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Association Between Vaginal Birth After Cesarean Delivery and Primary Cesarean Delivery Rates

Melissa G. Rosenstein, MD, MAS, **Miriam Kuppermann, PhD, MPH**, **Steven E. Gregorich, PhD**, **Erika K. Cottrell, PhD, MPP**, **Aaron B. Caughey, MD, PhD**, and **Yvonne W. Cheng, MD, PhD**
Departments of Obstetrics, Gynecology, and Reproductive Sciences, Epidemiology & Biostatistics, and Medicine, University of California, San Francisco, San Francisco, California; and the Department of Obstetrics and Gynecology, Oregon Health & Science University, Portland, Oregon

Abstract

OBJECTIVE—To estimate the association between vaginal birth after cesarean delivery (VBAC) rates and primary cesarean delivery rates in California hospitals.

METHODS—Hospital VBAC rates were calculated using birth certificate and discharge data from 2009, and hospitals were categorized by quartile of VBAC rate. Multivariable logistic regression analysis was performed to estimate the odds of cesarean delivery among low-risk nulliparous women with singleton pregnancies at term in vertex presentation (nulliparous term singleton vertex) by hospital VBAC quartile while controlling for many patient-level and hospital-level confounders.

RESULTS—There were 468,789 term singleton births in California in 2009 at 255 hospitals, 125,471 of which were low-risk nulliparous term singleton vertex. Vaginal birth after cesarean delivery rates varied between hospitals, with a range of 0–44.6%. Rates of cesarean delivery among low-risk nulliparous term singleton vertex women declined significantly with increasing VBAC rate. When adjusted for maternal and hospital characteristics, low-risk nulliparous term singleton vertex women who gave birth in hospitals in the highest VBAC quartile had an odds ratio of 0.55 (95% confidence interval 0.46–0.66) of cesarean delivery compared with women at hospitals with the lowest VBAC rates. Each percentage point increase in a hospital's VBAC rate was associated with a 0.65% decrease in the low-risk nulliparous term singleton vertex cesarean delivery rate.

CONCLUSION—Hospitals with higher rates of VBAC have lower rates of primary cesarean delivery among low-risk nulliparous women with singleton pregnancies at term in vertex presentation.

Corresponding author: Melissa G. Rosenstein, MD, MAS, 505 Parnassus Avenue, Box 1483, San Francisco, CA 94143; rosensteinm@obgyn.ucsf.edu.

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The overall rate of cesarean delivery has been increasing in the United States and accounted for 32.8% of all births in 2011.[1] Recent reports of large variations in cesarean delivery rates across hospitals have led to suggestions that there may be nonmedical factors associated with higher or lower cesarean delivery rates.[2–4] One identified cause for the increasing total cesarean delivery rate is the declining rate of vaginal birth after cesarean delivery (VBAC), a procedure that also has great variation between hospitals.[5–7]

One source of the variation in VBAC rates is the decision by many health care providers and hospitals to discontinue offering their patients the opportunity to attempt a trial of labor after cesarean delivery (TOLAC). Although the American College of Obstetricians and Gynecologists (the College) reaffirmed in 2010 that the opportunity to undergo TOLAC should be made available to most women with one prior cesarean delivery,[8] it has been recently reported that this opportunity is not available to women in 43% of California hospitals and 59% of New Mexico counties.[9,10] Even when hospitals do not ban the procedure, the number of obstetricians who will offer their patients TOLAC is declining and was estimated at only 52% among private obstetricians in Texas in 2010.[11] Some of the causes for this diminished access include uncertainty about whether appropriate emergency care can be offered, concern about the safety of VBAC (primarily focused on the consequences of uterine rupture), and increasing influence of medicolegal liability concerns.[11,12]

Both the decreasing VBAC rate and the increasing primary cesarean delivery rate are clearly contributing to a change in delivery patterns in the United States, but little is known about the association between these trends. In addition to quantifiable factors that might have an effect on both of these rates, it is possible that when a hospital and its health care providers allow or even encourage VBAC (evidenced by a higher than average VBAC rate), there may be an underlying culture that values vaginal birth with intangible effects that also may affect the rate of cesarean delivery in nulliparous women. Our study was designed to test the hypothesis that decreased use of VBAC at the hospital level, as determined by a low hospitalwide VBAC rate, is associated with an increased rate of primary cesarean deliveries in low-risk, term nulliparas while controlling for other hospital- and patient-level covariates.

PATIENTS AND METHODS

We conducted a cross-sectional historical cohort study of all term singleton births in the state of California in 2009. Information about the hospitals and deliveries came from the California Office of Statewide Health Planning and Development Birth Cohort File, a publicly available data set composed of birth certificate data that was linked with the maternal and neonatal Patient Discharge Data and Death File. Birth centers or hospitals with fewer than 50 deliveries or with zero or only one woman coded as having had a previous cesarean delivery were excluded because these hospitals' VBAC and cesarean delivery rates were likely to be unstable or undercoded. Data from all term singleton births at included hospitals were evaluated and used to calculate total delivery volume. Rates of VBAC were determined for each hospital by summing the number of VBACs and dividing this sum by the number of women with a history of prior cesarean delivery identified with a diagnosis code for prior cesarean delivery from the discharge records. Trial of labor after cesarean delivery rates were calculated as the sum of all women who had a VBAC plus those who had a repeat cesarean delivery while in labor (identified from the birth certificate or with a diagnosis code indicative of labor or a procedure code for induction of labor) divided by the total number of women with a previous cesarean delivery. The sample was then restricted to low-risk nulliparous pregnancies in vertex presentation at term (gestational age between 37 0/7 weeks and 41 6/7 completed weeks). Women with placenta previa or placental abruption, stillbirth, pre-existing or gestational hypertension or diabetes, preeclampsia, renal disease, and neonates with congenital anomalies or weighing less than 2,500 g or more than 5,000 g were excluded to minimize confounding based on these covariates. These diagnoses were captured by International Classification of Diseases, 9th Revision, Clinical Modification codes on maternal discharge documentation or from neonatal birth certificates. This low-risk sample was used to determine a hospital's low-risk nulliparous term singleton vertex cesarean delivery rate.

Because initial data exploration revealed a substantial variation in the number and rate of VBACs performed at hospitals in California, we categorized hospitals by their VBAC rate. We focused on rate (rather than absolute number of VBACs) to separate the contribution of hospital volume on the association. We also elected to use the VBAC rate rather than the TOLAC rate because of the greater reliability of VBAC coding as well as the fact that many women who have a repeat cesarean delivery in the setting of labor may not have intended to have a VBAC but began spontaneous labor at home and had an intended cesarean delivery. Hospitals were classified into four quartiles of VBAC rate. Hospitals with nonzero VBAC rates did not tend to have clearcut thresholds to differentiate between high and low rates, and it was difficult to determine one a priori. Also, we chose to use quartiles rather than dichotomize hospitals into those with zero and nonzero VBAC rates, because hospitals with very low VBAC rates are likely more similar to those with zero VBAC rates than those with higher rates. Some women whose health care providers or hospitals do not offer TOLAC may present in advanced labor and end up with an unplanned VBAC, either because they decline repeat cesarean delivery against the counsel of their health care providers or because they delivered vaginally before a cesarean delivery could be performed. Thus, we chose quartiles of VBAC percentage so that hospitals with very few VBACs could be evaluated without any assumptions made about whether women intended to attempt a VBAC or have a repeat cesarean delivery.

To examine the association between the quartile of VBAC rate and low-risk nulliparous term singleton vertex cesarean delivery rate, we performed unadjusted analysis at both the hospital level and at the patient level, adjusting for clustering within hospital, using a test for linear trend and a test for trend using a Wilcoxon ranked sum test for ordered groups.[13] Multivariable logistic models were then fit that controlled for confounders and adjusted for clustering of deliveries within hospitals using robust standard errors. Using the patient as the unit of analysis and controlling for the covariates listed subsequently, adjusted odds ratios were estimated to summarize the relationship between the hospital's VBAC rate and the likelihood that the woman would have a cesarean delivery.

Hospital-level confounders included hospital volume, geographic location as determined by California Health Service Area, rural or nonrural location, hospital ownership, presence of a state of California-recognized community, regional, or intermediate neonatal intensive care unit, teaching status (defined as presence of an obstetrics residency program), presence of midwives as part of the labor and delivery staff, and the presence of 24-hour in-house obstetrician coverage. Hospital volume was categorized into three groups: small hospitals (50–1,000 deliveries), medium hospitals (1,001–2,500 deliveries), and large hospitals (greater than 2,500 deliveries). Hospital ownership was categorized into four groups: public hospitals with federal, state, county, or district ownership; for-profit; nonprofit; or Kaiser Foundation. Data on hospital location, ownership, neonatal intensive care unit status, and teaching status were obtained from California Office of Statewide Health Planning and Development data. Hospitals were designated as rural based on California Office of Statewide Health Planning and Development classification or if they were located in a town with a California Association of Rural Health Clinics member clinic or in a rural zip code.[14] Data on whether a hospital had midwifery and 24-hour in-house obstetric coverage were obtained from telephone surveys of labor and delivery staff conducted in 2011 and 2012. Patient-level variables obtained from neonate birth and maternal discharge records included maternal age, race or ethnicity, education status (classified as less than or greater than a completed high school diploma), and insurance (public or private insurance); whether labor was induced; gestational age at delivery; and neonate's birth weight.

We used linear regression at the hospital level to examine the association between VBAC rate and low-risk nulliparous term singleton vertex primary cesarean delivery rate. This analysis controlled for the listed hospital-level covariates, and patient case-mix adjustment was included in the model by incorporating a composite term reflecting the average expected cesarean delivery rate at each hospital based on patient-level covariates calculated as a sum of probabilities. Both the logistic and linear models were checked for and optimized against departures from linearity and for sensitivity to influential outliers. All statistical analyses were performed with Stata 12. Institutional review board approval was obtained from the University of California, San Francisco, Committee on Human Research as well as the California Committee for the Protection of Human Subjects.

RESULTS

There were 468,789 term singleton births in California in 2009 at the 255 included hospitals, 127,471 of which were low-risk nulliparous term singleton vertex. Twenty-one facilities where births occurred were excluded, 15 because they had fewer than 50 deliveries (range 1–9) and six because of undercoded previous cesarean delivery. Of the total sample, 72,865 had a previous cesarean delivery, of whom 6,905 delivered vaginally, for a total VBAC rate of 9.5%. The median hospital VBAC rate was 5.0% with an overall range of 0–44.6% and an interquartile range of 1.5–13.9%. The distribution of VBAC rates was right-skewed (Fig. 1).

When classified into four quartiles of VBAC rate, significant differences were seen in both hospital and patient characteristics. As a result of the large sample size, all of these differences had *P* values of <.05 for a test for trend. Notable differences between groups at the hospital level included the following (data presented in the text are for the lowest and highest VBAC quartiles, respectively, with a *P* value for the overall test of trend including the values for quartiles 2 and 3, shown in Tables 1 and 2): hospital volume (median delivery volume 862 compared with 1,926, *P*<.001), teaching status (0% compared with 32.3%, *P*<.001), midwifery coverage (16.1% compared with 55.6%, *P*<.001), and 24-hour obstetric coverage (13.1% compared with 61.9%, *P*<.001). Clinically significant maternal variables included maternal racial or ethnic distribution (26.4% white in quartile 1 compared with 34.1% in quartile 4, *P*<.001), public payer (60.5% compared with 34.1%, *P*<.001), proportion of patients aged 35 years and older (4.8% compared with 11.5%, *P*<.001), and proportion of patients with more than 12 years of education (43.8% compared with 61.4%, *P*<.001) (Table 2).

Rates of cesarean delivery among low-risk nulliparous term singleton vertex women also varied significantly by VBAC rate quartile, with the rate of nulliparous term singleton vertex cesarean delivery declining with increasing VBAC rate quartile. At the patient level, the unadjusted rate of cesarean delivery for low-risk nulliparous term singleton vertex women was 31.4% in the lowest VBAC quartile, 26.1% in quartile 2, 25.3% in quartile 3, and 21.4% in the highest VBAC quartile (quartile 4) (*P*<.001) (Table 3). When adjusted for maternal and hospital characteristics, women in quartile 4 had the lowest odds of cesarean delivery relative to women in quartile 1 (adjusted odds ratio [OR] 0.55, 95% confidence interval [CI] 0.46–0.66) followed by women in quartile 3 (adjusted OR 0.68, 95% CI 0.57–0.81) and women in quartile 2 (adjusted OR 0.72, 95% CI 0.61–0.86). A test for linear trend across all four quartiles was statistically significant (*P*<.001). The multivariable logistic model was refit including restricted cubic splines to model possible nonlinear effects of maternal age, neonate birth weight, gestational age, and hospital volume, but the results did not change substantially, and so the simplified model is presented in Table 4.

To examine the association between VBAC rate and low-risk nulliparous term singleton vertex cesarean delivery rate at the hospital level, we began by plotting these rates for each hospital and modeling an unadjusted linear regression line; increases in VBAC rate were associated with decreases in nulliparous term singleton vertex cesarean delivery rates (Fig. 2; unadjusted coefficient 0.32, *P*<.001). We then performed multivariable linear regression to control for hospital characteristics and patient case-mix, finding that each 1% increase in a hospital's VBAC rate was associated with a 0.65% decrease in the low-risk nulliparous term singleton vertex cesarean delivery rate (95% CI 0.33–0.97%, *P*<.001).

DISCUSSION

In this cross-sectional historical cohort study of low-risk nulliparous term singleton vertex pregnancies in Cal-ifornia, we observed an inverse relationship between hospital VBAC rates and primary cesarean delivery rates such that hospitals with higher VBAC rates had lower rates of low-risk nulliparous term singleton vertex cesarean delivery. It seems plausible that hospitals in which VBACs are performed have an organizational culture with policies and health care providers that place a higher value on vaginal birth, in general, and are willing to assume some risks to enable women with a prior cesarean delivery to attempt a vaginal birth. We hypothesized that this support for vaginal birth among women with a history of a previous cesarean delivery translates into a lower rate of cesarean delivery among nulliparous women. Although we cannot be certain of the reason for the observed inverse relationship, it is clearly demonstrated in this study.

Our study confirms previous findings that hospitals with residents, midwives, and not-for-profit or public status have higher VBAC rates than other hospitals[15,16] and that many of these factors also are associated with a decreased primary cesarean delivery rate.[17,18] However, our multivariable regression models controlled for these known confounders and many others, and still, the association between VBAC rate and decreased primary cesarean delivery rates persisted. This suggests that in addition to the tangible hospital resources available that could support both increased VBAC and decreased primary cesarean delivery, there is an independent association between the two delivery trends.

The variation we observed in VBAC rate has been reported previously but, like with other elective procedures, deserves further scrutiny.[5] A 2012 national survey of women with a prior cesarean delivery revealed that 48% of respondents would have preferred a VBAC for their subsequent delivery, and 46% of those who desired VBAC were denied that possibility.[19] Both the National Institutes of Health Consensus Conference on VBAC and the College's Practice Bulletin of 2010 indicate that maternal preference should be the primary determination of whether VBAC is attempted, but this cannot be practically implemented if almost half of California hospitals do not offer that option.[8,9,20]

Although it may not be reasonable to assume that every hospital will have the resources to offer TOLAC, the College's requirement that "immediate cesarean delivery" services be available in hospitals that offer VBAC has been interpreted in varying ways.[8,9] Indeed, we found some small, rural hospitals to be among the institutions with the highest VBAC rates, confirming prior studies that there is not one single model of VBAC provision.[21,22] Perhaps these "immediately available" emergency cesarean delivery services (however this standard is interpreted) enable health care providers to avoid primary cesarean deliveries for labor dystocia or questionable fetal heart rate tracings, two potentially modifiable indications whose management has been identified as a potential cause of the current high primary cesarean delivery rate.[23] We cannot prove this causal link, but further study into the effect that emergency cesarean delivery availability has on primary cesarean delivery rates is warranted so that hospitals considering altering their emergency services can be aware of potential secondary consequences.

Our study is not without limitations. The first is that our data come from birth certificates and hospital discharge data and depend highly on whether VBAC was correctly coded. Miscoding could have led to misclassification bias, because hospitals with low VBAC rates and low volume may be more likely to have errors in coding. Determining accurate VBAC rates requires a valid denominator of women with a previous cesarean delivery, the coding of which may also have error.

The cross-sectional nature of our study prohibits us from making any determination of cause and effect. For example, it may be that a culture on a labor and delivery unit that leads to a low rate of primary cesarean delivery will in turn lead to having policies supportive of

VBAC. Alternatively, it may be that another factor affects both the primary cesarean delivery and VBAC rate directly, leading to an association that is not causal. Although we controlled for many hospital- and patient-level confounders, we cannot rule out the possibility that unmeasured confounders such as patient characteristics and preferences, quality improvement efforts targeting both behaviors, and malpractice coverage patterns may be driving both of these trends.

The strengths of our study include its size of more than 100,000 births in a large number of diverse hospitals in 1 calendar year. Restricting our study of primary nulliparous term singleton vertex cesarean delivery rates to only low-risk women reduced the possibility that unmeasured confounding on the patient level explains the variation between hospitals.

It is clear that there is an inverse association between VBAC rates and low-risk nulliparous term singleton vertex cesarean delivery rates both at the patient and the hospital level. The Centers for Disease Control and Prevention has identified both increasing the VBAC rate and decreasing the primary cesarean delivery rate as two of their Healthy People 2020 goals.[24] Although it may seem that reducing the cesar-ean delivery rate is an elusive goal, an increasing VBAC rate did contribute to the decrease in U.S. cesarean delivery rates seen in the early 1990s.[25] Our study suggests that efforts to decrease both repeat and primary cesarean delivery will likely go hand in hand and may reinforce each other.

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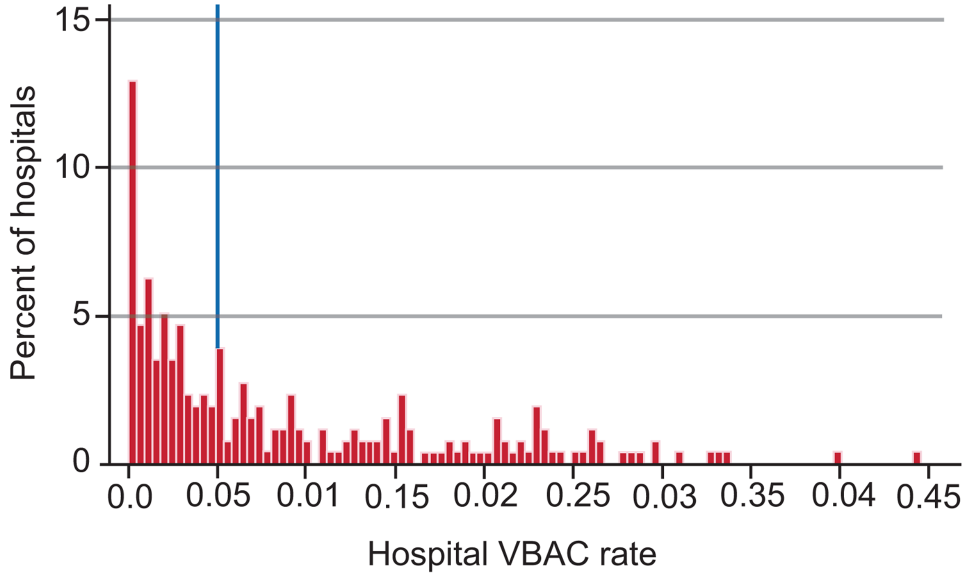

Fig. 1.
The distribution of hospital vaginal birth after cesar-ean delivery (VBAC) rates in California, 2009. This histogram shows the distribution of hospital VBAC rates and the median VBAC rate in California, 2009. Blue line indicates median VBAC rate. Rosenstein. Hospital VBAC and Primary Cesarean Rates. Obstet Gynecol 2013.

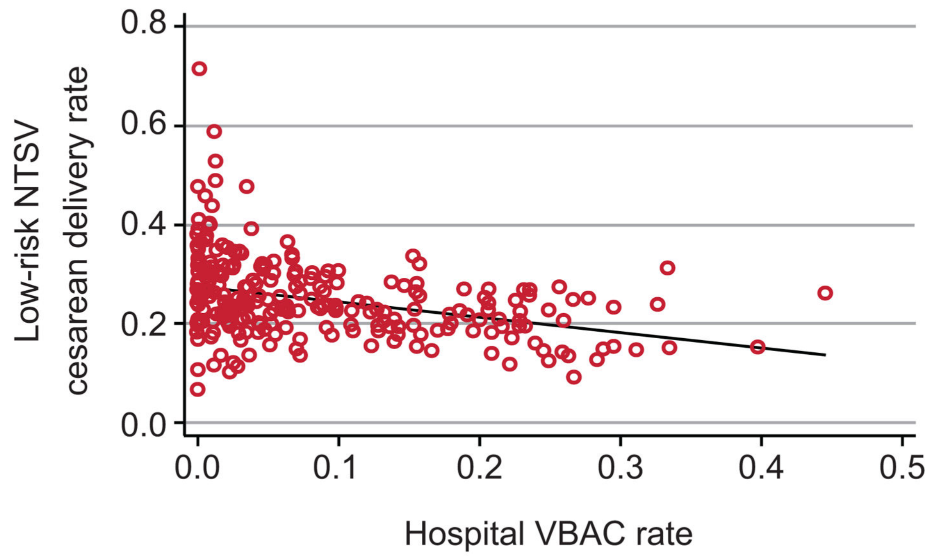

Fig. 2.

Low-risk nulliparous term singleton vertex (NTSV) cesarean delivery rates and vaginal birth after cesarean delivery rates (VBAC) in California hospitals, 2009. This scatterplot shows the VBAC and NTSV cesarean delivery rates with an unadjusted linear regression line demonstrating their inverse relationship.

Rosenstein. Hospital VBAC and Primary Cesarean Rates. Obstet Gynecol 2013.

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Table 1

Characteristics of California Hospitals Stratified by Quartile of Vaginal Birth After Cesarean Delivery Rate

	VBAC Rate Quartile*				
Characteristic	1 (n=64)	2 (n=64)	3 (n=64)	4 (n=63)	*P*†
Annual VBAC rate (%)	0.4 (0–1.5)	2.8 (1.6–5.0)	8.1 (5.1–14.0)	21.6 (14.3–44.6)	<.001
Annual no. of deliveries	862 (55–4,809)	1,472 (158–5,991)	1,974 (148–7,094)	1,926 (78–6,704)	<.001
Annual no. of TOLAC	2 (0–180)	12 (1–165)	36 (3–370)	83 (2–468)	<.001
Annual no. of VBAC	1 (0–12)	6 (1–37)	26 (2–101)	54 (2–258)	<.001
Overall cesarean delivery rate (%)	34 (21–68)	30 (18–49)	29 (19–40)	27 (17–35)	<.001
Location					.044‡
San Francisco Bay Area	6 (9.4)	5 (7.8)	7 (10.9)	16 (25.4)	
Northern California	9 (14.1)	4 (6.3)	2 (3.1)	4 (6.4)	
Sacramento area	9 (14.1)	8 (12.5)	10 (15.6)	6 (9.5)	
Central California	5 (7.8)	12 (18.8)	11 (17.2)	12 (19)	
Los Angeles area	33 (51.6)	31 (48.4)	30 (46.9)	19 (30.2)	
San Diego area	2 (3.1)	4 (6.3)	4 (6.3)	6 (9.5)	
Hospital ownership					<.001‡
For-profit	15 (23.4)	12 (18.8)	8 (12.5)	4 (6.4)	
Public	16 (25)	14 (21.9)	14 (21.9)	15 (23.8)	
Nonprofit	33 (51.6)	38 (59.4)	36 (56.3)	23 (36.5)	
Kaiser	0	0	6 (9.4)	21 (33.3)	
Teaching hospital	0	1 (1.6)	5 (7.9)	20 (32.3)	<.001
Midwifery presence	10 (16.1)	14 (22.2)	22 (34.9)	35 (55.6)	<.001
24-h obstetric coverage	8 (13.1)	10 (15.6)	18 (28.6)	39 (61.9)	<.001
Rural	24 (37.5)	15 (23.4)	10 (15.6)	4 (6.4)	<.001
NICU	11 (17.2)	25 (39.1)	33 (51.6)	31 (49.2)	<.001

VBAC, vaginal birth after cesarean delivery; TOLAC, trial of labor after cesarean delivery; NICU, neonatal intensive care unit. Data are median (range) or n (%) unless otherwise specified.

*Hospitals were categorized by their institutional vaginal birth after cesarean delivery rate and grouped into quartiles.

† All *P* values are for test of trend for ordered groups, unless designated otherwise.

‡ *P* for χ^2 test.

Table 2

Clinical Characteristics of Low-Risk Nulliparous Women With Singleton, Vertex, Term Pregnancies in California in 2009, Stratified by Hospital Vaginal Birth After Cesarean Delivery Rate Quartile

	VBAC Rate Quartile				
Characteristic	**1 (n=19,194)**	**2 (n=30,504)**	**3 (n=40,240)**	**4 (n=35,533)**	***P*** *
VBAC rate (%)	0–1.5	1.6–5.0	5.1–14.0	14.3–44.6	
Maternal age older than 35 y	918 (4.8)	2,415 (7.9)	3,971 (9.9)	4,075 (11.5)	<.001
Induction of labor	6,254 (32.3)	8,300 (27.2)	9,825 (24.4)	8,460 (23.8)	<.001
Public insurance	11,443 (60.5)	15,720 (52.2)	18,309 (46.0)	11,963 (34.1)	<.001
More than 12 y of education	8,204 (43.8)	14,761 (49.8)	20,635 (54.0)	21,037 (61.4)	<.001
Race or ethnicity					<.001 †
White (non-Hispanic)	5,071 (26.4)	7,347 (24.1)	12,702 (31.6)	12,104 (34.1)	
Black (non-Hispanic)	721 (3.8)	1,031 (3.4)	1,797 (4.5)	2,709 (7.6)	
Hispanic	11,814 (61.6)	16,522 (54.2)	18,696 (46.5)	14,625 (41.2)	
Asian	1,163 (6.1)	4,935 (16.2)	6,058 (15.1)	4,927 (13.9)	
Gestational age (wk)	39.3±1.1	39.3±1.1	39.3±1.1	39.4±1.1	<.001
Birth weight (g)	3,371±408	3,349±401	3,370±406	3,389±413	<.001

VBAC, vaginal birth after cesarean delivery.

Data are range, n (%), or mean±standard deviation unless otherwise specified.

* *P* value for test of trend unless otherwise specified.

† *P* value for χ^2 test.

Table 3

Low-Risk Nulliparous Term Singleton Vertex Cesarean Delivery Rates by Hospital Vaginal Birth After Cesarean Delivery Rate Quartile, at Hospital and Patient Levels

	VBAC Rate Quartile*				
	1	2	3	4	Total
Average hospital low-risk nulliparous term singleton vertex cesarean delivery rate	30.0	24.9	23.9	21.0	25.0
Percentage of low-risk nulliparous term singleton vertex women with cesarean delivery	31.4	26.1	25.3	21.4	25.3
No. of low-risk nulliparous term singleton vertex women with cesarean delivery	6,025	7,955	10,818	7,592	31,753
Total low-risk nulliparous term singleton vertex women	19,194	30,504	40,241	35,533	125,471

VBAC, vaginal birth after cesarean delivery.

P value for comparison of nulliparous term singleton vertex rates among quartiles is <.001, by test for trend.

*Hospitals grouped in quartiles based on vaginal birth after cesarean delivery rates.

Quartile 1: vaginal birth after cesarean delivery rate 0–0.5%; quartile 2: 0.5–2.6%; quartile 3: 2.6–8.3%; quartile 4: 8.7–46.5%.

Table 4

Association of Hospital and Maternal Factors on the Odds of Cesarean Delivery Among Nulliparous Women With Low-Risk Singleton Term Vertex Pregnancies

Factor	Unadjusted OR (95% CI)	*P*	Adjusted OR (95% CI)	*P*
VBAC rate quartile*				
1	1.0 (Reference)	—	1.0 (Reference)	—
2	0.77 (0.65–0.91)	.002	0.72 (0.61–0.86)	<.001
3	0.74 (0.62–0.88)	<.001	0.68 (0.57–0.81)	<.001
4	0.59 (0.50–0.71)	<.001	0.55 (0.46–0.66)	<.001
Maternal age (per 5 y)	1.30 (1.27–1.33)	<.001	1.44 (1.42–1.47)	<.001
Birth weight (per 100 g)	1.10 (1.10–1.11)	<.001	1.10 (1.10–1.11)	<.001
Gestational age (per wk)	1.16 (1.14–1.18)	<.001	1.07 (1.05–1.09)	<.001
Induction of labor	1.51 (1.41–1.63)	<.001	1.36 (1.26–1.47)	<.001
Public payer	0.87 (0.81–0.93)	<.001	1.15 (1.09–1.20)	<.001
More than 12 y of education	1.25 (1.18–1.33)	<.001	0.91 (0.87–0.95)	<.001
Race or ethnicity				
White	1.0 (Reference)	—	1.0 (Reference)	—
Black	1.18 (1.07–1.30)	.001	1.97 (1.83–2.13)	<.001
Hispanic	0.96 (0.89–1.03)	.266	1.26 (1.20–1.33)	<.001
Asian	1.07 (1.01–1.14)	.031	1.24 (1.15–1.33)	<.001
Hospital volume (annual deliveries/y)				
Small (50–1,000)	1.0 (Reference)	—	1.0 (Reference)	—
Medium (1,001–2,500)	1.00 (0.87–1.14)	.997	0.95 (0.82–1.11)	.515
Large (greater than 2,500)	1.08 (0.94–1.25)	.255	1.06 (0.89–1.27)	.492
Location				
San Francisco Bay Area	1.0 (Reference)	—	1.0 (Reference)	—
Northern California	0.95 (0.82–1.10)	.506	0.87 (0.70–1.08)	.214
Sacramento area	1.05 (0.88–1.26)	.578	1.15 (0.96–1.38)	.127
Central California	1.06 (0.89–1.26)	.489	1.21 (1.02–1.44)	.027
Los Angeles area	1.37 (1.21–1.56)	<.001	1.31 (1.16–1.49)	<.001
San Diego area	1.44 (1.17–1.78)	.001	1.53 (1.30–1.81)	<.001
Hospital ownership				
For-profit	1.0 (Reference)	—	1.0 (Reference)	—
Public	0.69 (0.58–0.81)	<.001	0.80 (0.66–0.97)	.021
Nonprofit	0.80 (0.69–0.93)	.004	0.85 (0.73–1.00)	.051
Kaiser	0.66 (0.55–0.79)	<.001	0.89 (0.71–1.13)	.342
Teaching hospital	0.81 (0.70–0.94)	.004	0.96 (0.83–1.10)	.532
Midwifery presence	0.83 (0.75–0.92)	<.001	0.91 (0.82–1.00)	.06
24-h in-house obstetric coverage	0.91 (0.81–1.03)	.145	0.95 (0.85–1.06)	.357
NICU presence	1.05 (0.95–1.17)	.337	1.03 (0.93–1.14)	.595
Rural location	0.92 (0.79–1.06)	.244	1.02 (0.82–1.28)	.829

OR, odds ratio; CI, confidence interval; VBAC, vaginal birth after cesarean delivery; NICU, neonatal intensive care unit.

*Hospitals grouped in quartiles based on vaginal birth after cesarean delivery rates.

Quartile 1: vaginal birth after cesarean delivery rate 0–0.5%; quartile 2: 0.5–2.6%; quartile 3: 2.6–8.3%; quartile 4: 8.7–46.5%.