




Applying a Prediction Model for Vaginal Birth after Cesarean to a Latina Inner-City Population

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Abstract

Background The Maternal–Fetal Medicine Units (MFMU) Network developed a prediction model for calculating the likelihood of successful vaginal birth after cesarean (VBAC) in patients undergoing a trial of labor after cesarean (TOLAC). In this prediction model, Latina ethnicity is considered a negative predictive factor for successful VBAC. Subsequent studies have found mixed results regarding VBAC success in Latina ethnicity.

Objective Our aim was to compare the predicted chance of successful VBAC (as calculated using the MFMU prediction model) to actual TOLAC outcomes in a large Latina sample.

Study Design We performed a retrospective cohort study of Latinas who underwent TOLAC at our institution from January 1, 2013 to December 31, 2016. The MFMU prediction model was used to calculate each participant’s predicted success, and the participants were then categorized into three groups based on predicted success: low (<35%), moderate (35–65%), and high (>65%). The predicted success rates versus actual outcomes were compared among the three groups.

Results A total of 567 Latinas met inclusion criteria. Successful VBAC occurred in 476 patients (84%). VBAC was achieved in 65.3% of the low predicted success group, 84.4% of the moderate predicted success group, and 91.7% of the predicted high success group. Actual VBAC success rates exceeded the predicted success rates for the low and moderate groups.

Conclusion Our results question whether Latina ethnicity should continue to be considered a negative predictive factor for VBAC success. Our results also suggest that Latinas with a low predicted VBAC success should not necessarily be discouraged from attempting TOLAC.

Keywords

- ▶ trial of labor after cesarean
- ▶ vaginal birth after cesarean
- ▶ hispanic
- ▶ Latina
- ▶ ethnicity

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The rate of cesarean delivery in the United States has increased from 5% in 1970 to 31.9% in 2016.¹ Offering a trial of labor after cesarean section (TOLAC) is one strategy to help reduce the rate of cesarean delivery. However, the overall morbidity and mortality associated with cesarean delivery in the setting of failed TOLAC is higher than the overall morbidity and mortality associated with elective repeat cesarean delivery.

Different tools have been developed to help obstetricians predict the chances of successful vaginal birth after cesarean (VBAC) and to facilitate shared decision-making with patients regarding TOLAC versus elective repeat cesarean delivery. One of the most widely recognized prediction models is the VBAC calculator developed in 2007 by the National Institute of Child Health and Human Development. Maternal-Fetal Medicine Units Network (MFMU) based on observational data published in 2005.^{2,3} This prediction model was subsequently expanded in 2009 to include additional information available at the time of admission.⁴ Both the original 2007 prediction model and the expanded 2009 prediction model identified “Hispanic” or “Latina” ethnicity as a negative predictive factor, based on an $n = 2,362$ Latinas (19.9% of the MFMU study population). In 2006 Hollard et al came to a similar conclusion that Latinas are significantly less likely than Caucasian women to achieve successful VBAC, based on a study that included $n = 993$ Latinas (39% of the study population).⁵

More recently in 2017, Maykin et al. performed a retrospective cohort study on an ethnically diverse population in which Latinas outnumbered any other ethnic group ($n = 229$ Latinas, 40.3% of the study population).⁶ This study categorized patients into one of three groups based on the percent chance of VBAC success: “low” if their predicted success was $<35\%$, “moderate” if their predicted success was 35 to 65%, and “high” if their predicted success $>65\%$. The majority of Latinas in the study fell into the low ($<35\%$) predicted success group. In contrast to prior studies, Maykin et al. observed that the MFMU prediction model underestimated the likelihood of VBAC success for patients in the low ($<35\%$) predicted success group and concluded that ethnicity is not predictive of VBAC success.

A recent commentary in *Obstetrics & Gynecology* regarding disparities in women’s health suggests that race has been “historically mishandled” in research and clinical care due to the presumption that race alone implies a biologic difference.⁷ We suspected that for our study population residing in East Los Angeles, there may be similar complexities in using “Latina” ethnicity as an *a priori* negative factor for predicting VBAC success. The objective of our study was to compare predicted VBAC success rates according to the MFMU prediction model with the observed VBAC success rates in an exclusively Latina patient population.

Materials and Methods

The western Institutional Review Board approved this study which was conducted at Adventist Health White Memorial (AHWM). AHWM is a teaching hospital in inner-city Los Angeles with a predominantly Latina patient population. A total of 15,245 deliveries occurred at AHWM from January 1, 2013 to December 31, 2016. All 701 women who attempted

TOLAC at AHWM within this time frame were identified through a review of the Obstetrics/Gynecology Department’s archive of statistical data forms for each delivery. Each patient’s ethnicity was based on self-reported information at the time of admission. 95% of our TOLAC patients during the study period were Latina; only 5% of all TOLAC patients identified themselves as Caucasian, African American, Asian, or other ethnicity and were excluded from analysis. The following Latina TOLAC patients were also excluded: <18 years of age, preterm (<37 weeks of gestational age), fetal demise, lethal fetal anomalies, deliveries at home or in transit to the hospital, precipitous deliveries upon arrival or shortly thereafter, incomplete medical records, and laboring patients who requested to stop TOLAC and proceed with elective repeat cesarean delivery. ►Fig. 1 depicts a flow diagram of the final study population after exclusions were made. Patients with two prior cesarean deliveries were not excluded because the prediction model has been validated by Metz et al. (2015) for women with two prior cesarean sections.⁸

To calculate the chance of successful VBAC for each patient using the MFMU prediction model, the following patient characteristics on admission were obtained from medical records: age, height, weight, body mass index (BMI), ethnicity, any prior vaginal delivery, any prior VBAC, indication for prior cesarean delivery, estimated gestational age at delivery, dilation, effacement, station, whether the patient had hypertensive disease of pregnancy, and whether labor was induced or spontaneous. A comparison of our study cohort characteristics to the 2007 MFMU cohort characteristics is described in ►Table 1.

We extracted the following data from the medical records for each patient: maternal comorbidities prior to labor onset (chronic hypertension and pregestational and gestational diabetes), intrapartum information (augmentation of labor with oxytocin, epidural use, and administration of magnesium sulfate), neonatal information (gestational age at delivery, birth weight, and 5-minute Apgar’s score), and peripartum complications (gestational hypertension and preeclampsia, chorioamnionitis, endometritis, uterine rupture, postpartum hemorrhage, and cesarean hysterectomy). In our study, uterine rupture is defined as a complete separation of the scar seen intraoperatively, with clinical signs and symptoms suspicious for rupture prior to surgery. Postpartum hemorrhage is defined as blood loss ≥ 500 ccs for vaginal delivery or $\geq 1,000$ ccs for cesarean delivery.

The MFMU prediction model was used to calculate each patient’s probability of VBAC success. As in the study by Maykin et al., our study participants were assigned to one of three groups based on the percent chance of VBAC success: “low” if their predicted success was $<35\%$, “moderate” if their predicted success was 35 to 65%, and “high” if their predicted success $>65\%$.

All statistical analyses and testing were performed using SAS software. For continuous variables such as maternal age or BMI, p -values were generated through analyses of variance. Values for categorical variables were calculated with the Chi-square statistic; when approximately 50% of the cells had expected counts of less than 5, the Chi-square was replaced with Fisher’s exact test (two-sided). When too many cells had expected counts of less than 5, statistical

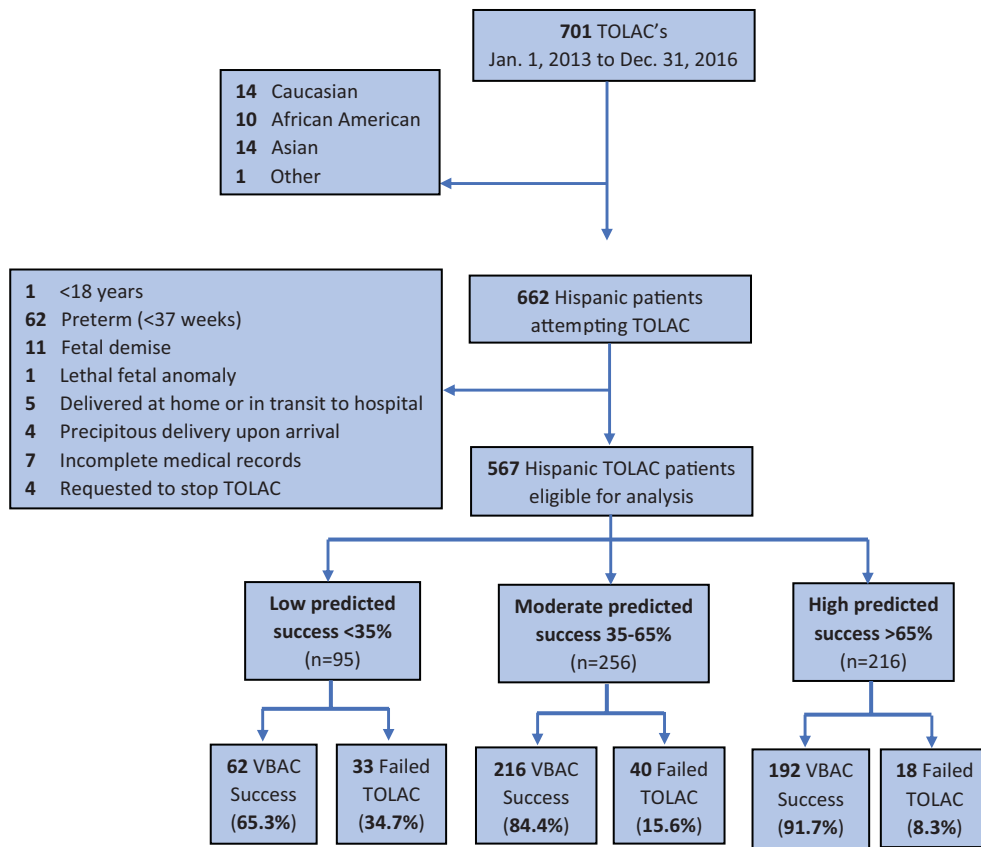


Fig. 1 Flow chart of study participants, exclusions, and final classification based on predicted success. TOLAC, trial of labor after cesarean; VBAC, vaginal birth after cesarean.

testing was not performed and *p*-values were not noted in the tables. For all other variables, we presented the actual calculated *p*-value, with a lower bound of 0.001 (any lower values were represented as <0.001).

Results

Of the 701 women who attempted TOLAC at AHWM during the study period, 662 were Latina and 567 of these Latina

TOLAC patients were eligible for analysis (→Fig. 1). Within the total cohort of 567 Latinas undergoing TOLAC, 476 (84.0%) successfully achieved VBAC and 91 (16.0%) failed TOLAC.

A comparison of variables between the 476 patients who achieved VBAC and the 91 patients who failed TOLAC is summarized in →Table 2. The successful VBAC group and the failed TOLAC group were similar in terms of rates of advanced maternal age, hypertensive disease, epidural use, and intrapartum magnesium use. However, Latina patients who failed TOLAC were more likely to have the following characteristics: obesity, diabetes, prior cesarean delivery for arrest of dilation or descent, and induced labor. Latinas who failed TOLAC were also more likely to experience chorioamnionitis. There were not enough cases of endometritis or 5-minute Apgar’s score <7 to make statistically meaningful comparisons between the two groups. Overall, the majority of negative predictive factors in the MFMU prediction model (i.e., obesity, prior cesarean delivery for arrest of dilation or descent, and induced labor) were also relevant in our Latina patient population.

The individual predicted VBAC success rates for our Latina TOLAC patients ranged from 5.0 to 94.0% (→Fig. 1 and →Tables 3–5). The 95 patients in the “low” (<35%) predicted success group had an actual VBAC success rate of 65.3%. The 256 patients in the “moderate” (35–65%) predicted success group had an actual VBAC success rate of 84.4%. The 216 patients in the “high” (>65%) predicted success group had an

Table 1 A Comparison of the 2007 maternal–fetal medicine units cohort to the current study cohort

Variable	2007 MFMU cohort	Current study cohort
Average maternal age (y)	28.6 ± 5.8	29.3 ± 5.6
Average BMI (kg/m ²)	26.4 ± 6.3	33.7 ± 6.1
Prior cesarean delivery for arrest of dilation or arrest of descent	4,108 (36.3%)	224 (39.5%)
Any prior vaginal delivery	5,617 (47.5%)	262 (46.2%)
Vaginal delivery after prior cesarean	3,996 (33.7%)	164 (28.9%)
Pre-existing diabetes	99 (0.84%)	12 (2.1%)
Latinas	2,362 (19.9%)	567 (100%)

Abbreviation: BMI, body mass index; MFMU, maternal–fetal medicine units.

Table 2 Characteristics of successful vaginal birth after cesarean group compared with characteristics of failed trial of labor after cesarean group

	VBAC (n = 476)		Failed TOLAC (n = 91)		Total (n = 567)		p-Value
Advanced maternal age (≥ 35 years)	89	18.70%	10	10.99%	100	17.46%	0.076
BMI ≥ 30 kg/m ²	339	71.22%	76	83.52%	416	73.19%	0.015
Indication for prior cesarean							
Arrest of dilation or descent	175	36.76%	49	53.85%	224	39.51%	0.002
Other (e.g., nonreassuring FHT, nonvertex)	301	63.24%	42	46.15%	346	60.49%	
Labor type							
Spontaneous	402	84.45%	62	68.13%	466	81.83%	<0.001
Induction	74	15.55%	29	31.87%	104	18.17%	<0.001
Augmentation	212	44.54%	41	45.05%	255	44.62%	0.928
Comorbidities							
Hypertensive disease of pregnancy	36	7.56%	10	10.99%	47	8.11%	0.273
Diabetes	48	10.08%	18	19.78%	66	11.64%	0.008
Intrapartum variables							
Cervical ripening balloon	45	9.45%	23	25.27%	69	11.99%	<0.001
Labor epidural	363	76.42%	71	78.02%	437	76.68%	0.741
Magnesium	20	4.21%	6	6.59%	27	4.59%	0.286
Perinatal outcomes							
Chorioamnionitis	45	9.45%	16	17.58%	61	10.76%	0.022
5-minute Apgar's score < 7	2	0.42%	3	3.30%	5	0.88%	0.031
Endometritis	1	0.21%	2	2.20%	3	0.53%	0.069
Uterine rupture	0	0.00%	3	3.30%	3	0.53%	0.004
Postpartum hemorrhage	23	4.83%	1	1.10%	24	4.23%	0.152

Abbreviations: FHT, fetal heart tracing; TOLAC, trial of labor after cesarean; VBAC, vaginal birth after cesarean.

actual VBAC success rate of 91.7%. Statistically significant differences were noted when comparing the three predicted success groups in terms of demographics and obstetrical histories (**Table 3**), intrapartum variables and comorbidities (**Table 4**), and perinatal outcomes (**Table 5**). The trends in these variables among the three predicted success groups were expected, given that the three groups were defined by these exact variables which are inherent in the MFMU prediction model.

Demographic information is summarized in **Table 3**. Patients with a low predicted success rate were younger (28.5 years) than patients with moderate (28.6 years) and high (30.5 years) predicted success rates ($p < 0.001$). The low predicted success group also had a higher average BMI (37.7 kg/m²) than the moderate (33.0 kg/m²) and high (32.9 kg/m²) predicted success groups ($p < 0.001$).

Obstetrical histories are summarized in **Table 3**. Women in the low predicted success group were less likely to have had a prior vaginal delivery (3.2%) compared with women in the moderate and high predicted success groups (23.1 and 92.6%, respectively; $p < 0.001$). Women in the low predicted success group were also less likely to have had a prior VBAC (0% vs. 6.6% vs. 68.1%; $p < 0.001$).

Intrapartum variables are summarized in **Table 4**. Induced labor occurred more frequently in the low predicted success group (53.7%) compared with the moderate (15.2%) and high (6.0%) predicted success groups ($p < 0.001$). Correspondingly, patients with a low predicted success were less likely to have spontaneous labor (46.3%) compared with patients with a moderate (84.8%) or high (94.0%) predicted success ($p < 0.001$). Furthermore, patients with a low predicted success were more likely to receive epidural anesthesia (88.4%) than those with a moderate (83.9%) or high (63.0%) predicted success ($p < 0.001$).

Comorbidities are summarized in **Table 4**. There were no statistically significant differences in the rates of diabetes or chronic hypertension among the three groups. In contrast, the rates of hypertensive diseases of pregnancy (i.e., gestational hypertension and preeclampsia) showed significant difference, with the low predicted success group exhibiting a higher rate of hypertensive disease (23.2%) than the moderate (7.8%) and high (1.9%) predicted success groups ($p < 0.001$). The low predicted success group also had a higher rate of intrapartum magnesium use (10.5%) than the moderate (5.1%) and high (1.4%) predicted success groups ($p < 0.002$).

Table 3 Demographics and obstetrical history compared among the three predicted success groups

Group	Low (n = 95)		Moderate (n = 256)		High (n = 216)		Total (n = 567)		p-Value
Predicted success	<35%		35–65%		>65%				
Maternal age	28.5 ± 4.7		28.6 ± 5.7		30.5 ± 5.5		29.3 ± 5.6		<0.001
BMI (kg/m ²)	37.7 ± 7.7		33.0 ± 5.3		32.9 ± 5.7		33.7 ± 6.1		<0.001
Gravidity	2.6 ± 0.9		3.0 ± 1.5		4.1 ± 1.5		3.4 ± 1.5		<0.001
Parity	1.1 ± 0.6		1.5 ± 1.0		2.7 ± 1.1		1.9 ± 1.2		<0.001
Any prior vaginal delivery	3	3.16%	59	23.05%	200	92.59%	262	46.21%	<0.001
Prior VBAC	0	0.00%	17	6.64%	147	68.06%	164	28.92%	<0.001
Prior cesarean deliveries									
1	95	100.0%	248	96.88%	208	96.30%	551	97.18%	0.178
2	0	0.00%	8	3.13%	8	3.70%	16	2.82%	
Prior incision type									
Low transverse × 1	42	44.21%	130	50.78%	70	32.41%	242	42.68%	<0.001
Unknown × 1	53	55.79%	118	46.09%	137	63.43%	308	54.32%	
Low transverse × 2	0	0.00%	5	1.95%	4	1.85%	9	1.59%	
Low transverse × 1, unknown × 1	0	0.00%	0	0.00%	2	0.93%	2	0.35%	
Unknown × 2	0	0.00%	3	1.17%	3	1.39%	6	1.06%	
Indication for prior cesarean delivery									
Arrest of dilation	63	66.32%	71	27.73%	41	18.98%	175	30.86%	<0.001
Arrest of descent	7	7.37%	30	11.72%	12	5.56%	49	8.64%	
Nonreassuring fetal heart tracing	11	11.58%	58	22.66%	44	20.37%	113	19.93%	
Malpresentation	6	6.32%	41	16.02%	56	25.93%	103	18.17%	
Other	8	8.42%	56	21.88%	63	29.17%	127	22.40%	

Abbreviations: BMI, body mass index; VBAC, vaginal birth after cesarean.

Perinatal outcomes are summarized in ► **Table 5**. The only statistically significant difference in outcomes was the rate of chorioamnionitis, which trended slightly higher in patients with a lower predicted success (14.7%) or moderate predicted success (14.1%) compared with a high (5.1%) predicted success ($p = 0.003$).

Discussion

The most significant finding of our study was that the application of the MFMU prediction model did not predict TOLAC success in our exclusively Latina patient population. The 567 Latinas who attempted TOLAC in our study achieved an overall 4-year VBAC rate of 84.0%, which exceeds the national VBAC rate of 60 to 80%.¹ When we recalculated each patient's predicted VBAC success rate using non-Latina ethnicity with all other variables unchanged, 141 patients (i.e., 24.9% of the study population) who had previously fallen in the low or moderate predicted success groups were now reclassified in the high-predicted success group (► **Table 6**).

The predicted VBAC success rates for the hypothetical non-Latina counterparts of our study population in ► **Table 6** still

underestimated actual VBAC outcomes, but to a lesser extent. Although Latina ethnicity may not have been the sole reason for the discrepancy between predicted and actual VBAC success rates, our results still raise important questions about whether Latina ethnicity has any relevance to a patient's likelihood of TOLAC success, and whether Latina ethnicity should continue to be treated as a negative predictive factor. Past research that found an association between Latina ethnicity and TOLAC failure did not elucidate an underlying physiologic or biologic explanation for this association.

Several studies including ours have demonstrated that obesity is a risk factor for failed TOLAC,^{9–12} and the prevalence of obesity in the United States is higher among Hispanics (47%) than non-Hispanic whites (37.9%).¹³ However, Latina ethnicity was determined to be a negative predictive factor independent of obesity in the original MFMU prediction model (i.e., Latina ethnicity and obesity were separate variables in the regression analysis). Therefore, obesity does not adequately explain why Latina ethnicity has emerged as a risk factor for failed TOLAC in prior studies. In fact, our Latina patients achieved a surprisingly high VBAC rate of 84.0% despite having an average BMI of 33.7 kg/m², compared with the average BMI of 26.4 kg/m² in the MFMU cohort.

Table 4 Intrapartum variables and maternal comorbidities compared among the three predicted success groups

Group	Low (n = 95)		Moderate (n = 256)		High (n = 216)		Total (n = 567)		p-Value
Predicted success	<35%		35–65%		>65%				
Spontaneous labor	44	46.32%	217	84.77%	203	93.98%	464	81.83%	<0.001
Induction	51	53.68%	39	15.23%	13	6.02%	103	18.17%	<0.001
Augmentation	38	40.00%	133	51.95%	82	37.96%	253	44.62%	0.006
Labor epidural	84	88.42%	214	83.92%	136	62.96%	434	76.68%	<0.001
Cervical ripening balloon	40	42.11%	22	8.59%	6	2.78%	68	11.99%	<0.001
Intrapartum magnesium	10	10.53%	13	5.08%	3	1.40%	26	4.59%	<0.002
Diabetes	12	12.63%	30	11.72%	24	11.11%	66	11.64%	0.927
A1DM	5	5.26%	17	6.64%	21	9.72%	43	7.58%	0.370
A2DM	1	1.05%	7	2.73%	3	1.39%	11	1.94%	
Class B DM	4	4.21%	6	2.34%	0	0.00%	10	1.76%	
Class C DM	2	2.11%	0	0.00%	0	0.00%	2	0.35%	
Hypertensive disease of pregnancy	22	23.16%	20	7.81%	4	1.85%	46	8.11%	<0.001
Chronic HTN	1	1.05%	4	1.56%	1	0.46%	6	1.06%	0.558

Abbreviations: DM, diabetes mellitus; HTN, hypertension.

Table 5 Perinatal outcomes compared among the three predicted success groups

Group	Low (n = 95)		Moderate (n = 256)		High (n = 216)		Total (n = 567)		p-Value
Predicted success	<35%		35–65%		>65%				
VBAC	62	65.26%	216	84.38%	198	91.67%	476	83.95%	<0.001
5-minute Apgar's score < 7	1	1.05%	3	1.17%	1	0.46%	5	0.88%	0.715
Birth weight (g)	3,490 ± 436		3,363 ± 438		3,382 ± 474		3,382 ± 474		0.052
Chorioamnionitis	14	14.74%	36	14.06%	11	5.09%	61	10.76%	0.003
Endometritis	1	1.05%	2	0.78%	0	0.00%	3	0.53%	0.396
Uterine rupture	1	1.05%	2	0.78%	0	0.00%	3	0.53%	0.396
Postpartum hemorrhage	7	7.37%	10	3.91%	7	3.24%	24	4.23%	0.235

Abbreviation: VBAC, vaginal birth after cesarean.

Table 6 Vaginal birth after cesarean rates compared among the three predicted success groups based on patient's actual ethnicity versus hypothetical non-Latina ethnicity

	Low predicted success (<35%)		Moderate predicted success (35–65%)		High predicted success (>65%)		Total		p-Value
VBAC in Latinas	n = 62/95	65.26%	n = 216/256	84.38%	n = 198/216	91.67%	n = 476/567	84.04%	<0.001
VBAC in hypothetical non-Latina counterparts	n = 15/25	60.00%	n = 122/162	75.30%	n = 339/380	89.21%	n = 476/567	84.04%	<0.001

Abbreviation: VBAC, vaginal birth after cesarean.

The primary limitation of our study was the use of self-reported information to determine each patient's ethnicity for calculating TOLAC success. As in other studies on the application of the MFMU prediction model, including the original study, no information was provided in terms of how ethnicity or race was defined or determined. The "Latinas" who served as the focus of our study represented a heterogeneous, poorly defined ethnic group. We did not have information regarding maternal birthplace, which could have helped us to compare the TOLAC success rates of Latinas born in the United States versus Latinas born in Mexico versus Latinas born in other countries. The Latina population in Southern California is predominantly of Mexican ancestry, and caution should be exercised in applying generalizations from our study to Latinas of Puerto Rican, Cuban, Central American, South American, or other origin. This underscores the limitations and hazards of including race or ethnicity alone as a loosely defined variable.

Another limitation is that the number of patients who initially considered TOLAC but ultimately decided to undergo elective repeat cesarean delivery is unknown, as is the case in most studies on predicting TOLAC success. There are many reasons why a patient may choose to decline TOLAC, including the obstetrician's counseling (whether biased or unbiased), the patient's predicted success according to the MFMU prediction model, and the patient's own personal values, preferences, and motivations. Our results may have differed if these patients had chosen to undergo TOLAC and were included in our study.

Our study also did not include information regarding the duration of labor for each patient undergoing TOLAC; therefore, it is unknown whether specific clinical interventions or management practices contributed to our success rates. The national changes in practice patterns that have developed since the original MFMU study in 2007 could possibly explain the higher than expected VBAC rates in our study. For example, the 2014 Obstetric Care Consensus on "Safe Prevention of the Primary Cesarean Delivery" currently allows women with a cervical dilation of at least 6 cm to continue labor for 4 hours with ruptured membranes and adequate uterine activity, or 6 hours with inadequate uterine activity.¹⁴ Management of category II fetal heart rate tracings were also not as standardized prior to the algorithm published by Clark et al in 2013.¹⁵

Regardless of the limitations, our study has ultimately demonstrated that Latinas should not be discouraged from undergoing TOLAC solely based on a single variable within the MFMU prediction model or based on a low predicted success score. As with patients of any other ethnicity, a Latina patient's choice to undergo TOLAC versus elective repeat cesarean delivery should involve a comprehensive shared decision-making process that includes careful consideration of multiple factors.

Note

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Conflict of Interest

None declared.

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