HHS Public Access
Author manuscript
Fertil Steril. Author manuscript; available in PMC 2019 August 01.

Published in final edited form as:
Fertil Steril. 2018 August ; 110(3): 429–436. doi:10.1016/j.fertnstert.2018.04.032.

FACTORS ASSOCIATED WITH THE INCREASED ODDS OF CESAREAN DELIVERY IN ART PREGNANCIES

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Abstract

Objective—To quantify the effect of medical and obstetric factors on odds of cesarean delivery, comparing assisted reproductive technology (ART)-treated women and women with subfertility not treated with ART, to fertile women.

Design—Retrospective cohort

Setting—Massachusetts vital and hospital records linked to the Society for Assisted Reproductive Technology Clinic Outcome Reporting System (SART CORS) data (2004–2010).

Patients—Singleton deliveries to primiparous women.

Intervention(s)—None

Main Outcome Measure(s)—Mode of delivery.

Results—The 173,130 deliveries included 5,768 ART-treated, 2,657 subfertile, (1,627 non-ART medically assisted reproduction(MAR), 1,030 unassisted infertile) 164,705 fertile, 117,743 vaginal and 55,387 cesarean deliveries. ART-treated women were older, more often white and non-Hispanic, having more private insurance, prior uterine surgery, gestational diabetes, pregnancy hypertension, bleeding, and placental complications than fertile women. Overall rates of cesarean

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Presented as an abstract at the American Society for Reproductive Medicine Annual meeting October 29–November 1, 2017.

delivery were 45.7%, 43.3%, and 31.1% for ART-treated, subfertile, and fertile women and 41.7%, 45.9% for MAR and unassisted infertile deliveries. When adjusted for demographics, underlying medical factors, prior uterine surgery, placental and delivery complications, adjusted odds ratios AORs compared to fertile women were 1.27 (95% confidence interval(CI)=1.19–1.36) for ART-treated and 1.15 (95% CI=1.04–1.27) for subfertile women, with greater odds among unassisted infertile (OR=1.26; 95% CI=1.07–1.47) not non-ART-MAR (OR=1.09; 95% CI=0.96–1.24) women. The strongest confounders of odds of cesarean were age and prior uterine surgery.

Conclusions—ART and unassisted infertility were associated with greater odds of cesarean compared to fertile women. Underlying medical and obstetric risks had strong confounding effects strongly attenuating the odds for cesarean delivery.

Clinical Trial Registration Number—NA

Keywords

ART; cesarean; vaginal delivery; medically assisted reproduction; subfertility

Introduction

It is well established that the incidence of cesarean delivery is higher in pregnancies conceived using assisted reproductive technology (ART) than in pregnancies to fertile women (1–5). However, the reasons for this increased surgical intervention are not clear. One possibility is that ART pregnancies have a greater number of obstetric complications that require cesarean delivery. Medical risks are greater in ART pregnancies and include increased rates of preeclampsia, pregnancy hypertension, placental abnormalities and delivery complications (3–7); though the extent to which these observed risks are directly a result of ART versus a confounding factor that predisposes both the need for ART and also pregnancy complications is unknown. It may also be that women who have undergone ART are already accepting of medicalization and have enhanced access to advanced obstetric care. In addition, it may be perceived that ART pregnancies are “precious” (8) and that physicians and patients, more invested in these pregnancies than in those conceived without assistance, lean toward elective cesarean delivery.

In the current study we identified factors associated with cesarean section among pregnancies in ART-treated women, women with indicators of subfertility not treated with ART, and fertile women. In addition, we evaluated potential confounders of underlying medical and obstetric risk factors on these associations.

Materials and Methods

This was a retrospective cohort study using Massachusetts ART data linked to vital records and hospital discharge records.

Patients

Primiparous women with vaginal or cesarean deliveries that occurred between July 1, 2004 and December 31, 2010 resulting in singleton live birth or fetal death at >20 weeks were included. All women had a minimum of adequate prenatal care as defined by the Kotelchuck index (9). Women were classified as ART-treated if the delivery was linked to ART data from the Society for Assisted Reproductive Technology Clinic Outcome Reporting System (SART CORS) online database. They were classified as "subfertile" if they had either or both of a diagnosis of infertility demonstrated by prior hospitalization (hospital discharge or observational stay) with an ICD9 code of infertility (628.9) or indication on the birth or fetal death certificate of use of non-ART medically assisted reproduction (MAR). The term subfertility was used rather than infertility or MAR (10) to indicate that this was a combination measure rather than one or the other of these determinations. The subfertile population was further divided into women who were identified by the checkbox on the birth certificate as having received non-ART-MAR and those identified from hospital discharges alone. Women were classified as fertile if they fell into neither the ART-treated nor the subfertile groups.

Data Sources

These data and methods have been described in detail previously (11). In brief, data were obtained from two sources 1) the SART CORS online database, a national registry containing cycle-based ART data from the majority of US ART clinics and 2) the Massachusetts-based Pregnancy to Early Life Longitudinal (PELL) data system, an ongoing population-based project that compiles data from statewide birth certificates, fetal death records, and hospital utilization data as well as other Massachusetts public programs such as Early Intervention (EI) and Special Supplemental Nutrition Program for Women, Infant, and Child (WIC). The study took place under a Memorandum of Understanding executed between SART, the Massachusetts Department of Public Health (MDPH) and the project principal investigators. Institutional Review Board approval was obtained from MDPH and the Committee for the Protection of Human Subjects at Dartmouth College.

The SART CORS contains comprehensive data from over 90% of all clinics performing ART in the US. Massachusetts has had between 6 and 8 clinics during the study period, all of which reported data to SART. Data were collected and verified by SART and reported to the Centers for Disease Control and Prevention in compliance with the Fertility Clinic Success Rate and Certification Act of 1992 (Public Law 102–493). The database includes information on demographic factors, ART diagnoses, ART cycle treatment parameters, and pregnancy outcomes. Data in the SART CORS are validated annually with some clinics randomly selected for on-site visits and chart review. Data reported by the clinic are compared with information recorded in patient charts. In 2013, 35 of a total of 467 clinics were randomly selected for review of 2,062 cycles. In these cycles, 10 of 11 fields reviewed had ≤3 % discrepancy proportion for chart information and entries into the database. The 11th field, diagnosis, had discrepancy proportions of up to 5.5% with underreporting being the most common reason for discrepancy (12).

The PELL data system links information on more than 98% of all resident births and fetal deaths in Massachusetts to corresponding hospital utilization data (hospital admissions, observational stays, and emergency room visits) for individual women and their children. MDPH and the Massachusetts Center for Health Information and Analysis are the custodians of the PELL data. PELL is a relational data system composed of individual databases linked together by randomly-generated unique IDs for mother and infant. The PELL data system is housed at MDPH.

Linkage of the SART CORS and PELL databases

We constructed the Massachusetts Outcome Study of Assisted Reproductive Technology (MOSART) database through linkage of the SART CORS and PELL data systems for all Massachusetts resident women delivering in Massachusetts hospitals between July 1, 2004 and December 31, 2010. The starting date was chosen based on the availability of SART CORS data (January 1, 2004). For the linkage, we obtained all cycles of data on any woman who had at least one cycle in which either her residency or treatment center were in Massachusetts, thereby capturing those residing in Massachusetts but treated out of state. A deterministic five phase linkage algorithm methodology was used with matching based on mother's date of birth, her first name and last name; father/partner's last name baby's date of birth as well as plurality and infant gender. Our linkage proportion was 89.7% overall and 95.0% for deliveries in which both mother's zip code and clinic were located in Massachusetts (11).

Outcome measures and covariates

The outcome measure was dichotomous, cesarean versus vaginal delivery, and was determined from the birth or fetal death certificates. Demographic data were from the birth/death certificates; medical history and delivery characteristics were determined from a combination of birth certificates and hospital discharge data. Prior uterine surgery included surgeries prior to calculated conception date with CPT codes of 574.60, 574.61, 578.00, 581.40, 581.45, 585.58, 585.60, 585.61, 591.36, and 591.40, and ICD9 codes of 752.2, 761.4, 68.22, 68.29, and 69.49. Pregnancy and delivery complications identified from checkboxes on the birth certificate and ICD9 codes in hospital discharges included gestational diabetes (ICD9 648.8), pregnancy hypertension (ICD9 642.3), eclampsia (ICD9: 642.4, 642.5, 642.6, 642.7), breech/malpresentation (ICD9: 652.0, 652.2, 652.3, 652.4, 652.6, 652.7, 652.8, 652.9, 660.0, 660.2, 660.3, 660.4, 660.5, 660.8, 660.9), cephalopelvic disproportion (ICD9: 653.4, 653.5, 653.6, 660.1, cord prolapse (ICD9: 663.0), dysfunctional or prolonged labor (ICD9: 661, 662.0, 6621, 662.2,662.3), febrile (defined as temperature greater and 100 F, ICD9: 659.2, 672, 780.31, 780.6), fetal distress (ICD9: 656.3, 659.7), bleeding (ICD9: 639.1, 640.0, 640.8, 640.9, 641.3, 641.7, 641.8, 641.9), and premature rupture of membranes (PROM, ICD9; 6581, 6582, 658.3, 761.1). Placental complications identified from hospital discharge included placental abruption (ICD9: 641.2, 762.1), placenta previa (ICD9: 641.0, 641.1), vasa previa (ICD9: 663.5) and placenta accreta (667.0).

Statistics

Multivariable unconditional logistic regression was applied to quantify adjusted odds ratios (AOR) and 95% confidence intervals (95% CI) comparing pregnancies among ART and subfertile, as well as non-ART-MAR and unassisted infertile women, to fertile women (referent) and likelihood of cesarean delivery. Model A adjusted for maternal age, race, insurance, education, marital status, chronic diabetes (type I or type II), chronic hypertension, previous uterine surgery, gestational diabetes, pregnancy hypertension, bleeding, and placenta complications; Model B adjusted for these same factors as well as delivery characteristics including breech/malpresentation, cephalopelvic disproportion, prolonged labor (> 20 hrs), dysfunctional labor, fetal distress, cord prolapse, and PROM. All subfertile deliveries and those in each of the categories were also compared with ART-treated deliveries using the ART-treated group as referent. After defining sets of potential confounding variables as noted above, we employed a backward elimination approach in which, we removed each potential confounding variable one-at-a-time and compared the estimates of association for the indicator variables comparing the ART and subfertile groups to the fertile women to determine those factors with a confounding effect of 10% or greater (13).

Results

There were 173,130 deliveries of which 5,768 were classified as ART, 2,657 as subfertile (1,627 non-ART-MAR and 1,030 unassisted infertile), and 164,705 as fertile. Of these 117,743 were vaginal and 55,387 were cesarean deliveries. The demographics of these women can be found in Table 1. ART-treated women were older, more likely to be non-Hispanic and white, more highly educated, more often married, and more likely to be covered by private insurance. ART-treated and subfertile women were also more likely than fertile women to have a history of chronic diabetes, hypertension or uterine surgery prior to conception. Among those who had a cesarean delivery, ART treated and subfertile women were >5 times more likely to have had uterine surgery prior to conception than fertile women and compared to all women, regardless of fertility status, with vaginal delivery. The two subfertile groups delivered by cesarean also differed in the incidence of prior uterine surgery with the non-ART-MAR group at 3.2% and the unassisted infertile at 8.2% (data not shown).

Table 2 shows the proportion of pregnancy and delivery complications in the vaginal delivery and cesarean groups. Fertility groups with vaginal and cesarean deliveries differed in incidence of gestational diabetes, pregnancy hypertension, bleeding, and placental complications. Placenta previa was much more common in ART-treated and somewhat more common in subfertile women than in fertile women with cesarean deliveries or any group of women with vaginal deliveries. Some delivery complications including cephalopelvic disproportion, dysfunctional or prolonged labor, fever, and fetal distress, were more common in fertile women with cesarean delivery than in ART-treated and subfertile women with this delivery method. Breech/malpresentation was more common in cesarean deliveries than vaginal deliveries but did not differ among fertility groups.

Odds of cesarean delivery associated with fertility group are shown in Table 3. The odds of cesarean delivery were greater among ART-treated and subfertile women compared to fertile women. All odds ratios were attenuated by greater than 10% when adjusting for patient demographic characteristics, medical and obstetric conditions (Model A) as well as delivery complications (Model B). However, the odds of cesarean delivery remained significantly greater among ART-treated and subfertile women compared to fertile women. When subfertile women were compared directly with ART-treated women there were no clinically or statistically significant differences in odds of cesarean delivery in either of the two models. When the subfertile group was subdivided into deliveries from women treated with non-ART -MAR and women without treatment to conceive, we found that cesarean rates were 41.7% and 45.9% respectively. After adjustment for the confounders and delivery complications (Model B), we observed no difference in odds of cesarean delivery between the non-ART-MAR exposed women (OR=1.09 (95% CI 0.96–1.24) compared to the fertile women. However, the unassisted infertile women were 30% more likely to have a cesarean delivery (OR=1.26 (95% CI 1.07–1.47) than the fertile women (Table 3).

When stepwise elimination was used to determine which factors had the strongest confounding affect in the regression models, maternal age and a history of prior uterine surgery were the most important factors affecting the AORs in each comparison (ART-treated to fertile, ART-treated to subfertile, and subfertile to fertile). In the ART-treated to fertile comparison removal of age or prior uterine surgery from Model B changed the adjusted odds ratios from 1.27 to 1.65 (95%CI 1.55–1.77) and 1.42 (95% CI 1.29–1.57) respectively.

Discussion

The results of this study show that incidence of cesarean delivery is higher in ART-treated and subfertile women than in fertile women and is attributable to older age and pregnancy complications associated with higher incidence of underlying medical complications (diabetes, high blood pressure, prior uterine surgery) experienced by these women. In addition, odds of cesarean delivery did not differ between ART-treated and subfertile women after adjustment for underlying factors (cephalopelvic disproportion, dysfunctional or prolonged labor, PROM, fetal distress). ART-treated and subfertile women clearly had higher incidence of certain conditions including, prior uterine surgeries and placental complications. Nevertheless, among cesarean deliveries, there were lower incidence among of some of the intrapartum delivery complications (fetal distress, fever, PROM).

Interestingly, the higher odds for cesarean delivery in the subfertile population were more pronounced in unassisted subfertile deliveries than in women using non-ART MAR treatments and the differences in this latter group were no longer significant after adjustment in Model B. The non-ART MAR group, identified as it was by the birth certificate checkbox for fertility treatment, comprised a range of treatments including gonadotropins, treatment with Clomid, or intrauterine insemination with or without fertility drugs. Since these are first line treatments often used before ART, the severity of infertility in this group is likely to have been less than in the ART-treated group. By contrast, the unassisted infertile group was identified through prior hospitalizations that had a diagnosis code of infertility and thus they may have more severe forms of infertility. The fact that prior uterine surgery was at found at the highest rate in the unassisted infertile group supports this assumption. These data are consistent with the importance of underlying disease rather than fertility treatment driving the use of cesarean section.

International medical practice with regard to method of delivery has changed over time. In particular, there have been changes in the rates of cesarean delivery (14). In the U.S., cesarean rates have been increasing even for low-risk patients (15,16). In Massachusetts, the changes over time showed a small increase between 1990 and 2006 but then a return to 1990 numbers in 2013 suggesting conservative management of deliveries in this state (16). The increases in cesarean delivery are at least in part a result of women choosing elective cesarean over vaginal delivery (17). This choice occurs in spite of the fact that cesarean delivery is associated with an increased incidence of maternal morbidity, particularly in subsequent deliveries (14,17) as well as possible negative consequences for the infant born via cesarean (18). It has been speculated that many patients and their physicians may elect for a non-medically indicated cesarean delivery, particularly in ART pregnancies where arguably a greater investment of time and resources have been spent in attaining the pregnancy, due to a desire to have the delivery go as smoothly as possible with the least risk for a healthy baby. This phenomenon has been demonstrated with regard to physician choices in limiting use of amniocentesis in ART pregnancies (8).

Prior studies have shown that odds of cesarean deliveries are higher following ART treatment than for women without this intervention (1–5). In a study of cesarean delivery in Australia, Sullivan et. al (1) found cesarean incidence to be 45.8% in singleton ART-treated deliveries to primiparous women. The incidence we found in this study in the ART-treated group, 45.7%, is comparable. Romundstad et. al. (2), while showing higher incidence of cesarean delivery in early years of ART (1980s and 1990s), demonstrated a reduction in breech and cephalic presentation and the cesarean deliveries associated with these conditions for ART-treated deliveries through 2006. In our study there were 11% that were large for gestational age (LGA) in all cesarean groups; thus, infant size may be one reason for the higher incidence of cephalopelvic disproportion seen in each group that had cesarean delivery.

There are many indications and risk factors for primary cesarean delivery, with the most common in the U.S. being dysfunctional labor, nonreassuring fetal heart rate tracing/fetal distress, malpresentation, multiple gestation, and suspected fetal macrosomia (19). Less common indications for cesarean delivery include placental abruption, cord prolapse, suspected uterine rupture, placenta previa, vasa previa, and placental accreta; these are potentially catastrophic and are absolute indications (14). Many indications, however, are not absolute and reflect the complexity of medical decision making that includes the values and preferences of the patient—who may be more or less risk adverse—and the comfort and capabilities of the provider (19). For example, while not an absolute indication, cesarean delivery should be offered in the setting of suspected fetal macrosomia (20). Advanced maternal age is associated with increased stillbirth and is a risk factor for cesarean delivery (14). Furthermore, prior uterine surgery, including prior cesarean delivery and myomectomy, is a relative indication for cesarean to decrease the chance for uterine rupture, although patients may elect to undergo a trial of labor to attempt vaginal birth if offered by their obstetrical provider (21). In this study, we limited our population to primiparous women in order to avoid the complexity of prior cesarean delivery. Nevertheless, other prior uterine surgeries--including cervical conization, myomectomy, and operative hysteroscopy--were significant confounding factors that were strongly associated with cesarean delivery and vaginal delivery and we found that these prior surgeries were much more common among ART-treated and subfertile women with cesarean deliveries as compared with fertile women with cesarean deliveries and all women with vaginal deliveries. While not a surprise finding, this is, to our knowledge, the first report of this higher incidence in the ART and subfertile groups.

Breech presentation is also an indication for cesarean delivery. Romundstad (2) has demonstrated a nearly 50% higher incidence of breech presentation in ART-treated singleton deliveries than in those to fertile women. However, in our study, the incidence of breech/malpresentation was not higher in ART-treated or subfertile deliveries than in those to fertile women. As expected, the incidence in all groups was higher when the delivery was by cesarean. This is consistent with clinical practice since fewer obstetricians are trained to deliver breech births vaginally (19, 22). Interestingly, other intrapartum problems such as failure to progress and dysfunctional labor were more common in the fertile population than in the ART-treated or subfertile women.

Strengths of this study include the large sample size as well as our use of a subfertility population for comparison. Limitations include the fact that we are looking at population based data and the reasons for individual decisions can be inferred but not readily ascertained from the available information. For example, timing of the decision to move to cesarean delivery cannot be determined from these records and thus decisions for elective use of cesarean section rather than attempts at vaginal delivery resulting in moves to this form of delivery cannot be distinguished. Another limitation is that the fertile group may contain individuals who were subfertile but whose condition could not be identified either from the birth certificate or prior hospitalizations. However, given the large size of the fertile group, these misclassified infertile women would not have significantly influenced our overall results. Any misclassification would drive the results toward the null, and therefore our results would be an underestimate, not an over estimate of the true odds of cesarean section. In addition, our information reflects the decisions made in a single state that has mandated insurance coverage for ART, and this could affect some patient and physician decision-making.

In summary, our data show that while cesarean delivery is 85% more common for deliveries in ART-treated women than fertile women, they are only 10% more common for ART-treated women when compared with a subfertile population. In addition, much of the difference in the odds of cesarean delivery in ART-treated women compared to fertile women is confounded by the older age of these women and the significantly higher incidence of prior uterine surgeries experienced by them. In addition, a higher incidence of placental abnormalities and underlying medical conditions also contributed to increased odds of cesarean delivery. The data suggest that the higher incidence of cesarean delivery following ART-treated pregnancy and pregnancy to subfertile women is consistent with the presence of underlying medical factors rather than the elective use for a “precious baby”.

Acknowledgments

Funding: NIH RO1HD067270

SART wishes to thank all of its members for providing clinical information to the SART CORS database for use by patients and researchers. Without the efforts of our members, this research would not have been possible.

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Table 1

Characteristics of Fertile, Subfertile, and ART-Treated Women, among all Women Stratified by Vaginal versus Cesarean Delivery

	All	Vaginal			Cesarean		
		Fertile	Subfertile	ART	Fertile	Subfertile	ART
All deliveries	173,130	113,104	1,506	3,133	51,601	1,151	2,635
Maternal age (years)							
Mean (SD)	28.0 (6.1)	27.0 (5.9)	33.4 (4.9)	34.5 (4.5)	29.0 (5.9)	34.9 (4.8)	36.2 (4.8)
Age groups (%)							
≤30	64	70	28	19	58	18	11
31–34	22	20	30	32	24	29	27
35–37	9	7	21	23	11	23	22
38–40	4	3	14	16	5	18	20
>40	2	1	7	10	2	13	19
Race/Ethnicity (%)							
Hispanic	12	13	4	3	10	5	4
NH-White	70	69	84	85	72	81	82
NH-Black	7	7	2	2	8	5	4
NH-Asian	8	9	8	8	8	8	9
NH-Other	2	2	1	1	2	1	1
Education (%)							
≤ High School	33	36	11	8	30	13	10
Some College	20	20	14	13	22	18	17
≥College	47	44	75	78	48	69	73
Marital Status (%)							
Married	64	60	93	95	66	93	95
Not married	36	40	7	5	34	7	5
Insurance (%)							
Private	63	60	91	96	66	91	96
Self-Pay	1	1	1	1	1	1	1
Public/Free	36	39	8	3	33	8	3

	All	Vaginal			Cesarean		
		Fertile	Subfertile	ART	Fertile	Subfertile	ART
Chronic Disease (%)							
Diabetes	1.2	0.8	1.5	1.7	1.9	2.1	3.0
Hypertension	1.7	1.2	1.9	2.3	2.5	5.0	4.6
Uterine Surgery Prior to Conception (%)							
Yes	0.4	0.1	0.9	0.5	0.6	5.3	5.6

Table 2

Proportion of Pregnancy Outcomes, and Obstetric and Delivery Complications among Fertile, Subfertile, and ART-Treated Women Stratified by Vaginal and Cesarean Delivery

	All	Vaginal			P-vaginal	Cesarean			P-Cesarean	P-All
		Fertile	Subfertile	ART		Fertile	Subfertile	ART		
N	173,130	113,104	1,506	3,133	51,601	1,151	2,635	2,635		
Pregnancy complications (%)										
Gestational Diabetes	5.3	4.2	7.6	6.8	<0.001	7.0	11.9	10.6	<0.001	<0.001
Pregnancy Hypertension	11.6	9.4	11.3	11.6	<0.001	16.0	18.3	19.5	<0.001	<0.001
Eclampsia	5.3	4.0	4.4	4.5	0.2	8.1	8.3	10.2	<0.001	<0.001
Bleeding Problems	2.6	2.6	3.6	5.0	<0.001	2.3	3.5	5.0	<0.001	<0.001
Placental abruption	1.2	0.8	0.9	1.5	<0.001	1.8	2.4	3.1	<0.001	<0.001
Placenta previa	0.6	0.2	0.7	0.7	<0.001	1.1	2.6	6.4	<0.001	<0.001
Vasa previa	0.0	0.0	0.0	0.0	0.9	0.1	0.2	0.6	<0.001	<0.001
Placenta accreta	0.5	0.6	1.1	1.7	<0.001	0.2	0.2	0.7	<0.001	<0.001
Placental complications (all)	2.2	1.6	2.6	3.9	<0.001	3.1	5.1	10.2	<0.001	<0.001
Delivery complications (%)										
Cephalopelvic disproportion	6.4	0.5	0.8	0.7	0.2	19.4	16.5	12.7	<0.001	<0.05
Breech/malpresentation	11.1	5.4	5.1	4.8	0.3	24.7	23.6	24.4	0.8	<0.001
Prolonged labor (>20 hrs)	2.9	3.0	4.2	2.6	<0.05	2.9	3.3	1.6	<0.001	<0.001
Dysfunctional labor	17.1	7.2	7.9	7.0	0.5	38.5	35.1	30.1	<0.001	<0.001
Dysfunctional and prolonged labor	17.4	7.5	8.4	7.3	0.4	38.8	35.4	30.2	<0.001	<0.001
Febrile	6.3	5.9	6.4	7.4	<0.01	7.2	6.1	5.8	<0.01	0.1
Fetal distress	24.3	17.8	18.2	19.1	0.2	38.5	36.1	30.8	<0.001	0.1
Cord prolapse	0.3	0.1	0.1	0.2	0.7	0.7	1.0	1.1	<0.05	<0.001
PROM	8.8	8.9	11.4	11.4	<0.001	8.3	8.0	8.3	0.9	<0.001
Length of gestation (weeks)										
Mean (SD)	39.0(2.0)	39.0(1.9)	38.9(2.2)	38.8(2.2)	<0.001	40.0(2.2)	38.6(2.4)	38.5(2.5)	<0.001	<0.001
Gestational age (%)										
<28 weeks	0.5	0.4	0.8	0.6	<0.01	0.6	0.9	0.9	<0.1	<0.001

	All	Vaginal			P-vaginal	Cesarean			P-Cesarean	P-All
		Fertile	Subfertile	ART		Fertile	Subfertile	ART		
28–33 weeks	1.5	1.0	1.4	1.8	<0.001	2.4	3.7	3.6	<0.001	<0.001
34–36 weeks	5.3	5.1	5.8	7.2	<0.001	5.3	7.7	9.2	<0.001	<0.001
≥ 37 weeks	92.7	93.5	92.0	90.4	<0.001	91.7	87.8	86.3	<0.001	<0.001
Birthweight (grams)										
Mean (SD)	3,299(582)	3,271(535)	3,257(585)	3,233(572)	<0.001	3,367(660)	3,315(705)	3,282(685)	<0.001	<0.001
Birthweight (%)										
Very low (<1,500g)	1.3	1.0	1.4	1.5	<0.01	1.9	2.6	2.5	<0.05	<0.001
Low (1,500–2,399g)	5.6	5.1	6.1	6.4	<0.01	6.3	8.5	7.9	<0.001	<0.001
Normal (≥2,500)	93.1	93.9	92.5	92.1	<0.001	91.8	88.9	89.6	<0.001	<0.001
Birthweight Z-score										
SGA	10.0	10.3	9.9	10.3	0.9	9.6	9.7	9.0	0.6	0.6
LGA	7.4	5.3	6.6	5.3	0.9	11.9	11.4	11.2	0.5	<0.01

Table 3

Odds of Cesarean Delivery by Fertility Group

	Cesarean Proportion	Unadjusted		Model A[1]		Model B[2]	
Group		OR	95% CI	AOR	95% CI	AOR	95% CI
Fertile	31.1	1.00	referent	1.00	referent	1.00	referent
Subfertile	43.3	1.68	1.55–1.81	1.14	1.05–1.23	1.15	1.04–1.27
Non-ART-MAR	41.7	1.57	1.42–1.73	1.12	1.01–1.24	1.09	0.96–1.24
Unassisted	45.9	1.86	1.65–2.11	1.16	1.02–1.32	1.26	1.07–1.47
ART	45.7	1.84	1.75–1.94	1.15	1.08–1.21	1.27	1.19–1.36
Subfertile	43.3	0.91	0.83–0.998	0.99	0.90–1.09	0.92	0.82–1.04
Non-ART-MAR	41.7	0.85	0.76–0.95	0.99	0.88–1.12	0.90	0.78–1.03
Unassisted	45.9	1.01	0.89–1.16	0.99	0.86–1.14	0.96	0.82–1.14
ART	45.7	1.00	referent	1.00	referent	1.00	referent

[1]Model A: Adjusted for maternal age, race, insurance, education, marital status, diabetes, chronic hypertension, previous uterine surgery, gestational diabetes, pregnancy hypertension, bleeding, and placenta complications.

[2]Model B: Adjusted for all variables in Model A plus (yes/no) breech/malpresentation, cephalopelvic disproportion, prolonged or dysfunctional labor, fetal distress, cord prolapse, PROM.