non-Hispanic white, Hispanic women were actually less likely to experience elective cesarean (aOR 0.60, 95% CI 0.42–0.87) or cesarean for arrest of dilation prior to 4 hours (aOR 0.67, 95% CI 0.49–0.92). Additionally, compared with non-Hispanic white, Asian women were more likely to experience cesarean for nonreassuring fetal status (aOR 1.29, 95% CI 1.09–1.53) and to have had that cesarean be performed in the setting of a 1-minute Apgar score ≤ 7 (aOR 1.79, 95% CI 1.07–3.00). A similar trend was seen among multiparous women with prior vaginal deliveries.

Conclusions—Although racial and ethnic disparities exist in the frequency of cesarean delivery, differential use of labor management strategies intended to reduce the cesarean delivery rate does not appear to be associated with these racial–ethnic disparities.

INTRODUCTION

In 2012, the Society for Maternal-Fetal Medicine (SMFM), Eunice Kennedy Shriver National Institute of Child Health and Human Development, and American College of Obstetricians and Gynecologists (the College) convened to review evidence for labor management strategies designed to safely reduce the rate of cesarean delivery.¹ This was followed by publication of Obstetric Care Consensus on prevention of primary cesarean delivery, which included guidelines regarding labor management best practices.²

Although the evidence for labor management best practices should be applied similarly to women of different races and ethnicities, disparities in obstetric care exist.^{3–6} *Health disparities*, or systematic differences in health status that “negatively impact less advantaged groups”⁷, exist in many aspects of maternal and neonatal morbidity and mortality.^{3–6} For example, non-Hispanic black women experience greater cesarean frequency than non-Hispanic white women, even after adjusting for risk factors.^{3,8–12} *Health care disparities* are differences in quality of care received by individuals in particular groups even when factors such as preferences and access are similar.¹³ Several racial and ethnic disparities in obstetrical care have been identified, including for labor induction, delayed pushing, and

analgesia use.^{3,14,15} However, it is unknown whether care disparities explain the racial and ethnic disparity in cesarean delivery frequency.^{3,16}

Achieving health equity requires understanding determinants of disparities.^{17,18} As reasons for the cesarean delivery disparity among minority women remain poorly characterized, we evaluated whether evidence regarding the safe promotion of vaginal delivery was applied differently based on maternal race and ethnicity. Our objectives were to examine whether racial and ethnic differences exist in the frequency of and indications for cesarean delivery, and determine whether these differences may be explained by disparities in the application of labor management strategies intended to reduce the frequency of cesarean deliveries.²

MATERIALS AND METHODS

This is a secondary analysis of the Assessment of Perinatal Excellence (APEX) study, a large, multicenter observational study performed at 25 hospitals in the United States. APEX methodology has been previously reported.^{19,20} The APEX cohort consisted of 115,502 women and their neonates who delivered at participating hospitals from 2008 to 2011. Study patients represented a diverse sample of sociodemographic characteristics and were sampled according to plans designed to avoid overrepresentation of patients from larger hospitals. Accoucheurs included general obstetricians, family medicine physicians, midwives, and maternal-fetal medicine physicians.^{19,20} Clinical data for patients who were at least 23 weeks of gestation and who had arrived at the hospital with a live fetus were collected by trained research personnel at each site. Maternal characteristics, details of the medical and obstetric history, intrapartum care, obstetric outcome, and indications for operative procedures were collected. Maternal race and ethnicity as reported in the chart were abstracted from the medical record. Institutional review board approval was obtained from all participating centers under a waiver of informed consent.

For this analysis, we analyzed two cohorts comprised of term, singleton, nonanomalous, vertex, liveborn neonates. The first cohort consisted of nulliparous women. The second cohort was composed of multiparous women with prior vaginal deliveries only. In both cohorts, women who were ineligible for vaginal deliveries (placenta previa, placenta accreta, prior cavity-entering myomectomy or classical cesarean delivery, active herpes infection) were excluded.

We first evaluated the frequencies of, and indications for, cesarean delivery. The indications assessed included non-reassuring fetal status, labor dystocia (inclusive of arrest of dilation, arrest of descent, or failed induction of labor), suspected macrosomia, elective, and “other” reasons (such as abruption or maternal medical complications).

In the nulliparous cohort, utilization of strategies intended to promote vaginal delivery was then evaluated using the College and SMFM Consensus² as a framework to guide the labor management strategies analyzed. Although the Consensus² was published after the APEX data accrual period, the evidence for these guidelines was accumulated before and during the APEX period. First, for failed induction of labor, we assessed the proportion of women who underwent cesarean performed for a diagnosis of failed induction prior to 5cm cervical

dilation and prior to 12 hours of oxytocin and rupture of membranes (whichever came last).^{2,21–23} We additionally assessed the proportion of women with unfavorable cervical exam (modified Bishop score <5) who underwent labor induction without cervical ripening compared with those undergoing induction with cervical ripening.^{2,24,25} For arrest of dilation, we assessed the proportion of women whose cesarean for an indication of arrest of labor was performed prior to 4 hours of labor dystocia after reaching 5cm cervical dilation with ruptured membranes.^{2,26–28} Determination of labor dystocia with regard to uterine activity was made by individual providers; APEX does not have information about uterine activity. For both failed induction and arrest of dilation, 5cm was chosen for this analysis because of availability of this landmark in the APEX database and prior use of 5cm in the diagnosis of failed labor induction.²² For arrest of descent, we assessed the proportion of women undergoing cesarean delivery for an indication of arrest of descent prior to 3 hours in the second stage.^{2,29–31} Finally, given that there is no standard to know whether the diagnosis of non-reassuring status (NRFS) was differentially applied, we examined the proportion of women who underwent cesarean for an indication of NRFS with a 1-minute Apgar score of ≤ 7 . Due to smaller sample sizes, we were not able to evaluate utilization of all these different labor management strategies in the multiparous cohort.

The outcomes that incorporate time were also evaluated as continuous variables: duration of induction prior to diagnosis of a failed induction (as defined above); duration of active labor prior to a diagnosis of arrest of dilation (length of time from 5cm until decision for cesarean delivery); and duration of second stage prior to diagnosis of arrest of descent (length of time from complete dilation until decision for cesarean delivery).

The Kruskal-Wallis test for continuous variables and the chi-square test for categorical variables were used to describe baseline demographic and clinical characteristics by maternal race and ethnicity. Multivariable logistic regression was used to evaluate binomial outcomes (cesarean delivery, adherence to failed induction guideline, adherence to cervical ripening guideline, adherence to arrest of dilation guideline, adherence to arrest of descent guideline, cesarean performed for NRFS with 1-minute Apgar ≤ 7 , and the composite). Multivariable multinomial logistic regression was used to evaluate indication for cesarean delivery, an outcome with more than two categories. The continuous outcomes were evaluated using comparisons of least squares means based on multivariable linear regression. All models were adjusted for age, body mass index, gestational age at delivery, diabetes, smoking, chorioamnionitis, and gestational hypertension or preeclampsia. Due to equipoise regarding whether payer status was in the causal pathway between maternal race and cesarean delivery rates, a secondary analysis was performed with insurance status included in the regression. Hospital was also included in the models as a fixed effect. Imputation for missing data was not performed. SAS software (SAS Institute, Cary, NC) was used for the analyses. All tests were two-tailed and a p-value of <0.05 was used to define statistical significance.

RESULTS

A total of 75,400 women were eligible for inclusion, of whom 47% (N=35,529) were in the nulliparous cohort and 53% (N=39,871) in the multiparous cohort. The majority of hospitals

were teaching hospitals (22/25, 88%). Of the 35,529 women eligible for analysis in the nulliparous cohort, 25.8% (9,156) underwent cesarean delivery (Table 1). There were a number of differences in demographic and clinical characteristics between racial and ethnic groups. Non-Hispanic black and Hispanic women were more likely to have government-assisted insurance and non-Hispanic white women were more likely to smoke. Asian women were more likely to have gestational diabetes mellitus, whereas non-Hispanic black women were more likely to have pre-gestational diabetes mellitus, chronic hypertension, or gestational hypertension or preeclampsia.

In the nulliparous cohort, the cesarean delivery frequencies were 25.0%, 28.3%, 28.7%, and 24.0% for non-Hispanic white, non-Hispanic black, Asian, and Hispanic women, respectively (Table 2). When adjusting for patient characteristics and hospital, the odds of cesarean delivery were higher in all racial and ethnic minority groups compared with non-Hispanic white women. This finding was related to both a greater odds of cesarean delivery for NRFS and labor dystocia (inclusive of arrest of dilation, arrest of descent and failed induction) in all racial and ethnic groups compared with non-Hispanic white women. Notably, non-Hispanic black women had a two-fold increase in odds of cesarean delivery for NRFS (aOR 2.39, 95% CI 2.13–2.69) compared with non-Hispanic white women. Conversely, non-Hispanic black (aOR 0.49, 95% CI 0.34–0.72) and Asian (aOR 0.48, 95% CI 0.28–0.81) women experienced lower odds of cesarean for suspected macrosomia, and Hispanic women experienced lower odds of elective cesarean delivery (aOR 0.60, 95% CI 0.42–0.87), compared with non-Hispanic white women.

Among the 39,871 multiparous women with prior vaginal deliveries only, the overall frequency of cesarean delivery was 6.0%. The frequencies of cesarean delivery were 4.9%, 8.4%, 5.8%, and 6.0%, for non-Hispanic white, non-Hispanic black, Asian, and Hispanic women, respectively (Table 3). Non-Hispanic black women experienced greater odds of cesarean delivery overall (aOR 1.51, 95% CI 1.33–1.70), mainly attributed to increased odds of cesarean for NRFS and labor dystocia compared with non-Hispanic white women. Hispanic women had higher odds of having cesarean for NRFS and labor dystocia compared with non-Hispanic white women. In contrast, non-Hispanic black and Asian women experienced lower odds of cesarean for suspected macrosomia, and non-Hispanic black and Hispanic women experienced lower odds of elective cesarean.

Nevertheless, women with racial and ethnic minority status did not experience higher frequencies of cesarean delivery secondary to differential application of labor management strategies or adherence to professional societies' guidelines for preventing cesarean delivery (Table 4). Specifically, over three-quarters of women who had a cesarean performed for failed induction had that cesarean performed prior to 12 hours of oxytocin and ruptured membranes, approximately 20% of women undergoing labor induction with an unfavorable cervix did not receive cervical ripening, and over half of women who underwent cesarean delivery for arrest of descent were delivered prior to 3 hours in the second stage. Yet, the odds of these occurrences were similar across all racial and ethnic groups. Also, approximately one quarter of all women who underwent cesarean delivery for arrest of dilation were delivered prior to 4 hours of labor dystocia, although Hispanic women actually had decreased odds compared with non-Hispanic white women (aOR 0.67, 95% CI 0.49–

0.92). Finally, in all racial and ethnic groups, over three-quarters of women experiencing cesarean delivery for NRFS had a neonate with a 1-minute Apgar score ≥ 7 ; however, Asian women were at increased odds of this scenario (aOR 1.79, 95% CI 1.07–3.00). The composite outcome (comprised of each of the above scenarios) did not differ by race and ethnicity.

The evaluation of continuous outcomes also could not explain the racial and ethnic differences in cesarean frequencies among the specific denominators. There were no differences in adjusted mean hours from oxytocin or rupture of membranes (whichever came last) to cesarean decision for failed induction by maternal race and ethnicity. Non-Hispanic black, Hispanic, and Asian women who reached 5cm cervical dilation remained pregnant for greater number of hours after 5 cm dilation and before a decision was made to proceed with cesarean decision for arrest of dilation compared with non-Hispanic white women (Table 5). In contrast, Asian women had a lower adjusted mean number of hours in the second stage prior to cesarean decision, although this finding does not fully explain the higher rate of cesarean delivery among Asian women, given the non-significant association between cesarean delivery for arrest of descent prior to 3 hours of the second stage and Asian race in categorical analyses.

Finally, all models were performed with inclusion of insurance status in the regression. Inclusion of insurance status in the regression equations did not materially alter any results (data not shown). Specifically, inclusion of insurance status in the model did not alter the significance of any findings for nulliparous women, including indications for cesarean delivery, the application of labor management strategies for preventing cesarean delivery, or the duration of time until cesarean delivery. However, for multiparous women with prior vaginal deliveries, the inclusion of insurance status in the model resulted in no association between Hispanic ethnicity and cesarean for NRFS (aOR 1.21, 95% CI 0.94–1.55) or elective cesarean (aOR 0.73, 95% CI 0.48–1.12); no other differences were identified for women in other racial and ethnic groups.

DISCUSSION

Our data showed that non-Hispanic black, Asian, and Hispanic women all experience greater likelihood of cesarean delivery than non-Hispanic white women, even after accounting for socio-demographic and clinical differences, and that indications for cesarean delivery vary by maternal race and ethnicity. However, we did not identify differences in care provision by maternal race and ethnicity. Notably, among nulliparous women, the differential odds of cesarean could not be traced to differential application of guidelines for failed induction of labor, arrest of dilation, arrest of descent, NRFS, or cervical ripening.

Understanding sources of disparities is essential to promoting equity in health care delivery. We designed this investigation to determine whether women of racial and ethnic minority status were more likely to experience cesarean delivery due to differences in application of labor management strategies intended to promote safe vaginal delivery.^{1,2} Disparities in application of professional guidelines have been well documented in other areas of medicine.¹³ Our findings regarding disparities in cesarean indication have been seen in other

cohorts. For example, Edmonds et al demonstrated non-Hispanic black women experienced greater odds of cesarean delivery for fetal distress or failure to progress⁹ and others have identified non-Hispanic black women were more likely to experience cesarean delivery for NRFS.^{10,12} Yet, the reasons for these disparities in overall rate and indication remain unknown.^{10,11,32} Although some have hypothesized minority women are at greater risk of cesarean delivery for “subjective” indications such as NRFS,¹⁰ our data do not support this hypothesis. This finding is consistent with data from a 1997–2002 California cohort in which, although specific labor and delivery practices could not be examined, racial differences in cesarean delivery rate were not fully explained by delivery hospital or physician.³³

Identifying the roots of disparities in obstetric outcomes requires understanding differences in care provision. These findings suggest that labor management strategies to promote vaginal delivery are not differentially applied by maternal race and ethnicity. It is unclear that differences in frequency of NRFS or labor dystocia are due to true biological differences; however, it is plausible that other mediating factors may underlie these disparities. For example, the greater frequencies of hypertensive disorders and small-for-gestational-age neonates^{16,34} among minority women may contribute to the greater likelihood of cesarean delivery for NRFS. Others have hypothesized that differential outcomes of labor induction may be due to differential pharmacologic response to induction agents.^{35,36} Perhaps these findings warrant investigation into individualized responses to induction or augmentation agents, particularly in this era of precision medicine.³⁷ Yet, any of these possibilities are speculative, and next steps must include multidisciplinary investigation of other patient- and provider-centered reasons for the identified disparities.

Strengths of this analysis include the large cohort with detailed information about patient characteristics and features of labor and delivery. In addition to having indications for cesarean delivery, we were able to take advantage of the granularity of APEX data to investigate specific labor and delivery management. Moreover, data were collected by trained research personnel at clinically and geographically diverse settings. However, several limitations warrant note. Evidence from the Consortium on Safe Labor has suggested using 6 cm as a cut-off for active labor,³⁸ but the APEX study collected information on time of achieving 5 cm cervical dilation. Additionally, as is necessary for the nature of this question, these data are observational and cannot demonstrate causation. Additionally, we are unable to account for the role of health care provider type, as APEX collected the delivering attending as the assigned provider, which may not have been the same provider type as the individual managing the patient’s labor. Further, the majority of hospitals were teaching hospitals, which limits the generalizability of the findings. Finally, due to small numbers for some racial and ethnic groups, we were not able to evaluate specific types of care in the cohort of multiparous women with prior vaginal deliveries only.

Understanding whether and how maternal race and ethnicity influence the complex decision making processes that take place in obstetric care is critical to improving the quality of care for all women. Although women of minority racial and ethnic status experience greater likelihood of cesarean delivery as well as differences in indications for cesarean delivery, our data suggest these differences are not clearly attributed to unequal application of labor

management strategies intended to promote safe vaginal deliveries. While these findings may offer some reassurance about equity in care provision, the racial and ethnic disparities in cesarean delivery and other maternal and neonatal health outcomes remain and the reasons for these differences continue to require elucidation.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Demographic and clinical characteristics of nulliparous cohort

	Non-Hispanic white n=18,377	Non-Hispanic black n=7,583	Asian n=2,570	Hispanic n=6,999	P
Age (years)	28 (24–32)	21 (19–25)	29 (27–32)	22 (19–26)	<.001
Insurance					<.001
Private	14317 (78.6)	2078 (27.5)	2064 (80.8)	1398 (20.2)	
Government assisted	3520 (19.3)	5127 (67.9)	354 (13.9)	3528 (50.9)	
Uninsured	388 (2.1)	342 (4.5)	136 (5.3)	2003 (28.9)	
BMI at delivery (kg/m ²)	29.5 (26.6–33.4)	30.9 (27.2–35.9)	27.3 (25.1–30.0)	29.9 (26.8–33.7)	<.001
Diabetes					<.001
None	17470 (95.1)	7228 (95.3)	2310 (89.9)	6601 (94.4)	
Pre-gestational	142 (0.8)	84 (1.1)	22 (0.9)	54 (0.8)	
Gestational	762 (4.2)	269 (3.6)	237 (9.2)	341 (4.9)	
Smoking	2039 (11.1)	694 (9.2)	34 (1.3)	220 (3.2)	<.001
Chronic hypertension	356 (1.9)	233 (3.1)	26 (1.0)	77 (1.1)	<.001
Gestational hypertension or preeclampsia	1997 (10.9)	993 (13.1)	101 (3.9)	824 (11.8)	<.001
>2 prenatal care visits	17545 (99.4)	7108 (98.5)	2426 (99.4)	6642 (98.8)	<.001
Type of labor					<.001
None	564 (3.1)	122 (1.6)	65 (2.5)	95 (1.4)	
Spontaneous	4433 (24.1)	1840 (24.3)	573 (22.3)	1739 (24.9)	
Spontaneous, augmented	6322 (34.4)	2771 (36.5)	1133 (44.1)	2732 (39.0)	
Induced	7058 (38.4)	2850 (37.6)	799 (31.1)	2433 (34.8)	
Chorioamnionitis (as reason for intrapartum antibiotics administration)	1103 (6.0)	442 (5.8)	224 (8.7)	851 (12.2)	<.001
Analgesia					<.001
None or IV or IM narcotic only	1278 (7.0)	696 (9.2)	207 (8.1)	1160 (16.6)	

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	Non-Hispanic white n=18,377	Non-Hispanic black n=7,583	Asian n=2,570	Hispanic n=6,999	P
Regional epidural anesthesia only	9728 (53.0)	3851 (50.8)	1223 (47.6)	2820 (40.3)	
Other anesthesia	7357 (40.1)	3030 (40.0)	1140 (44.4)	3011 (43.1)	
Gestational age at delivery (weeks)	39.9 (39.0–40.6)	39.7 (38.9–40.4)	39.6 (38.9–40.3)	39.7 (38.9–40.6)	<.001

BMI, body mass index; IV, intravenous; IM, intramuscular
Number of missing values: insurance (274); BMI (486); diabetes (9); smoking (30); chronic hypertension (3); gestational hypertension or preeclampsia (2); number of prenatal visits (1505); chorioamnionitis (4); analgesia (28)
Data displayed as N (%) or median (IQR). The Kruskal-Wallis test was used for continuous variables and the chi-square test for categorical variables. P-value represents comparison across all racial and ethnic groups.

Table 2

Frequency and odds of cesarean delivery by maternal race and ethnicity in nulliparous cohort

	Non-Hispanic white			Non-Hispanic black			Asian			Hispanic		
	N (% 95%CI)	N (% 95%CI)	aOR* (95%CI)	Unadjusted OR (95%CI)	aOR* (95%CI)	N (% 95%CI)	Unadjusted OR (95%CI)	aOR* (95%CI)	N (% 95%CI)	Unadjusted OR (95%CI)	aOR* (95%CI)	N (% 95%CI)
Cesarean delivery (vs. vaginal delivery) [‡]	4594 (25.0, 24.4–25.6)	2148 (28.3, 27.3–29.3)	1.19 (1.12–1.26)	1.47 (1.36–1.59)	737 (28.7, 26.9–30.4)	1.21 (1.10–1.32)	1.26 (1.14–1.40)	1677 (24.0, 23.0–25.0)	0.95 (0.89–1.01)	1.17 (1.07–1.27)		
Indication (vs. vaginal delivery) [‡]												
Non-reassuring fetal status	1106 (6.0, 5.7–6.4)	945 (12.5, 11.7–13.2)	2.17 (1.98–2.38)	2.39 (2.13–2.69)	196 (7.6, 6.6–8.7)	1.33 (1.14–1.56)	1.29 (1.09–1.53)	492 (7.0, 6.4–7.6)	1.15 (1.03–1.29)	1.22 (1.07–1.40)		
Labor dystocia or failed induction	2807 (15.3, 14.8–15.8)	1043 (13.8, 13.0–14.5)	0.94 (0.87–1.02)	1.21 (1.09–1.33)	460 (17.9, 16.4–19.4)	1.23 (1.10–1.38)	1.39 (1.23–1.57)	1052 (15.1, 14.2–15.9)	0.97 (0.90–1.05)	1.24 (1.13–1.38)		
Suspected macrosomia	244 (1.3, 1.2–1.5)	45 (0.6, 0.4–0.8)	0.47 (0.34–0.64)	0.49 (0.34–0.72)	17 (0.7, 0.4–1.0)	0.52 (0.32–0.86)	0.48 (0.28–0.81)	43 (0.6, 0.4–0.8)	0.46 (0.33–0.63)	0.76 (0.52–1.12)		
Elective	291 (1.6, 1.4–1.8)	55 (0.7, 0.5–0.9)	0.48 (0.36–0.64)	0.84 (0.60–1.16)	45 (1.8, 1.2–2.3)	1.16 (0.85–1.60)	1.02 (0.72–1.44)	43 (0.6, 0.4–0.8)	0.38 (0.28–0.53)	0.60 (0.42–0.87)		
Other	138 (0.8, 0.6–0.9)	54 (0.7, 0.5–0.9)	0.99 (0.72–1.36)	1.23 (0.85–1.79)	19 (0.7, 0.4–1.1)	1.04 (0.64–1.68)	0.98 (0.58–1.65)	38 (0.5, 0.4–0.7)	0.71 (0.50–1.02)	0.90 (0.57–1.42)		

^{*} Multivariable logistic regression (cesarean delivery) and multivariable multinomial logistic regression (indication). Compared with non-Hispanic white women. Adjusted for age, BMI, diabetes, smoking, chorioamnionitis, gestational hypertension or preeclampsia, gestational age at delivery, and hospital.

[‡] n=35,529; n=35,005 with complete covariable data.

[‡] n=35,529; n=34,982 with complete covariable data.

Table 3
Frequency and odds of cesarean delivery by maternal race and ethnicity in multiparous (prior vaginal deliveries only) cohort

	Non-Hispanic white			Non-Hispanic black			Asian			Hispanic			
	N (%) 95%CI)	N (%) 95%CI)	Unadjusted OR (95%CI)	aOR* (95% CI)	N (%) 95%CI)	Unadjusted OR (95%CI)	aOR* (95% CI)	N (%) 95%CI)	Unadjusted OR (95%CI)	aOR* (95% CI)	N (%) 95%CI)	Unadjusted OR (95%CI)	aOR* (95% CI)
Cesarean delivery (vs. vaginal delivery) [†]	873 (4.9, 4.6–5.2)	712 (8.4, 7.9–9.0)	1.78 (1.61–1.97)	1.51 (1.33–1.70)	105 (5.8, 4.8–6.9)	1.20 (0.97–1.48)	1.00 (0.80–1.25)	718 (6.0, 5.6–6.5)	1.24 (1.12–1.37)			1.12 (0.98–1.27)	
Indication (vs. vaginal delivery) [‡]													
Non-reassuring fetal status	210 (1.2, 1.0–1.3)	361 (4.3, 3.9–4.7)	3.75 (3.16–4.46)	3.12 (2.54–3.84)	27 (1.5, 0.9–2.1)	1.28 (0.85–1.92)	1.24 (0.81–1.90)	282 (2.4, 2.1–2.6)	2.02 (1.69–2.42)			1.48 (1.18–1.85)	
Labor dystocia or failed induction	233 (1.3, 1.2–1.5)	210 (2.5, 2.2–2.8)	1.97 (1.63–2.38)	1.77 (1.42–2.21)	30 (1.7, 1.1–2.3)	1.28 (0.87–1.88)	1.38 (0.91–2.08)	232 (2.0, 1.7–2.2)	1.50 (1.25–1.80)			1.44 (1.14–1.82)	
Suspected macrosomia	100 (0.6, 0.5–0.7)	34 (0.4, 0.3–0.5)	0.74 (0.50–1.10)	0.51 (0.32–0.80)	6 (0.3, 0.1–0.6)	0.60 (0.26–1.36)	0.33 (0.14–0.78)	72 (0.6, 0.5–0.7)	1.09 (0.80–1.47)			1.06 (0.72–1.56)	
Elective	167 (0.9, 0.8–1.1)	31 (0.4, 0.2–0.5)	0.41 (0.28–0.60)	0.43 (0.28–0.66)	21 (1.2, 0.7–1.7)	1.25 (0.79–1.98)	0.76 (0.47–1.26)	46 (0.4, 0.3–0.5)	0.42 (0.30–0.58)			0.51 (0.34–0.75)	
Other	163 (0.9, 0.8–1.1)	74 (0.9, 0.7–1.1)	0.99 (0.75–1.31)	0.82 (0.60–1.14)	20 (1.1, 0.6–1.6)	1.22 (0.77–1.95)	0.84 (0.51–1.40)	86 (0.7, 0.6–0.9)	0.80 (0.61–1.03)			0.86 (0.62–1.20)	

^{*} Multivariable logistic regression (cesarean delivery) and multivariable multinomial logistic regression (indication). Compared with non-Hispanic white women. Adjusted for age, BMI, diabetes, smoking, chorioamnionitis, gestational hypertension or preeclampsia, gestational age at delivery, and hospital.

[†] n=39,871; n=38,831 with complete covariable data.

[‡] n=39,871; n=38,828 with complete covariable data.

Table 4

Use of labor management strategies to reduce cesarean deliveries in nulliparous cohort by maternal race and ethnicity

	Non-Hispanic white			Non-Hispanic Black			Asian			Hispanic			
	N (%)	N (%)	Unadjusted OR (95%CI)	aOR (95% CI)*	N (%)	Unadjusted OR (95%CI)	aOR (95% CI)*	N (%)	Unadjusted OR (95%CI)	aOR (95% CI)*	N (%)	Unadjusted OR (95%CI)	aOR (95% CI)*
Cesarean performed for failed induction prior to 5cm dilation and prior to 12 hours of oxytocin or rupture of membranes (whichever came last) [†]	357 (80.6)	150 (75.8)	0.75 (0.50–1.13)	1.02 (0.61–1.72)	43 (89.6)	2.07 (0.80–5.39)	1.06 (0.35–3.19)	119 (78.8)	0.90 (0.57–1.41)	1.35 (0.69–2.63)			
Labor induction with an unfavorable cervix and without cervical ripening [‡]	212 (21.2)	147 (18.5)	1.18 (0.93–1.49)	0.99 (0.72–1.37)	32 (19.5)	1.11 (0.73–1.68)	1.08 (0.67–1.76)	86 (18.0)	1.23 (0.93–1.62)	0.98 (0.68–1.40)			
Cesarean performed for arrest of dilation after reaching 5 cm dilatation and prior to 4 hours of dystocia [§]	309 (26.0)	135 (23.4)	0.87 (0.69–1.10)	0.79 (0.60–1.05)	43 (23.1)	0.86 (0.60–1.24)	0.76 (0.51–1.13)	105 (19.7)	0.70 (0.55–0.90)	0.67 (0.49–0.92)			
Cesarean performed for arrest of descent after reaching complete dilation and prior to 3 hours of second stage	464 (54.9)	71 (60.2)	1.24 (0.84–1.84)	1.09 (0.69–1.72)	94 (57.3)	1.10 (0.79–1.55)	1.25 (0.85–1.86)	139 (55.2)	1.01 (0.76–1.34)	1.26 (0.87–1.83)			
Cesarean for NRFS and Apgar score at 1 minute [¶]	890 (80.5)	749 (79.3)	0.93 (0.75–1.15)	0.88 (0.67–1.16)	175 (89.3)	2.01 (1.25–3.24)	1.79 (1.07–3.00)	394 (80.1)	0.97 (0.74–1.27)	1.05 (0.76–1.45)			
Composite, any [#]	2179 (49.6)	1219 (51.7)	1.09 (0.98–1.20)	1.08 (0.96–1.23)	379 (52.2)	1.11 (0.95–1.30)	1.04 (0.88–1.24)	822 (46.1)	0.87 (0.78–0.97)	0.91 (0.80–1.04)			

aOR, adjusted odds ratio; CI, confidence interval; NRFS, non-reassuring fetal status

* Multivariable logistic regression. Compared with non-Hispanic white women. Adjusted for age, BMI, diabetes, smoking, chorioamnionitis, gestational hypertension or preeclampsia, gestational age at delivery, and hospital.

[†] In patients who were induced, received oxytocin, did not reach 5 cm dilation, and underwent cesarean for an indication of failed induction (n=908; n=831 with complete covariable data).

[‡] In patients who were induced and had an unfavorable cervix (modified Bishop score <5) (n=2436; n=2403 with complete covariable data).

[§] In patients with who reached 5 cm dilation but did not reach complete dilation, and underwent cesarean for an indication of arrest of dilation (n=2667; n=2466 with complete covariable data).

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// In patients with who reached complete dilation, and underwent cesarean for an indication of arrest of descent (n=1533; n=1359 with complete covariable data).

¶ In patients who underwent cesarean for an indication of non-reassuring fetal status (n=2739; n=2699 with complete covariable data).

Of the strategies that the patient was eligible for, patient received one or more strategies considered non-use of labor management strategies to reduce cesarean deliveries (cesarean performed for failed induction prior to 5cm dilation and prior to 12 hours of oxytocin and rupture of membranes, labor induction without cervical ripening in women with an unfavorable cervix, cesarean performed for arrest of dilation prior to 4 hours of dystocia after reaching 5 cm dilatation, cesarean performed for arrest of descent prior to 3 hours of second stage, cesarean for NRFS with Apgar score at 1 minute 7).

Table 5
Duration of time until cesarean decision by maternal race and ethnicity in nulliparous cohort

	Non-Hispanic white	Non-Hispanic Black	Asian	Hispanic
	Adjusted mean (95%CI) *	Adjusted mean (95%CI) *	Adjusted mean (95%CI) *	Adjusted mean (95%CI) *
	P	P	P	P
Hours from oxytocin or rupture of membranes (whichever came last) to cesarean decision [†]	9.50 (8.06–10.94)	9.36 (7.74–10.98)	10.15 (7.76–12.54)	9.19 (7.40–10.98)
Hours from 5 cm to cesarean decision [‡]	7.9 (7.3–8.5)	8.4 (7.7–9.1)	8.6 (7.8–9.4)	8.8 (8.1–9.5)
Hours from complete dilation to cesarean decision [§]	2.96 (2.63–3.28)	2.88 (2.47–3.29)	2.68 (2.29–3.06)	2.78 (2.41–3.16)
CI, confidence interval				

CI, confidence interval

* Comparisons of least squares means based on multivariable linear regression. Compared with non-Hispanic white women. Adjusted for age, BMI, diabetes, smoking, chorioamnionitis, gestational hypertension or preeclampsia, gestational age at delivery, and hospital.

[†] In patients who were induced, received oxytocin, did not reach 5 cm dilation, and underwent cesarean for an indication of failed induction (n=908; n=838 with complete covariable data).

[‡] In patients who reached 5 cm dilation but did not reach complete dilation, and underwent cesarean for an indication of arrest of labor (n=2472; n=2454 with complete covariable data).

[§] In patients with who reached complete dilation, and underwent cesarean for an indication of arrest of descent (n=1533; n=1366 with complete covariable data).