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Risk of stillbirth among Zambian women with a prior cesarean delivery

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Abstract

Objective: Cesarean delivery (CD) may be associated with stillbirth in future pregnancies. We investigated prior CD as a risk factor for stillbirth in Lusaka, Zambia.

Methods: We conducted a retrospective cohort analysis of women with only one prior pregnancy who delivered between February 1, 2006, and May 31, 2013. We analysed data from the Zambia Electronic Perinatal System. Maternal and infant characteristics were analyzed for association with stillbirth using Pearson's χ^2 test or the Wilcoxon rank-sum test. We calculated risk of stillbirth (antepartum vs intrapartum) by prior CD, with a log Poisson model to adjust for confounding.

Results: Of 57,320 women in our cohort, 1933 (3.4%) reported a prior CD. There were 1012 (1.8%) stillbirths in the no prior CD group and 81 (4.2%) in the prior CD group ($P<0.001$). In multivariate models adjusting for stillbirth risk factors, prior CD was associated with antepartum (adjusted risk ratio 1.56, 95% confidence interval 1.08–2.24) and intrapartum (3.26, 2.40–4.42) stillbirth compared with no prior CD. The difference between groups was most apparent at 36–37 weeks' gestation (log-rank $P<0.001$).

Conclusion: Prior CD was associated with increased risk of stillbirth. Improved monitoring during labor and safe methods for induction are urgently needed in low-resource settings.

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Author contributions

MCC and EMS co-wrote and made iterative revisions to the manuscript based on coauthor feedback. MCC, MCDS, BHC, JSAS, and EMS contributed to the analysis plan. MCDS conducted the statistical analysis. BV, MK, and AK contributed to the oversight of data. BV, MCDS, BHC, JSAS, MK, and AK contributed to the design and interpretation of this analysis. All co-authors reviewed drafts of the manuscript and provided critiques about intellectual content. All authors approved the final version of the article.

Conflicts of interest

EMS is a member of the *IJGO* Editorial Board. The authors have no conflicts of interest.

Keywords

Africa; Antepartum stillbirth; Intrapartum stillbirth; Prior cesarean delivery; Stillbirth; Stillbirth risk factors; Zambia

1 INTRODUCTION

Every year more than 3 million stillbirths occur worldwide, and this number has not changed significantly over the past 20 years [1,2]. Approximately 98% of these stillbirths occur in low- and middle-income countries, with 50%–70% during the intrapartum period [2–5]. Similar rates of stillbirth are not seen in industrialized countries because of the widespread availability of skilled providers in the antepartum period and access to timely delivery [4]. Because comprehensive obstetric care is not readily available in many resource-constrained settings, new and effective approaches to identify, triage, and manage high-risk pregnancies are urgently needed.

Prior cesarean delivery (CD) has been associated with both antepartum and intrapartum stillbirth in future pregnancies, although findings have not been consistent [5–11]. In the antepartum period, this increased risk may be attributed to abnormal placentation at the uterine scar or adhesion formation due to a prior CD [7]. A systematic review and meta-analysis by O'Neill et al.[5] found that prior CD was associated with a 23% increased odds of a subsequent stillbirth in a pooled adjusted model. Studies from the USA, Europe, and Australia have reported up to a 3.7-fold risk for antepartum stillbirths among women with a prior CD [6,8,9]. Other studies of large perinatal databases did not find such relationships [5,9]. In a 2015 cohort analysis of Canadian women, for example, Wood et al.[10] showed that previous CD was not associated with stillbirth when potential confounders were considered, including maternal risk factors in the second pregnancy [10].

Currently, CD rates remain low in many African settings, due primarily to health infrastructure constraints. As CD rates rise in many parts of Africa [11], and move closer to WHO's recommended rate of 5–15% [12], the impact of CD on subsequent delivery will become increasingly important. It is unclear how the rising rates of CD will affect a woman's future childbearing, future pregnancy risks, healthcare costs, and the surgical quality of CD. In this analysis, we investigated the relationship between prior CD and stillbirth in a subsequent pregnancy in Lusaka, Zambia. We evaluated this relationship for all stillbirths, and then stratified analyses to examine by type of stillbirth (antepartum vs intrapartum).

2 MATERIALS AND METHODS:

We conducted a retrospective analysis of a cohort of women who delivered between February 1, 2006 and May 31, 2013. We only included women with two deliveries recorded in the Zambia Electronic Perinatal Record System (ZEPRS) in Lusaka, Zambia, to enable evaluation of a direct relationship between the first and second pregnancy. We obtained approval for the use of these routinely collected clinical data through the University of North

Carolina Institutional Review Board (Chapel Hill, NC, USA) and the University of Zambia Biomedical Research Ethics Committee (Lusaka, Zambia).

We excluded mothers with multiple gestation, without two deliveries recorded in ZEPRS, with fetuses weighing less than 1000 g, with missing information about mode of delivery for the first pregnancy, and with missing information about birth outcome for the second delivery. Our unit of analysis was the parturient pair. Delivery information for the first pregnancy was obtained from patients through routinely collected data for past pregnancy outcomes. We hypothesized that stillbirth rates would be higher among women with a prior CD. To test this hypothesis, we analyzed data from ZEPRS. Implemented in 2006, ZEPRS is a patient-level electronic medical record system that includes data for all women receiving antenatal and/or delivery care in 25 Lusaka public-sector health facilities. Data technicians directly enter information into ZEPRS, capturing demographic information, medical and obstetrical history, laboratory test results, and delivery and postnatal information for both the mother and newborn [13].

Women seeking antenatal care in Lusaka present to any of 25 primary care facilities across the city. Ten of these primary care facilities also provide delivery services. The University Teaching Hospital receives referrals for high-risk pregnancies from the entire district and, at the time these data were collected, it was the only facility equipped to conduct CD [14]. With the exception of the University Teaching Hospital, nurse midwives attend deliveries at these facilities.

Antenatal care is provided according to standard national guidelines from the Zambian Ministry of Health. Gestational age is estimated at the first antenatal care visit through a combined assessment of last menstrual period and symphysis-fundal height or estimation of uterine size on examination. Ultrasonography is limited. At this first visit, women are offered HIV screening with a rapid antibody test, syphilis screening with a non-treponemal test, and anemia screening using hemoglobin measurement. Screening for diabetes, renal disease, isoimmunization, fetal aneuploidy, or other maternal infections is typically unavailable in the public sector. During the time period of this study, pregnant women typically had four antenatal visits, with the last one occurring around 36 weeks. Most women, even with a past CD, are seen in the public health clinics and referred to the University Teaching Hospital for delivery only at the time of labor.

Stillbirth, our primary outcome, was defined as a newborn with no signs of life at delivery (i.e., no respiratory effort or cardiac activity) and weighing 1000 g or more. Attendant medical staff diagnosed the stillbirth and its suspected timing (antepartum vs intrapartum) at the time of delivery. The distinction between antepartum and intrapartum stillbirth was based on signs of maceration at delivery. Intact skin with no signs of disintegration in utero were assumed to have occurred in the 12 hours before delivery and were classified as intrapartum stillbirths. Stillbirths with signs of maceration, including skin and soft tissue changes, were assumed to have occurred more than 12 hours before delivery and were classified as antepartum [1,3].

We considered additional pregnancy complications in our analysis. Using a previously published convention by our group [15], women whose recorded blood pressure exceeded 140 mm Hg systolic or 80 mm Hg diastolic at any pregnancy or delivery visit, or who were diagnosed with eclampsia, were categorized as having pregnancy-associated hypertension. We were unable to reliably differentiate pregnancy-associated hypertension or pre-eclampsia from chronic hypertension in this dataset. Preterm birth, a patient-reported outcome, was defined by a previous delivery occurring at 8 months' gestation or earlier. Patients reported birth weight and neonatal outcomes for the first pregnancy during antenatal care in the second pregnancy. The indication for CD in the first or second pregnancy was not documented in the ZEPRS database. Interpregnancy interval was defined as the difference between delivery of the first infant and the late menstrual period of the second pregnancy.

Maternal and infant characteristics were analyzed for association with stillbirth using Pearson's χ^2 test or the Wilcoxon rank-sum test. We also examined cumulative incidence of stillbirth by time since conception using the complement of the Kaplan–Meier survival function. Women were censored if they delivered, and removed from the risk set if they had a stillbirth. A log Poisson model was then used to estimate the risk ratio for the association between stillbirth and prior CD. The Poisson model was used to approximate the binomial model [16,17]. Independent variables that were identified a priori from literature review and that were statistically significant ($p < 0.05$) in univariable analyses were included in an adjusted model and expressed as adjusted risk ratios (ARRs). These variables included birth weight in the second pregnancy, prior stillbirth, obesity, maternal age of 35 years or older, rapid plasma reagin (RPR) status, HIV status, and pregnancy-associated hypertension. We excluded variables such as birth weight in the first pregnancy and mode of delivery in second pregnancy in the adjusted model due to the possibility of confounding by indication for CD. We examined the risk of each type of stillbirth (antepartum and intrapartum) to prior CD by comparing each type alone to those without a stillbirth. All analyses were conducted with SAS version 9.3 (SAS Institute, Cary, NC, USA).

3 RESULTS

Between February 2006 and May 2013, 263,700 women from 25 public-sector sites had antenatal care and delivery information recorded in ZEPRS (Figure 1). Of these, we excluded 201,383 (76%) women who had more than two deliveries, no previous deliveries, or missing delivery information from prior pregnancies. We also excluded 4399 (1.7%) women with multiple gestations in a prior pregnancy. Among the 57,918 women with two deliveries recorded in ZEPRS, we excluded 28 (<0.1%) women who delivered infants weighing less than 1000 g in the first pregnancy. Of the 57,890 women with delivery information for the first pregnancy, we excluded 433 (0.7%) women with missing information about birth outcome in the second pregnancy and 137 (0.2%) women who delivered infants weighing less than 1000 g in the second pregnancy. The remaining 57,320 women comprised our study cohort, of whom 1933 (3.4%) had a prior CD.

Women with a prior CD were slightly older, had a higher body mass index (BMI), and were more likely to have hypertension during pregnancy than were those with no prior CD (Table 1). In their first pregnancy, women with a prior CD were more likely to have delivered a

preterm infant or an infant weighing more than 3500 g, to have had a stillbirth, and to have experienced a neonatal death in the first 28 days of life. In the second pregnancy, women with a prior CD were more likely than those with no prior CD to deliver at a later gestational age (39 weeks vs 38 weeks; $P<0.001$), deliver infants with higher birth weights (3100 g vs 3000 g; $P<0.001$), and to experience a neonatal death in the first 28 days of life (1.1% vs 0.7%; $P=0.031$) (Table 2). Of women with a prior CD, 796 (41.4%) delivered via a repeat CD and 1126 (58.6%) had a vaginal birth after CD. Additionally, 1268 (2.3%) women with vaginal delivery in the first pregnancy had a CD in the second pregnancy.

There were 1093 (1.9%) stillbirths in our study cohort; 1012 (1.8%) stillbirths were in women without a prior CD and 81 (4.2%) stillbirths were in women with a prior CD. Women with a prior CD had a higher number of stillbirths in their second pregnancy (4.2% vs 1.8%, $P<0.001$). When stratified by type of stillbirth, women with a prior CD were more likely than those with no prior CD to have both an antepartum stillbirth (1.6% vs 1.0%; $P=0.031$) and an intrapartum stillbirth (2.6% vs 0.8%; $P<0.001$).

In multivariate analysis, women with a prior CD were 2.3 (95% CI 1.79–2.83) times more likely to experience a stillbirth in their second pregnancy than were those without a prior CD (Table 3). This trend remained consistent when we stratified by type of stillbirth, with an elevated risk observed for both antepartum (ARR 1.56, 95% CI 1.08–2.24) and intrapartum (3.26, 2.40–4.42) stillbirths. Birth weight less than 2500 g was significantly associated with both antepartum and intrapartum stillbirths. Maternal BMI greater than 30 kg/m² or weight more than 91 kg, HIV infection, and pregnancy-associated hypertension were significantly associated with antepartum stillbirth. Additionally, prior stillbirth was significantly associated with intrapartum stillbirths.

Figure 2 shows the cumulative incidence of intrapartum stillbirth and antepartum stillbirth in the second pregnancy, by estimated gestational age at delivery. The risk of intrapartum stillbirth was significantly higher in women with a prior CD, and the increased risk was most apparent from 36 to 37 weeks' gestation (log-rank $P<0.001$).

4 DISCUSSION

In a large pregnancy cohort in Lusaka, Zambia, women with a prior CD were more likely to have a stillbirth in their second pregnancy, both during the antepartum and intrapartum periods. The increased risk of intrapartum stillbirth became apparent among women with a CD from around 36–37 weeks' gestation, and increased dramatically after 41 weeks.

A particular strength of our study is that we were able to adjust for important confounders such as prior stillbirth, age, BMI, infant birth weight, and hypertension. Specific to our large patient population, we were also able to adjust for HIV infection and RPR reactivity. The large sample size enabled us to capture enough stillbirths to increase our statistical power to detect differences between women who had a prior CD and those who did not.

We also acknowledge several limitations. First, certain risk factors for stillbirth, including pre-eclampsia, diabetes, and rhesus status, were not well documented in our database, largely due to the limited screening and diagnostic tests available in our setting. Second, in

our analysis of this large retrospective cohort, we were unable to ascertain causes of the antepartum stillbirths or to determine the precipitating events for the intrapartum stillbirths. Third, we acknowledge the suboptimal dating criteria for estimation of gestational age due to late presentation to antenatal care and limited ultrasound availability in our setting. Finally, the definitions of antepartum and intrapartum stillbirth are determined by observation at the time of delivery, and previous studies have indicated that this method may overestimate intrapartum stillbirths [18]. That the association between prior CD and both types of stillbirths remained consistent is reassuring, and suggests that such biases may have had minimal impact.

To our knowledge, this is one of the largest studies to evaluate the association between a prior CD and stillbirth in a subsequent pregnancy in Africa. Most studies in high-income countries focus primarily on antepartum stillbirths [1,19] because intrapartum stillbirths are rare due to improvements in intrapartum monitoring and interventions such as CD in these settings [20,21]. By contrast, 63% of all stillbirths in our cohort likely occurred during labor or near the time of delivery. This estimate is similar to that from a recent study from rural Zambia, which showed a rate of 72% of non-macerated stillbirths [22], and a multi-country study from the Global Network, which reported that 67% of all stillbirths in Zambia were non-macerated, suggesting an intrapartum stillbirth [20].

In our cohort of women with a prior CD, intrapartum stillbirths were more likely to occur than antepartum stillbirths. This adverse outcome may be specific to a subgroup of women with a prior CD. Women in Zambia with a prior CD rarely have scheduled repeat CDs at 39 weeks, rarely undergo an induction of labor because of the risk of uterine rupture, and do not have fetal testing or evaluation for amniotic fluid index if they progress past 41 weeks. Our data support this practice because women with prior CD delivered subsequent postdate pregnancies more frequently than those without prior CD, and delivered larger infants. The condition of postdates is a well-known risk factor for stillbirth [23] and our data suggest that the duration of pregnancies in women with a prior CD may be one of the biggest risk factors for stillbirth compared with simply having had a prior CD.

The American Congress of Obstetrician and Gynecologists recommends that most women with one previous CD with a low-transverse incision are candidates for, and should be counseled about, vaginal birth after CD and offered trial of labor after cesarean [24]. In Zambia, there is a structured referral system from the district clinics to the University Teaching Hospital, but women with a prior CD are not typically referred while pregnant for consultation to determine eligibility for vaginal birth after CD.

On the basis of our findings, we recommend that healthcare professionals provide earlier referrals (e.g., by 34 weeks) to tertiary care facilities for women with prior CD. The elevated risk for stillbirth, beginning at that time, suggests that discussions of mode and timing of delivery and further monitoring—possibly with antepartum testing—need to be implemented. Key to decreasing stillbirths in women with a prior CD is an improved understanding of cause. Better differentiation of the causes of stillbirths will improve with the scale up and implementation of the WHO application of ICD-10 to deaths during the perinatal period (ICD-PM) [25]. The ICD-PM will help to identify the causes of stillbirths

“in order to identify possible interventions to prevent future deaths.” [25] Gestational age dating as well as determining the optimal timing of delivery and mode of delivery is highly important. Studies that prioritize the best ways to induce labor even in women with a prior CD, and ways to best monitor the fetus in labor in low-income settings, are urgently needed.

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References

1. Lawn JE, Gravett MG, Nunes TN, Rubens CE, Stanton C, Group GR. Global report on preterm birth and stillbirth (1 of 7): definitions, description of the burden and opportunities to improve data. *BMC Pregnancy Childbirth*. 2010;10(Suppl 1):S1. [PubMed: 20233382]
2. Goldenberg RL, McClure EM, Bhutta ZA, et al. Stillbirths: the vision for 2020. *Lancet*. 2011;377:1798–805. [PubMed: 21496912]
3. Lawn JE, Kinney M, Lee AC, et al. Reducing intrapartum-related deaths and disability: can the health system deliver? *Int J Gynaecol Obstet*. 2009;107(Suppl 1):S123–40, S40–42. [PubMed: 19815205]
4. Lawn J, Shibuya K, Stein C. No cry at birth: global estimates of intrapartum stillbirths and intrapartum-related neonatal deaths. *Bull World Health Organ*. 2005;83:409–17. [PubMed: 15976891]
5. O'Neill SM, Kearney PM, Kenny LC, et al. Caesarean delivery and subsequent stillbirth or miscarriage: systematic review and meta-analysis. *PLoS One*. 2013;8:e54588. [PubMed: 23372739]
6. Kok N, Ruiter L, Hof M, et al. Risk of maternal and neonatal complications in subsequent pregnancy after planned caesarean section in a first birth, compared with emergency caesarean section: a nationwide comparative cohort study. *BJOG*. 2014;121:216–23. [PubMed: 24373595]
7. Reddy UM. Unravelling caesarean delivery as a risk factor for antepartum stillbirth. *BJOG*. 2015;122:1475. [PubMed: 26234883]
8. O'Neill SM, Agerbo E, Kenny LC, et al. Cesarean section and rate of subsequent stillbirth, miscarriage, and ectopic pregnancy: a Danish register-based cohort study. *PLoS Med*. 2014;11:e1001670. [PubMed: 24983970]
9. Moraitis AA, Oliver-Williams C, Wood AM, Fleming M, Pell JP, Smith G. Previous caesarean delivery and the risk of unexplained stillbirth: retrospective cohort study and meta-analysis. *BJOG*. 2015;122:1467–74. [PubMed: 26033155]
10. Wood S, Ross S, Sauve R. Cesarean section and subsequent stillbirth, is confounding by indication responsible for the apparent association? An updated cohort analysis of a large perinatal database. *PLoS One*. 2015;10:e0136272. [PubMed: 26331274]
11. Betran AP, Ye J, Moller AB, Zhang J, Gulmezoglu AM, Torloni MR. The increasing trend in caesarean section rates: global, regional and national estimates: 1990–2014. *PLoS One*. 2016;11:e0148343. [PubMed: 26849801]
12. Harrison MS, Goldenberg RL. Cesarean section in sub-Saharan Africa. *Matern Health Neonatol Perinatol*. 2016;2:6. [PubMed: 27398224]
13. Chi BH, Vwalika B, Killam WP, et al. Implementation of the Zambia electronic perinatal record system for comprehensive prenatal and delivery care. *Int J Gynaecol Obstet*. 2011;113:131–36. [PubMed: 21315347]
14. Vwalika B, Stoner MC, Mwanahamuntu M, et al. Maternal and newborn outcomes at a tertiary care hospital in Lusaka, Zambia, 2008–2012. *Int J Gynaecol Obstet*. 2017;136:180–87. [PubMed: 28099725]
15. Stoner MC, Vwalika B, Smid MC, et al. A retrospective study of HIV, antiretroviral therapy, and pregnancy-associated hypertension among women in Lusaka, Zambia. *Int J Gynaecol Obstet*. 2016;134:299–303. [PubMed: 27365290]

16. Williamson T, Eliasziw M, Fick GH. Log-binomial models: exploring failed convergence. *Emerg Themes Epidemiol.* 2013;10:14. [PubMed: 24330636]
17. Cheung YB. A modified least-squares regression approach to the estimation of risk difference. *Am J Epidemiol.* 2007;166:1337–44. [PubMed: 18000021]
18. Gold KJ, Abdul-Mumin AR, Boggs ME, Opare-Addo HS, Lieberman RW. Assessment of “fresh” versus “macerated” as accurate markers of time since intrauterine fetal demise in low-income countries. *Int J Gynaecol Obstet.* 2014;125:223–27. [PubMed: 24680841]
19. Maiti K, Sultana Z, Aitken RJ, et al. Evidence that fetal death is associated with placental aging. *Am J Obstet Gynecol.* 2017;217:441.e1–e14. [PubMed: 28645573]
20. McClure EM, Saleem S, Goudar SS, et al. Stillbirth rates in low-middle income countries 2010–2013: a population-based, multi-country study from the Global Network. *Reprod Health.* 2015;12(Suppl 2):S7.
21. Goldenberg RL, McClure EM. Reducing intrapartum stillbirths and intrapartum-related neonatal deaths. *Int J Gynaecol Obstet.* 2009;107(Suppl 1):S1–3. [PubMed: 19815207]
22. Turnbull E, Lembalemba MK, Guffey MB, et al. Causes of stillbirth, neonatal death and early childhood death in rural Zambia by verbal autopsy assessments. *Trop Med Int Health.* 2011;16:894–901. [PubMed: 21470348]
23. Rosenstein MG, Cheng YW, Snowden JM, Nicholson JM, Caughey AB. Risk of stillbirth and infant death stratified by gestational age. *Obstet Gynecol.* 2012;120:76–82. [PubMed: 22914394]
24. American College of Obstetricians and Gynecologists. ACOG Practice bulletin no. 115: Vaginal birth after previous cesarean delivery. *Obstet Gynecol.* 2010;116:450–63. [PubMed: 20664418]
25. World Health Organization. The WHO application of ICD-10 to deaths during the perinatal period: ICD-PM. Geneva: World Health Organization; 2016.

Synopsis:

Prior cesarean delivery is a risk factor for antepartum and intrapartum stillbirth in Lusaka, Zambia.

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FIGURE 1. Flow chart of study participants. Abbreviation: ZEPRS, Zambia Electronic Perinatal Record System.

(A)

(B)

FIGURE 2.

Cumulative incidence of antepartum stillbirths (A) and intrapartum stillbirths (B) in the second pregnancy by estimated gestational age at delivery in women with and without a prior cesarean delivery.

TABLE 1

Maternal characteristics in relation to prior CD, February 2006–2013 (N=57,320).^a

Characteristic	Prior CD (n=1933)	No prior CD (n=55,387)	P value ^b
Maternal age, y	24 (21–28)	23 (21–26)	<0.001
BMI, kg/m ²	24 (22–27) (n=1220)	23 (21–25) (n=36,041)	<0.001
Gestational age at first ANC visit, wk	21 (17–24)	21 (17–25)	<0.001
RPR status			
Non-reactive	1373 (71.0)	38,108 (68.8)	0.113
Reactive with treatment	24 (1.2)	925 (1.7)	
Reactive no treatment	12 (0.6)	452 (0.8)	
Not done/no results	524 (27.1)	12,902 (28.7%)	
HIV status			
Uninfected	1416 (73.3)	40,711 (73.5)	0.160
Infected	443 (22.9)	12,974 (23.4)	
Unknown	74 (3.8)	1702 (3.1)	
Pregnancy-associated hypertension	174 (9.0)	2593 (4.7%)	<0.001
History of diabetes	3 (0.2)	56 (0.1)	0.466
Outcome of first pregnancy ^c			
Preterm birth	64 (3.3)	1255 (2.3)	0.003
Birth weight, g	3200 (2800–3600) (n=1529)	3000 (2700–3400) (n=39,414)	<0.001
<2500	180 (11.8)	3985 (10.1)	<0.001
2500–3500	894 (58.5)	29,748 (75.5)	
>3500	455 (29.8)	5681 (14.4)	
Stillbirths	57 (2.9)	619 (1.1)	<0.001
Neonatal death (< 28 days of life)	111 (5.7)	1174 (2.1)	<0.001

Abbreviations: CD, cesarean delivery; BMI, body mass index; ANC, antenatal care; RPR, rapid plasma reagin.

^aValues are given as median (interquartile range) or number (percentage), unless indicated otherwise. When data are missing, the reduced sample size is given in parentheses.^bReported for comparison group only.^cIncludes only linked records of first and second pregnancies.

TABLE 2:

Obstetric and neonatal outcomes in the second pregnancy in relation to prior CD in the first pregnancy, February 2006–2013 (N=57,320).^a

Outcome	Prior CD (n=1,933)	No prior CD (n=55,387)	<i>P</i> value ^b
All stillbirths	81 (4.2)	1012 (1.8)	<0.001
Antepartum (macrated)	30 (1.6)	577 (1.0)	0.031
Intrapartum (fresh)	51 (2.6)	435 (0.8)	<0.001
Interpregnancy interval, month	36 (22–55)	34 (22–54)	0.0530
Gestational age at delivery, wk	39 (36–40) (n=1932)	38 (35–40) (n=55,373)	<0.001
24–32 (or <32)	130 (6.7)	4940 (8.9)	<0.001
32–36	408 (21.1)	15,651 (28.3)	
37–42	1124 (58.2)	25,832 (52.1)	
42	270 (14.0)	5950 (10.7)	
Birth weight, g	3100 (2800–3400) (n=1873)	3000 (2800–3300) (n=54,896)	<0.001
<2500	167 (8.9)	5039 (9.2)	<0.001
2500–3500	1344 (71.8)	41,137 (74.9)	
>3500	362 (19.3)	8720 (15.9)	
Mode of delivery			
Vaginal	1126 (58.6)	53,563 (97.7)	<0.001
Cesarean	796 (41.4)	1268 (2.3)	
Neonatal death (28 days of life)	21 (1.1)	373 (0.7)	0.031

Abbreviations: CD, cesarean delivery.

^aValues are given as number (percentage) or median (interquartile range), unless indicated otherwise. When data are missing, the reduced sample size is given in parentheses.

^bReported for comparison group only.

TABLE 3

Association between prior CD and subsequent stillbirths in the second pregnancy, February 2006 to March 2013.

Characteristics	All stillbirths (antepartum and intrapartum) (N=57,320)		Antepartum stillbirths (n=56,834)		Intrapartum stillbirths (n=56,713)	
	Crude RR (95% CI)	Adjusted RR (95% CI)	Crude RR (95% CI)	Adjusted RR (95% CI)	Crude RR (95% CI)	Adjusted RR (95% CI)
Prior CD	2.29 (1.84–2.86)	2.25 (1.79–2.83)	1.52 (1.05–2.19)	1.56 (1.08–2.24)	3.38 (2.54–4.50)	3.26 (2.40–4.42)
Prior stillbirth	2.77 (2.00–3.85)	1.74 (1.23–2.46)	2.75 (1.75–4.31)	1.58 (0.98–2.55)	2.90 (1.78–4.75)	2.00 (1.18–3.37)
Birth weight, g						
<2500	13.10 (11.54–14.87)	12.40 (10.88–14.12)	20.94 (17.46–25.12)	19.39 (16.06–23.40)	8.39 (6.93–10.15)	8.20 (6.75–9.97)
2500–3500	1	1	1	1	1	1
>3500	1.32 (1.02–1.71)	1.26 (0.98–1.63)	1.46 (1.00–2.14)	1.41 (0.97–2.05)	1.22 (0.86–1.73)	1.15 (0.80–1.64)
Obese (BMI ≥ 30 kg/m ²) or weight ≥ 91 kg	1.47 (1.14–1.89)	1.53 (1.18–1.99)	1.61 (1.16–2.23)	1.80 (1.29–2.53)	1.31 (0.88–1.95)	1.28 (0.83–1.97)
Maternal age ≥ 35 y	1.93 (1.38–2.70)	1.25 (0.87–1.78)	2.17 (1.41–3.34)	1.16 (0.72–1.86)	1.68 (0.97–2.90)	1.38 (0.79–2.42)
RPR						
Non-reactive	1	1	1	1	1	1
Reactive with treatment	1.76 (1.24–2.51)	1.31 (0.92–1.87)	2.00 (1.27–3.16)	1.50 (0.96–2.34)	1.50 (0.84–2.65)	1.09 (0.59–2.03)
Reactive no treatment	2.55 (1.69–3.86)	1.96 (1.31–2.96)	3.45 (2.11–5.64)	2.44 (1.51–3.96)	1.55 (0.70–3.46)	1.37 (0.61–3.06)
Not done/no results	1.01 (0.88–1.15)	0.95 (0.83–1.09)	1.07 (0.89–1.27)	1.00 (0.84–1.20)	0.93 (0.76–1.14)	0.88 (0.72–1.09)
HIV status						
Uninfected	1	1	1	1	1	1
Infected	1.79 (1.58–2.02)	1.30 (1.14–1.49)	2.20 (1.86–2.59)	1.51 (1.27–1.80)	1.37 (1.12–1.67)	1.07 (0.87–1.32)
Unknown	1.60 (1.19–2.15)	1.60 (1.19–2.16)	1.59 (1.05–2.42)	1.57 (1.03–2.39)	1.62 (1.05–2.49)	1.68 (1.08–2.62)
Pregnancy-associated hypertension	1.77 (1.43–2.19)	1.34 (1.07–1.67)	1.97 (1.50–2.60)	1.46 (1.10–1.94)	1.55 (1.10–2.17)	1.21 (0.84–1.75)

Abbreviations: RR, risk ratio; CI, confidence interval; CD, cesarean delivery; BMI, body mass index; RPR, rapid plasma reagin.