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Protocol versus Practice: Deviations from 2 Guidelines in Low-Risk Twin Deliveries in the United States

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ABSTRACT

Background: Medical guidelines recommend vaginal delivery for low-risk twin pregnancies because cesareans increase the probability of maternal morbidity and mortality. Yet, vaginal delivery rates for twins are considerably lower than for comparable singletons. One explanation for this disparity argues that greater risk associated with twins warrants increased surgical intervention. An alternative explanation is that twin deliveries are more likely to deviate from protocols that advise vaginal birth.

Methods: Using the 2017 Natality Detail file (N=3,197,401), we measured alignment of vaginal birth and trial of labor (TOL) with the American College of Obstetricians and Gynecologists' guidelines for twin and singleton no-indicated-risk births. We calculated predicted probabilities for the population and by maternal race/ethnicity to assess whether low rates of vaginal births among twins are explained by associated risk factors, or by deviations from recommended delivery methods.

Results: Overall, 31.2% of twins were born vaginally, compared to 79.4% of singletons. Controlling for indicated risks, the predicted probability of vaginal birth for twins was 0.49 and

0.85 for singletons. The predicted probability of TOL for twins was 0.18 and 0.47 for singletons. Maternal race/ethnicity was only weakly associated with mode of delivery. These findings indicate that no-indicated-risk twin pregnancies, across maternal racial/ethnic categories, have lower probabilities of vaginal birth and TOL than would be expected with widespread adherence to current guidelines.

Conclusions: Given the life-threatening consequences that may result from unnecessary surgical procedures, our findings highlight the need for further research to illuminate medical and nonmedical mechanisms driving nonadherence with clinical guidelines for twin births.

Keywords: Cesarean; Twin; Medical protocol

1 | INTRODUCTION

According to the American College of Obstetricians and Gynecologists (ACOG), "for most pregnancies, which are low risk, cesarean delivery appears to pose greater risk of maternal morbidity and mortality than vaginal delivery"[1]. For low-risk pregnancies, cesarean delivery is associated with increased rates of hysterectomy, uterine rupture, cardiac arrest, venous thromboembolism, pain, hemorrhage, and infection for the woman[2], and weakened immune response and heightened risk for cerebral palsy for the infant[3,4]. As such, ACOG guidelines state that vaginal delivery is preferred for singleton and twin pregnancies that present with no indicated risk[1]. Yet, the vaginal birth rate for twins (25%) is considerably lower than the vaginal birth rate for singletons (75%)[5-7]. Causes of these disparities in mode of delivery between twins and singletons are yet to be fully understood, and a combination of factors are likely at play. However, the literature examining the rise in overall cesarean rates offers two possible explanations: (1) increases in relevant risk factors and (2) inconsistent adherence to medical guidelines that promote vaginal birth.

The first explanation for the increased use of cesarean in recent years focuses on maternal demographics and risk factors[8-11]. Advanced maternal age, obesity, hypertension, and diabetes, which are associated with vaginal delivery complications and heightened use of cesarean, have increased over the past several decades[2,10,12,13]. For example, the average maternal age at first birth rose from 22.7 in 1980 to 26.3 in 2016,[14] and the maternal obesity rate rose from 13% in 1994[15] to 24.8% in 2014[16]. This explanation assumes medical guidelines are generally followed, and that the nearly one-third of pregnancies delivered via cesarean today result from increased rates of risk factors that characterize contemporary maternal landscapes.

Following this rationale, twin-singleton disparities in mode of delivery might be explained by twin pregnancies being more frequently associated with such risk factors relative to singletons. For example, low birthweight comprises 56.6% of twin births compared to only 6.4% of singleton births[17,18]. Twins are born prematurely (less than 37 weeks gestation) in 58.8% of births compared to only 10.4% for singletons, with a 13-fold increase in extreme prematurity (before 32 weeks gestation) for twins relative to singletons[18]. First-born twins present breech in 21-30% of births[19,20], whereas only 3-4% of singletons present breech[21,22]. Additional prenatal complications more common among twin pregnancies include gestational diabetes mellitus, hypertensive disorders, and preeclampsia[23-25].

The second explanation suggests that rising cesarean rates are the result of inconsistent adherence to medical guidelines[26], leading to an "overuse, underuse, and misuse of medical care"[27]. Though protocols for pregnancies with no indicated risk have remained supportive of vaginal delivery[1], cesarean rates among these pregnancies rose from 3.3% in 1991 to 5.5% in 2001; a 67% increase over a single decade[28]. A comprehensive study by MacDorman and colleagues[10] found that the large and rapid increase in the no-indicated-risk cesarean rate is more attributable to changing obstetric practices than changing maternal risk factors or preferences. These results are supported by more recent work confirming that features unrelated to maternal or fetal risk factors, such as hospital context or physician incentives, influence cesarean delivery[29,30].

From this perspective, twin-singleton disparities in mode of delivery might be explained by a greater influence of outside factors on twin pregnancy outcomes compared to singletons. Research has shown maternal request for cesarean delivery is associated with fear and perceptions of safety[31]. Fear of negative birth outcomes above-and-beyond identified risk may

then influence maternal request for cesarean delivery among twin births at higher rates than for singleton births. Other nonmedical factors potentially driving deviations from recommended delivery methods unequally across comparable twin and singleton births include factors like physician concern over litigation[30,32] and physician training (e.g., limited training in breech vaginal deliveries)[33,34].

Taking these explanations into consideration, the purpose of our study was to compare mode of delivery for twins versus singletons to determine whether low rates of vaginal delivery among twins are more likely due to (1) increased risk factors or (2) nonadherence to medical recommendations. Holding constant the risk factors outlined in ACOG guidelines, we examined whether twin-singleton disparities in vaginal birth are attenuated, as would be expected if practices were congruent with protocols. If twin pregnancies deliver vaginally less frequently than singleton pregnancies when controlling for risk factors outlined in ACOG guidelines, non-adherence of some sort may be driving twin-singleton vaginal birth disparities.

Our secondary aim was to examine whether there is evidence of racial/ethnic disparities in adherence to ACOG guidelines. There is abundant evidence that racial categories influence reproductive healthcare[35-37], and various pregnancy- and birth-related outcomes, such as maternal mortality [38,39], venous thromboembolism[40], premature birth, low birth weight, and preeclampsia[41-43]. However, research examining the relationship between cesareans and race/ethnicity is inconsistent[43,44]. Several analyses note differences in cesarean rates by race/ethnicity[45,46], but others find minimal variation[47-49] or mixed results[50-53]. ACOG protocols on twin pregnancies do not delineate race-based recommendations. Therefore, racial/ethnic variation in the mode of delivery of no-indicated-risk twin pregnancies could suggest disparities in adherence to professional guidelines based on racial/ethnic categories. Conversely, lack of

such variation could suggest that patient racial/ethnic identity does not play a major role in adherence to protocols that indicate vaginal delivery for low-risk twins.

2 | METHODS

2.1 | Research Questions and Hypotheses

This cross-sectional study investigates how closely modes of delivery align with ACOG guidelines comparing twin to singleton births. Specifically, we ask two questions: 1) Is the predicted probabilities of vaginal delivery among no-indicated-risk twins similar to or less than the predicted probabilities of vaginal delivery among no-indicated-risk singletons?; and 2) Is the predicted probabilities of trial of labor among no-indicated-risk twins similar to or less than the predicted probabilities of trial of labor among no-indicated-risk singletons? To test these questions, we developed the following null and research hypotheses.

Null Hypotheses

The probability of vaginal birth for twins will approximately equal the probability of vaginal birth for singletons, holding constant risk factors outlined by ACOG guidelines at zero.

H_0:P(vaginal birth | no risks)$_{twin}$ = P(vaginal birth | no risks)$_{singleton}$

The probability of trial of labor (TOL) for twins will approximately equal the probability of trial of labor for singletons, holding constant risk factors outlined by ACOG guidelines at zero.

H_0:P(TOL | no risks)$_{twin}$ = P(TOL | no risks)$_{singleton}$

If, after controlling for risk factors described in ACOG guidelines (specified in the Data and Variables section below), the predicted probabilities of vaginal birth and trial of labor are similar between no-indicated risk twins and no-indicated risk singletons, then our data would support the

hypothesis that mode of delivery and trial of labor are explained by associated risks. These patterns would be expected with widespread adherence to medical protocols.

Research Hypotheses

The probability of vaginal birth for twins will be less than the probability of vaginal birth for singletons, holding constant risk factors outlined by ACOG guidelines at zero.

H_1:P(vaginal birth | no risks)$_{twin}$ < P(vaginal birth | no risks)$_{singleton}$

The probability of trial of labor for twins will be less than the probability of trial of labor for singletons, holding constant risk factors outlined by ACOG guidelines at zero.

H_1:P(TOL | no risks)$_{twin}$ < P(TOL | no risks)$_{singleton}$

If, after controlling for risk factors described in ACOG guidelines (outlined in the Data and Variables section below), the predicted probabilities of vaginal birth and trial of labor for no-indicated risk twins are less than those for no-indicated risk singletons, then our data would support the notion that mode of delivery and trial of labor cannot be explained by associated risks alone. These patterns would suggest that gaps in adherence with clinical guidelines exist among twin births and may be driving twin-singleton vaginal birth rate disparities.

2.2 | Data and Variables

Our findings derive from birth certificate data culled by the 2017 Natality Detail File[54]. These data are publicly available from the National Vital Statistics System and provide information on all recorded live births occurring in the United States. Since these data contain no personal or geographic identifiers, this study was exempt from Institutional Review Board (IRB) review.

The units of analysis were twins and singletons born alive in a hospital in the United States in 2017 to women who had no previous cesarean (N = 3,197,401). We examined two

dependent variables: mode of delivery (vaginal vs primary cesarean); and trial of labor (yes vs no). Trial of labor (TOL) applies only to cesarean births and specifies if vaginal labor was attempted prior to the final route of cesarean delivery. Our independent variable was plurality (twin vs singleton).

To test our hypotheses, we controlled for the risk factors that current ACOG recommendations outline as potential indicators of mode of delivery. We consulted all ACOG documents that made recommendations regarding twin delivery at the time of our writing[1,2,55]. Overall, twins follow the same general recommendations as singletons[2], with the slight distinction that vaginal delivery is suggested when the first twin is cephalic even if the second twin presents breech[2,56]. Fetal risk factors outlined by ACOG guidelines include: presentation (cephalic vs breech), birthweight (in grams), and gestational age (in weeks)[2]. Maternal risks include: age (in years) and body mass index (BMI)[2]. Our analysis also uses a binary measure of the presence of one or more of the following maternal health risks associated with pregnancy complications: diabetes (pre-pregnancy or gestational), hypertension (pre-pregnancy or gestational), eclampsia, previous preterm birth, use of infertility treatment, and the presence of gonorrhea, syphilis or chlamydia[1].

For ease of interpretation of the crosstabulations, we recoded continuous variables into categories consistent with risk thresholds: birthweight (<2500, 2500-3999, 4000+ grams), gestational age (< 37, 37-39, 40+ weeks), maternal age (<20, 20s, 30-34, 35+) and maternal BMI (<18.5, 18.5-24.99, 25-29.99, 30+). We left them as continuous for our multivariate analysis, except for birthweight as described below. For the multivariate analysis, we combined plurality with presentation and set order to account for the presentation of first twin, a central variable

outlined by ACOG guidelines. As such, categories included singleton cephalic, singleton breech, first twin cephalic, first twin breech, and second twin (regardless of presentation).

To examine if there is evidence of racial/ethnic disparities in adherence to medical guidelines regarding twin pregnancies, we stratified the population by maternal race/ethnicity (non-Hispanic White identifying – hereafter referred to as "White", non-Hispanic Black identifying – hereafter referred to as "Black", and Hispanic identifying – hereafter referred to as "Hispanic"). We focus our analysis on the three most populous groups because detailed racial analysis is beyond the scope of this project, and evidence suggests that combining smaller, heterogenous populations into an "other" category is problematic[57].

2.3 | Analysis

To measure the association between mode of delivery and TOL with plurality, risk factors, and maternal race/ethnicity, we calculated crosstabulations (see Tables 1 and 2). Next, we constructed two separate multivariate binary logistic regression models to calculate predicted probabilities (see Figures 1 and 2). The first regression model calculated the odds of vaginal birth, while holding indicated risk factors constant (see Table 3). The second calculated the odds of attempting labor prior to cesarean, while holding indicated risk factors constant (see Table 4).

For the vaginal birth logistic regression model, vaginal was coded 1 and cesarean was coded 0. Birthweight was shown to have a nonlinear relationship with vaginal birth in the crosstabulations, with low birthweight (<2500 grams) and high birthweight (4000+ grams) births having lower percentages of vaginal birth, relative to normal birthweight (2500-3999 grams) births. Based upon this observed relationship, we maintain the low/normal/high birthweight categories in the multivariate analysis for this control variable. The low-risk independent and control categories (singleton cephalic, normal birthweight, and no maternal health risk factors)

186 served as referent categories to report odds of cesarean birth for the indicated-risk categories
187 (first twin breech, low/high birthweight, and maternal health risk factors present).
188 For the attempted-labor regression model, trial of labor was coded 1 and no trial was
189 coded 0. As with the cesarean model, the low-risk independent and control categories (singleton
190 cephalic, normal birthweight, and no maternal health risk factors) served as referent categories to
191 report odds of attempting labor prior to cesarean for the indicated-risk categories (first twin
192 breech, low/high birthweight, and maternal health risk factors present). Because BMI was not
193 associated with trial of labor in the crosstabulations, we omitted it from the second logistic
194 regression model.
195 Finally, we calculated the predicted probabilities of vaginal birth and trial of labor using
196 coefficients from the multivariate logistic regression models. Predicted probabilities were
197 derived from a series of equations, starting with log odds = log (π / 1 – π) = α + β1X1 + β2X2 + .
198 . . + βKXK, which were exponentiated = exp(logit), and then converted to predicted probabilities
199 = odds / (1 + odds)[58]. To isolate predicted probabilities of no-indicated-risk pregnancies, we used
200 coefficients for low-risk categories of our categorical control variables (cephalic, no maternal
201 health risk factors, normal birth weight). For most continuous variables, we entered mean values
202 of our sample into the predicted probability formula (gestational age = 38.2 weeks, maternal age
203 = 28 years). However, since the mean BMI was in the overweight range (26.9), we used a score
204 in the normal range (24) to calculate the predicted probability of vaginal and attempted vaginal
205 birth among twin and singleton births devoid of other risk factors. Inferential tests of difference
206 were not conducted for this study because we have the population of all recorded births from
207 2017. Alongside the predicted probabilities of vaginal delivery and TOL for singletons and
208 twins, we report the net difference in those predicted probabilities across the plurality groups.

The logistic regression and predicted probability analyses were executed for all births in our population (i.e., twins and singletons born alive in a hospital in the United States in 2017 to women who had no previous cesarean) and then separately stratified by maternal race/ethnicity. Tables and figures display the entire population along with the three subsets for comparison.

3 | RESULTS

3.1 | Crosstabulations

Of the 3,197,401 total live twin and singleton hospital births by women with no previous cesareans in 2017, 77.8% were born vaginally, including 31.2% of twins and 79.4% of singletons (see Table 1). Wider gaps in delivery method across birthweight, presentation, and maternal health risk factor categories were observed for vaginal birth among singletons than among twins, indicating weaker relationships between risk categories and delivery method for twins relative to singletons. For example, only 40.1% of cephalic twins and 33.3% of twins with no maternal health risk factors were born vaginally compared to 82% and 81.2% of singletons, respectively. Stratifying by race/ethnicity illuminated a weak association with mode of delivery. Rates of vaginal delivery between twins of Black and White women were essentially equal, with twins of Hispanic women about 4 points lower. Births of Black women displayed the least variation in mode of delivery by plurality, followed by births of White and then Hispanic women.

Of the 702,730 total live twin and singleton cesarean hospital births by women with no previous cesareans in 2017, 41.2% attempted vaginal birth, including 11.8% of twins and 44.5% of singletons (see Table 2). Like mode of delivery, the relationships between TOL and birth weight, presentation, and maternal health risk factors were weaker among twins than among singletons. For example, only 13.8% of cephalic first-twins and 11.3% of twins with no maternal

health risk factors attempted labor compared to 50.4% and 43.5% of singletons, respectively. Stratifying by race/ethnicity illuminated essentially no association with trial of labor. TOL among White women for both singletons and twins were just one or two percentage points below TOL among Black and Hispanic women.

These findings support our research hypotheses. For each risk category and across racial/ethnic groups, twin births deliver vaginally and attempt labor less often, even controlling for indicated risk factors.

3.2 | Predicted Probabilities

Our multivariate predicted probability analysis of vaginal birth and trial of labor focused on differences across plurality for births exhibiting no indicated fetal or maternal risk factors outlined in ACOG documents. Overall, twin pregnancies had considerably lower predicted probability of vaginal birth than singleton pregnancies (see Figure 1). The overall predicted probability of vaginal birth for no-indicated-risk twins was 0.56 compared to 0.86 for no-indicated-risk singletons. The predicted probability of vaginal delivery of no-indicated-risk twins varied only slightly by maternal race/ethnicity. Twins of Hispanic women had .08 lower predicted probability of vaginal birth than twins of White and Black women. Births of Hispanic women also varied more by plurality (.36) than births of White (.28) or Black (.24) women.

Similarly, twins had considerably lower predicted probability of TOL than singletons. Overall predicted probability of TOL for no-indicated-risk twins was 0.18 compared to 0.48 for no-indicated-risk singletons. The predicted probability of TOL of no-indicated-risk twins varied only slightly by race/ethnicity. Twins of Hispanic women had .04 lower predicted probability of vaginal birth than twins of White and Black women. Births of White women varied slightly more by plurality (.31) than births of Black (.28) or Hispanic (.28) women.

Results of our predicted probability calculations lend further support for our research hypotheses for vaginal birth and trial of labor. When holding constant the risk factors outlined by ACOG protocols, the probabilities of vaginal delivery and trial of labor were considerably lower for twins than for singletons across racial categories. Cesarean was widely utilized even for cases seemingly fitting medical recommendations for non-intervention. This indicates possible nonadherence with clinical guidelines and heightened potential for negative consequences associated with unnecessary surgical procedures.

4 | DISCUSSION

Motivated by medical research showing that vaginal delivery decreases the probability of maternal morbidity and mortality for low-risk twin pregnancies relative to cesarean, this study examined how closely mode of delivery aligns with ACOG guidelines. Results from our analysis showed that the probabilities of vaginal delivery and trial of labor were considerably lower for twins with no indicated risks than for comparable singletons, including across racial/ethnic groupings. These findings lend support for our research hypotheses, suggesting widespread disparities between practice and medical protocols that recommend vaginal birth for twin pregnancies devoid of indicated risks. Additionally, our findings suggest that adherence to ACOG guidelines recommending vaginal birth does not appear to vary across racial/ethnic categories. Similar to various other studies[47,49,59], we found no meaningful association between the categories of White/Black/Hispanic, and mode of delivery for singletons and twins (see Edmonds et al 2014 for discussion about the effect of more detailed race/ethnicity categories).

There are undoubtedly circumstantial factors affecting individual deliveries that cannot be accounted for in this study. Yet, the stark variation in predicted probabilities by plurality

suggest that there are systemic deviations going above and beyond individual circumstances. Existing literature provides several possible explanations to contextualize our findings. Particularly applicable are how physician training, patient preferences, and litigation may differentially impact twin relative to singleton births.

First, research suggests that cesarean deliveries are frequently used in instances when physicians are not confident in their ability to deliver a breech pregnancy[34,60]. Few physicians receive comprehensive training in vaginal breech delivery[33,34] and twins have a greater probability of presenting breech[20,21]. As such, lack of provider training in methods promoting vaginal delivery (e.g., manual breech extraction) might contribute to heightened cesarean rates among twins[33,34]. Since ACOG guidelines suggest external cephalic version for twins[55,61] and vaginal delivery when first twin is cephalic, even if second twin is breech[2], increased physician training in breech delivery methods could help to decrease the cesarean rate among twins.

Second, patients choose elective cesarean for myriad reasons, including fear of the pain of delivery, beliefs that the procedure is safer than vaginal birth, and a heightened sense of control over uncertainty[66,67]. Particularly in the case of twin births, an elevated sense of fear and uncertainty is purported to drive maternal request for cesarean delivery, more so than among singleton births[31]. Though the role of women's preference on increasing overall cesarean rates is debated[68,69], evidence suggests that women are more likely to request cesarean with twins than singletons[31,70]. Therefore, intervention programs aimed at educating and supporting pregnant women, and addressing their concerns about the labor and delivery processes, may then help to reduce excessive maternal request for cesarean for twins[66,71].

A final potential factor influencing deviation from clinical guidelines for twin births is the litigious landscape of practicing medicine in the United States. Malpractice claims have

bourgeoned across medicine, and obstetricians face heightened risk of liability relative to physicians of other specialties[62,63]. Fear of litigation drives many obstetricians to engage in "defensive" medicine, i.e., making decisions to minimize as much risk as possible through action, including the use of surveillance, pharmaceuticals, technologies, and surgery[30,32,64,65]. Indeed, the likelihood of a malpractice claim is shown to decrease with every additional intervention performed[30]. Thus, if twin births are assumed to be more dangerous by birthing mothers[31], litigation-motivated medical decision-making may account for some of the deviation between protocol and practice observed in this study.

Due to data limitations, our study cannot confirm that physician training, maternal preferences, and/or litigation affect adherence to medical guidelines differently for twins than for singletons[30-32]. Nor can we measure the effects of various other factors known to influence mode of delivery more generally, such as geographic region[72], hospital type[73], financial incentives[29,74], or "leisure" incentives (e.g., personal obligations and rest)[75,76].

Instead, the value of this analysis lies in its unique quantification of the gap between identifiable medical risk factors and mode of delivery to demonstrate the lack of adherence to medical guidelines for twin births. It also contributes to a larger literature examining variation in adherence to medical guidelines, which is considered one of the leading healthcare issues in the United States [77].

CONCLUSION

Nonadherence to medical guidelines that support vaginal birth can have detrimental health outcomes for women, infants, and broader public health trends[27]. Results from this study indicate a potential overuse of cesarean delivery among low-risk twin births in the US. Given the life-threatening consequences that can result when cesareans are overused, our findings highlight

the need for further research to illuminate the complicated medical and nonmedical mechanisms driving nonadherence with clinical guidelines for low-risk twin births.

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TABLE 1. Percent of Total Hospital Births Delivered Vaginally by Risk Factors and Maternal Race/Ethnicity

		Total	Singletons	Twins
N = 3,197,401		77.8%	79.4%	31.2%
Birth weight	<2500 grams	55.2%	62.7%	29.6%
	2500 -3999 grams	80.6%	81.5%	32.9%
	4000+ grams	70.6%	70.6%	24.4%
Gestational Age	<37 weeks	62.0%	68.7%	29.0%
	37-39 weeks	79.3%	80.4%	34.2%
	40+ weeks	80.6%	80.8%	32.9%
Presentation	Cephalic	81.0%	82.0%	40.1%
	Breech	15.1%	16.3%	10.6%
Maternal Health Risk Factors	Absent	79.9%	81.2%	33.3%
	Present	70.3%	73.4%	27.6%
Maternal Age	<20	81.5%	82.3%	30.1%
	20s	79.7%	81.0%	33.0%
	30-34	77.1%	78.9%	31.8%
	35+	71.7%	74.0%	27.2%
Maternal BMI	<18.5	84.1%	85.5%	32.6%
	18.5-24.99	81.5%	83.0%	33.1%
	25-29.99	77.6%	79.2%	30.9%
	30+	71.2%	72.9%	28.7%
Maternal Race/Ethnicity	White	78%	79.7%	32.2%
	Black	74.6%	76.3%	32.7%
	Hispanic	79.6%	80.9%	28.4%

Source: NCHS, National Vital Statistics System, 2017 Natality Detail File

Note: Sample limited to live singletons and twins born in a hospital to women who had no previous cesarean. Maternal health risk factors include diabetes, hypertension, eclampsia, previous preterm birth, infertility treatment used, gonorrhea, syphilis or chlamydia.

TABLE 2. Percent of Total Hospital Births that Attempted Vaginal Birth Prior to Cesarean Delivery (Trial of Labor/TOL) by Risk Factors and Maternal Race/Ethnicity

		Total	Singletons	Twins
N = 702,730		41.2%	44.5%	11.8%
Birth weight	<2500 grams	22.3%	28.4%	11.5%
	2500 -3999 grams	44.7%	46.8%	12.2%
	4000+ grams	46.3%	46.3%	15.5%
Gestational Age	<37 weeks	22.2%	27.4%	11.2%
	37-39 weeks	38.0%	40.0%	12.7%
	40+ weeks	58.5%	59.2%	12.6%
Presentation	Cephalic	47.6%	50.4%	13.8%
	Breech	12.6%	13.7%	8.6%
Maternal Health Risk Factors	Absent	40.7%	43.5%	11.3%
	Present	39.4%	44.7%	12.5%
Maternal Age	<20	53.2%	55.9%	11.4%
	20s	45.1%	48.3%	11.9%
	30-34	38.1%	41.5%	12.2%
	35+	33.6%	36.8%	11.1%
Maternal BMI	<18.5	36.2%	39.2%	11.0%
	18.5-24.99	39.7%	43.2%	11.9%
	25-29.99	41.5%	45.0%	11.7%
	30+	42.8%	46.0%	11.7%
Maternal Race/Ethnicity	White	41.2%	44.5%	11.8%
	Black	42.3%	46.0%	12.2%
	Hispanic	42.2%	45.6%	13.2%

Source: NCHS, National Vital Statistics System, 2017 Natality Detail File

Note: Sample limited to live singletons and twins born in a hospital to women who had no previous cesarean. Maternal health risk factors include diabetes, hypertension, eclampsia, previous preterm birth, infertility treatment used, gonorrhea, syphilis or chlamydia.

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TABLE 3. Logistic Regression Analysis of Singleton and Twin Hospital Births Delivered Vaginally by Risk Factors, Stratified by Maternal Race/Ethnicity

	Overall	White	Black	Hispanic
	B (S.E.)	B (S.E.)	B (S.E.)	B (S.E.)
Plurality + Presentation + Order				
Singleton Cephalic	R	R	R	R
Singleton Breech	-3.188 (.008)	-3.484 (.012)	-2.328 (.021)	-2.998 (.017)
First Twin Cephalic	-1.580 (.011)	-1.528 (.015)	-1.254 (.028)	-1.853 (.131)
First Twin Breech	-4.526 (.049)	-4.735 (.071)	-3.791 (.096)	-4.819 (.131)
Second Twin	-2.086 (.011)	-2.056 (.014)	-1.812 (.026)	-2.315 (.027)
Birthweight in Grams				
<2500 grams	-.642 (.006)	-.661 (.0009)	-.598 (.013)	-.651 (.014)
2500 -3999 grams	R	R	R	R
4000+ grams	-.580 (.005)	-.533 (.007)	-.711 (.017)	-0.745 (.011)
Gestation in Weeks	.000 (.001)	.012 (.001)	-.008 (.002)	-0.007 (.002)
Maternal Health Risk Factors				
Absent	R	R	R	R
Present	-.253 (.004)	-.0296 (.006)	-.136 (.010)	-.200 (.009)
Maternal Age in Years	-.023 (.000)	-0.021 (.000)	-0.038 (.001)	-0.020 (.001)
Maternal Body Mass Index	-.042 (.000)	-0.049 (.000)	-0.038 (.001)	-0.032 (.001)
Constant	-1.048 (.057)	3.197 (.046)	3.566 (.064)	3.466 (.064)

Source: NCHS, National Vital Statistics System, 2017 Natality Detail File, N = 3,197,401

Note: Mode of delivery is the dependent variable, coded 0 for cesarean and 1 for vaginal. Maternal health risk factors include diabetes, hypertension, eclampsia, previous preterm birth, infertility treatment used, gonorrhea, syphilis or chlamydia. Sample limited to live singletons and twins born in a hospital to women who had no previous cesarean.

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TABLE 4. Logistic Regression Analysis of Births that Attempted Vaginal Birth Prior to Cesarean Delivery (Trial of Labor/TOL) by Risk Factors, Stratified by Maternal Race/Ethnicity

	Overall	White	Black	Hispanic
	B (S.E.)	B (S.E.)	B (S.E.)	B (S.E.)
Plurality + Presentation + Order				
Singleton Cephalic	R	R	R	R
Singleton Breech	-1.742 (.010)	-1.913 (.014)	-1.350 (.029)	-1.505 (.022)
First Twin Cephalic	-1.455 (.021)	-1.460 (.028)	-1.323 (.052)	-1.447 (.053)
First Twin Breech	-2.467 (.042)	-2.622 (.058)	-2.123 (.092)	-2.434 (.108)
Second Twin	-1.446 (.017)	-1.479 (.023)	-1.288 (.041)	-1.422 (.043)
Birthweight in Grams				
<2500 grams	-.081 (.011)	-.020 (.016)	-.241 (.022)	-.104 (.024)
2500 -3999 grams	R	R	R	R
4000+ grams	-.177 (.009)	-.215 (.012)	-.111 (.027)	-.206 (.019)
Gestation in Weeks	.142 (.001)	.162 (.002)	.108 (.003)	.127 (.003)
Maternal Health Risk Factors				
Absent	R	R	R	R
Present	.269 (.007)	.235 (.010)	.293 (.017)	.326 (.016)
Maternal Age in Years	-.037 (.000)	-.038 (.001)	-.040 (.001)	-.035 (.001)
Constant	-6.925 (.068)	-5.116 (.081)	-3.117 (.115)	-4.151 (.119)

Source: NCHS, National Vital Statistics System, 2017 Natality Detail File, N = 702,730

Note: Attempted vaginal delivery is the dependent variable, coded 0 for not attempted and 1 for attempted. Maternal health risk factors include diabetes, hypertension, eclampsia, previous preterm birth, infertility treatment used, gonorrhea, syphilis or chlamydia. Sample limited to live singletons and twins born in a hospital to women who had no previous cesarean.

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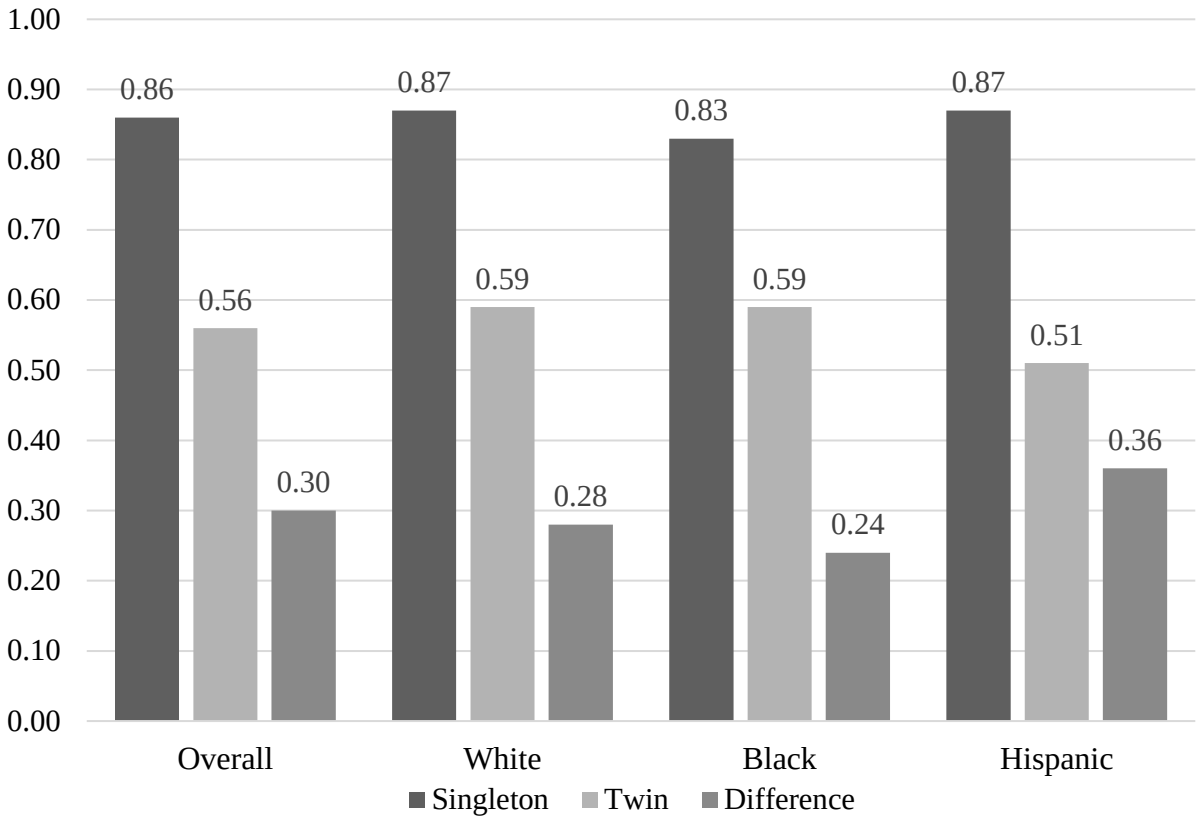
FIGURE 1.
Predicted Probability of Vaginal Birth

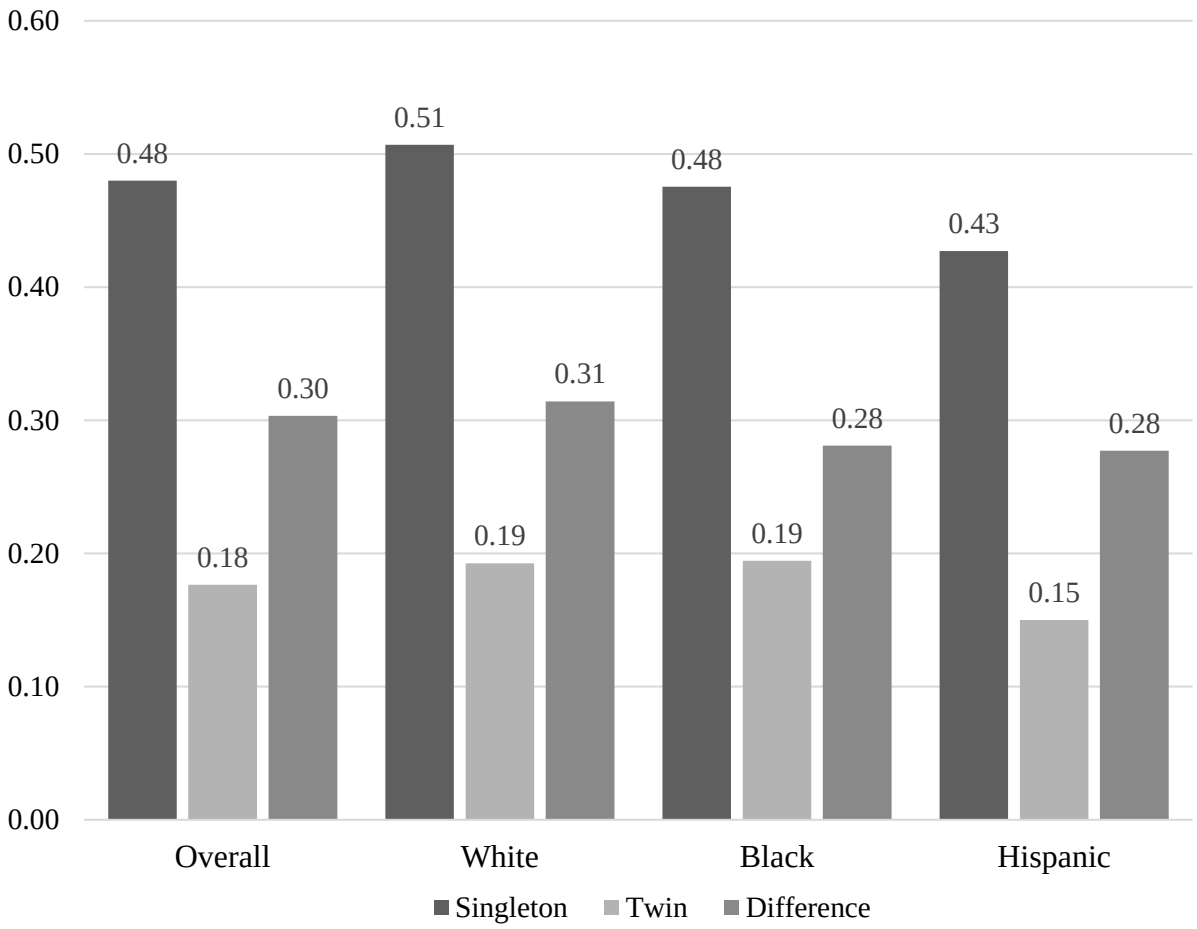


Source: NCHS, National Vital Statistics System, 2017 Natality Detail File, N = 3,197,401

Note: Predicted probability of vaginal birth (coded 1) is calculated in comparison to cesarean birth (coded 0). Predicted probability assumes "low risk" status: cephalic, no maternal health risk factors, 2500 -3999 grams birthweight, 38.2 weeks gestational age, 28 years maternal age, BMI of 24.

602

FIGURE 2.
Attempted Vaginal Birth Among Cesarean Births (Trial of Labor/TOL)



Source: NCHS, National Vital Statistics System, 2017 Natality Detail File, N = 702,730

Note: Predicated probability of attempted vaginal birth among cesarean births (coded 1) is calculated in comparison to no attempt prior to cesarean birth (coded 0). Predicted probability assumes "low risk" status: cephalic, no maternal health risk factors, 2500 -3999 grams birthweight, 38.2 weeks gestational age, 28 years maternal age.

603