The final version of this paper was published in *Paediatr Perinat Epidemiol* 2013; 27(2):109-117

Characteristics in the first vaginal birth and their association with mode of delivery in the subsequent birth

Jian Sheng Chen[1,2], Jane B. Ford[1], Amanda Ampt[1], Judy M. Simpson[2], Christine L. Roberts[1]

1. Clinical and Population Perinatal Health Research, The Kolling Institute of Medical Research, University of Sydney, Australia

2. Sydney School of Public Health, University of Sydney, Australia

Address for correspondence

Jian Sheng Chen, Clinical and Population Perinatal Health Research,
Building 52, Royal North Shore Hospital, St Leonards 2065 NSW Australia
E-mail: jschen@med.usyd.edu.au

Abstract

Background

The extent to which complications or adverse outcomes in a first vaginal birth may contribute to mode of delivery in the next birth remains unclear. This study examines the impact of the first birth on subsequent mode of delivery.

Methods

The study population included women with a first vaginal birth and a consecutive second birth. Data were obtained from linked birth and hospital records for the state of New South Wales, Australia 2000-2009. The primary outcome was the mode of delivery for the second birth. Planned caesarean was modelled using logistic regression; intrapartum caesarean and instrumental delivery were modelled using multinomial logistic regression.

Results

Of the 114,287 second births, 4.2% were planned caesarean, 3.0% were intrapartum caesarean and 4.8% were instrumental deliveries. Adjusted risk factors from the first birth for a planned second birth caesarean were 3^{rd}-4^{th} degree tear (odds ratio [OR]=5.0, 95% confidence interval [CI] 4.6, 5.4), severe neonatal morbidity (OR=3.2, 95% CI 2.9, 3.6), perinatal death (OR=3.2, 95% CI 2.3, 4.4), severe maternal morbidity (OR=2.8, 95% CI 2.3, 3.3), instrumental delivery, large infant, labour induction, epidural use, use of oxytocin for augmentation and episiotomy. Important risk factors (OR >2) for intrapartum caesarean in the second birth were perinatal death or severe neonatal morbidity in the first birth. Risk factors for instrumental delivery in the second birth were perinatal death, preterm delivery and instrumental delivery.

Conclusions

Obstetrical interventions and adverse pregnancy outcomes in the first birth were associated with increased risk of operative delivery in the second birth.

Introduction

There is increasing recognition that mode of delivery in a first birth affects future pregnancies, including the delivery mode and outcomes.[1-3] However, the extent to which complications or adverse outcomes following a first vaginal birth may contribute to increased risk of operative delivery in the next birth is not clear. Understanding the impact of previous birth factors on subsequent mode of delivery should provide important insights into target areas for reducing obstetrical intervention rates and counselling women about what to expect for future births.

Concerns have been expressed over increasing caesarean rates which are increasing not only among first births, but also among women with a previous vaginal birth.[4-7] Between 1998 and 2008, in Australia, the proportion of multiparous women (without previous caesarean) delivering by caesarean increased, on average, by 4% per year.[4] Of interest are the factors driving the rise in primary caesareans among multiparous women.[8]

Although births after a caesarean have been widely studied, data on the impact of other obstetrical interventions on the subsequent mode of delivery remains limited. Previous studies suggest women with a prior instrumental delivery are 3 to 4 times more likely to have another instrumental delivery.[1,9] In 2008, a survey at six months postpartum found that, among Hong Kong women preferring vaginal birth before the birth, one in ten changed their preference to elective caesarean for future pregnancy after having a first instrumental delivery.[10] Untangling the effects of other interventions, complications and

outcomes among first instrumental and non-instrumental (spontaneous vaginal) births may shed light on mode of delivery decisions for subsequent births.

We hypothesized that obstetrical intervention and/or adverse outcome in a first vaginal birth influences subsequent pregnancy and mode of delivery in the second birth. We examined these among women with a first vaginal birth. The aim of this study was to determine first birth factors that are independently associated with a second birth (primary) planned caesarean, intrapartum caesarean and instrumental delivery.

Methods

Study population and data sources

The study population included all women with both a first vaginal birth and a second consecutive birth during 2000 to 2009. Data were obtained from two linked population level data collections, the New South Wales (NSW) Perinatal Data Collection ('birth data') and the NSW Admitted Patient Data Collection ('hospital data') from July 2000 to December 2009. The birth data are a statutory surveillance system of all live births or stillbirths of at least 20 weeks gestation or at least 400 grams birth weight in NSW. The hospital data are a census of all hospitalizations that includes summary discharge information for every inpatient admission to NSW public and private hospitals. Diagnoses and procedures for each admission are coded according to the 10th revision of the International Classification of Diseases Australian Modification (ICD-10-AM) and the affiliated Australian Classification of Health Interventions.[11] Up to 20 diagnoses and 20 procedures were used for disease identification in this study. Record linkage of birth

data and hospital data (by the Centre for Health Record Linkage [CHeReL][12]) was approved by the NSW Population and Health Services Research Ethics Committee. The CHeReL undertakes quality assurance for all record linkage and assesses the linkage quality by manually reviewing personal identifiers for a sample of the records obtained for linkage. For this study, the CHeReL reported the linkage quality as <1/1,000 missed links and <2/1,000 false positive links.

Ascertainment of study factors and outcomes

The primary outcome was mode of delivery in the second birth: planned caesarean, intrapartum caesarean, instrumental delivery or spontaneous vaginal birth. First and second birth variables identified from birth data included maternal age, socio-economic status (SES) based on residential postcode (Index of Relative Socio-economic Disadvantage),[13] mode of delivery, year of birth, interval between first and second births, gestation-adjusted birth weight (i.e., <10^{th}, 10^{th} - 90^{th} and >90^{th} percentiles),[14] preterm birth (<37 gestational weeks), smoking during pregnancy, labour induction, epidural, episiotomy, oxytocin for augmentation of spontaneous labour and perinatal death. Hospital data were used to identify region of hospital (urban or rural), payment status (public or private maternity care), antepartum haemorrhage (including placental abruption) and severe perineal trauma (3^{rd}-4^{th} degree tear). Variables utilising information from both hospital data and birth data included maternal hypertension (gestational, preeclampsia or chronic),[15] gestational or pre-gestational diabetes,[16] severe maternal morbidity[17] and severe neonatal morbidity.[18] When data were available in both birth and hospital records, decision rules were based on previous data quality studies of the

databases.[15,16] A recent systematic review of the quality of perinatal data indicated that identifying cases from more than one dataset increased ascertainment without increasing false positives.[19]

Data analysis

Median inter-birth interval was estimated by the Kaplan–Meier method. Logistic regression was employed to determine the effect size (odds ratio [OR]) of potential risk factors for second birth planned caesarean compared with women who laboured in their second birth. Among women who laboured, multinomial logistic regression was used to assess risk factors for intrapartum caesarean and instrumental delivery compared with spontaneous vaginal birth.

Population attributable fraction (PAF) and the 95% confidence interval (CI) were calculated for first birth risk factors for 2nd birth planned caesarean, intrapartum caesarean and instrumental delivery in Stata/SE 11.2.[20] The PAF of a risk factor indicates the proportion of the burden of a delivery mode (e.g. planned caesarean) in a population that could be eliminated if the effect of that risk factor in the first birth is eliminated from the population, based on the assumption that the factor is causally associated with delivery mode.

Results

Between 2000 and 2009, 160,973 women had both their first and second births in NSW and for 73.2% (n=117,787) of these the first births was a vaginal birth (Figure 1). To

examine our hypothesis that risk factors in the first birth influence mode of delivery in the second birth, women with recognized second birth indications for caesarean (breech presentation, placenta praevia or multiple pregnancy) were excluded from further analyses (n=3,500). Of the remaining 114,287 women, 4.2% had a (primary) planned caesarean, 3.0% had an intrapartum caesarean and 4.8% had an instrumental delivery in their second birth. Table 1 presents distributions of risk factors in the first birth for the 114,287 women by mode of delivery at the second birth. Compared to women with a spontaneous vaginal second birth, women having any form of operative second birth were older, had higher rates of hypertension, diabetes, obstetrical interventions and adverse outcomes in their first birth.

Compared to 83,408 women with a spontaneous vaginal first birth, the 30,879 (27.0%) women with an instrumental first birth were more likely to have all forms of operative delivery in their second birth, including 7.5% versus 3.0% planned caesarean, 4.6% vs 2.4% intrapartum caesarean and 10.4% vs 2.7% instrumental delivery. The median inter-birth interval between first and second births was 2.2 years and differed little by first birth delivery mode. There were 113,059 women with first vaginal births before 2005, and thus at least 5 years of follow-up time. Of these, 81,521 (72.1%) had a subsequent birth by the end of 2009, 71.4% for women with an instrumental first birth and 72.4% for women with a spontaneous vaginal first birth. For these women with at least 5 years of follow-up, the median time to the next birth was 3.1 years regardless of the mode of delivery in the first birth.

Risk factors for planned caesarean at the second birth

After adjusting for factors in the second pregnancy, first birth factors independently associated with planned caesarean in the second birth (in order of effect size) were 3^{rd}-4^{th} degree tear, severe neonatal morbidity, perinatal death, severe maternal morbidity, instrumental delivery, large infant, labour induction, epidural use, use of oxytocin for labour augmentation and episiotomy (Table 2). The leading four first birth risk factors each increased the risk of planned caesarean by more than 100% (adjusted OR>2). As the effect of hospital region was modified by payment status (P<0.001), a composite second birth variable 'Hospital region + care type' was created for inclusion in the regression model. There was no difference in planned caesarean between women with different SES (P=0.59).

Risk factors for intrapartum caesarean and instrumental delivery at the second birth

While 3^{rd}-4^{th} degree tear and severe maternal morbidity in the first birth were independent risk factors only for intrapartum caesarean at the second birth, perinatal death, severe neonatal morbidity, instrumental delivery, preterm birth, use of oxytocin for labour augmentation, labour induction and small infant were independent first birth risk factors for both intrapartum caesarean and instrumental delivery (Table 3). Perinatal death and severe neonatal morbidity in the first birth were associated with more than 100% increased risk of intrapartum caesarean at the second birth. For instrumental delivery at the second birth, important first birth factors (adjusted OR>2) were instrumental delivery, perinatal death and preterm birth. SES was not a risk factor for either delivery method (P=0.14).

Population attributable fractions (PAF) of first birth risk factors are shown in Table 4. Instrumental delivery in the first birth had the largest PAF of all first birth factors for planned caesarean, intrapartum caesarean and instrumental delivery at the second birth (20%, 16% and 39% respectively). The only other first birth factors with PAF >10% were 3^{rd}-4^{th} degree tears and labour induction which had PAFs for planned caesarean of 13% and 11% respectively. First birth adverse outcomes that were associated with high risk second birth operative delivery, but occurred rarely contributed little to the burden of the operative delivery at the second birth (e.g. perinatal death PAFs ≤0.7%).

Comment

This study showed that obstetrical interventions and adverse pregnancy outcomes in a first birth influence the likelihood of all forms of operative delivery in the second birth. Maternal and infant factors as well as interventions were associated with increased risk of subsequent operative delivery. An adverse pregnancy outcome such as perinatal death at first birth could reduce the threshold for an obstetrical intervention and therefore increase the risk of an operative delivery at second birth. Alternatively, a subsequent birth operative delivery may reflect a recurrence of complications present at first birth (eg. preterm delivery).

Population attributable fraction estimates can help prioritize possible targets for reducing second birth operative delivery as they take into account both the prevalence and size of effect of risk factors. However population attributable fractions should be interpreted

with caution. Their validity is based on a number of assumptions including a causal relationship between risk factor and outcome, and the independence of the risk factor. [21] This study cannot demonstrate causal associations with operative delivery at a second birth. The identified factors may be surrogates of some underlying causes for a specific intervention. For example, small for gestational age infant at first birth might be an indication of intrauterine growth restriction caused by high blood pressure, insulin dependent diabetes, antiphospholipid antibodies, smoking or antepartum hemorrhage, and without addressing the underlying causes, intrauterine growth restriction is likely to recur in a subsequent pregnancy leading to increased risk of intrapartum caesarean.[22] However, PAF can be used to compare the relative impact of identified risk factors which are modifiable. The risk factors with highest PAF for operative second births were first births with instrumental delivery, third or fourth degree tear or labour inductions.

Instrumental first birth had the highest population attributable fractions for all 3 operative delivery modes (planned caesarean, intrapartum caesarean, instrumental delivery) at second birth. Other studies have similarly shown increased rates of caesarean and instrumental birth subsequent to a first instrumental birth.[1,23] To our knowledge the only intervention shown to reduce operative delivery is continuous support in labour.[24] Therefore, limiting obstetrical interventions and increasing continuous support in labour at first birth, where possible, may reduce the risk of subsequent operative delivery. In the context of rising caesarean section rates, concern has been raised about losing instrumental delivery skill among newly trained obstetricians.[25] Improving techniques to reduce physical impacts (e.g. 3rd-4th degree tear) and psychological impacts of first instrumental delivery may also have a positive impact on subsequent birth.

Third and fourth degree tears are also potentially modifiable first birth risk factors for second birth caesareans. While many of the factors associated with a third or fourth degree tear in the first birth are not readily modifiable (for example, large baby), there is increasing evidence that vacuum deliveries are associated with fewer third or fourth degree tears than forceps deliveries and that where forceps deliveries are necessary, an accompanying episiotomy may lessen the likelihood of third or fourth degree tear.[26]

Like caesarean sections, there is international concern about increasing labour induction rates[27] and more specifically about the proportion of inductions performed without medical indication[28] and among first births,[28,29] failure rates,[29] variations in practice (between institutions, states and countries)[30] and more broadly the safe use of oxytocin (for induction and augmentation).[31] There is scope for change. One study reported dramatically reduced elective no-medical-indication births before 39 weeks (from 8.2% to 1.7%) through application of a strict protocol, and the Institute for Healthcare Improvement has an "Elective Induction Bundle" (a group of evidence-based interventions) that aims to guide appropriate use and reduce adverse outcomes.[32,33] Limiting first birth obstetrical interventions may not only improve outcomes for the first birth but also reduce the risk of subsequent operative delivery.

Strengths of this study include the large cohort with longitudinal linkage enabling us to explore the effects of various obstetrical interventions and adverse outcomes in the first birth. We were unable to undertake analyses by intention to deliver as some women intending to have planned caesarean will have gone into labour before their scheduled

date and would be classified as intrapartum caesarean in this study. Also, it was not possible to ascertain from these data the roles of women and caregivers in decision-making regarding second birth mode of delivery. Moreover, women who migrated to other states or countries and had a second birth outside NSW were not included in this study; but the percentage is likely to be small[34] and these out-of-state births are unlikely to be associated with first pregnancy factors.

In summary, women who had obstetrical interventions and adverse pregnancy outcomes in the first birth were at increased risk of operative delivery in the second birth. The results indicate the importance of 'getting the first birth right' in reducing rates of subsequent operative deliveries. A conservative approach to the use of obstetric interventions among women having a first birth is an important strategy in attempts to curb the rising obstetrical intervention rates.

Acknowledgements

The authors thank the NSW Department of Health for access to the population health data and the NSW Centre for Health Record Linkage for linking the data sets. We also thank Prof. Cande Ananth for assistance in copy-editing the manuscript. This work was supported by an Australian National Health and Medical Research Council (NHMRC) Capacity Building Grant (#573122). Christine Roberts is supported by a NHMRC Senior Research Fellowship (#457078).

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Figure 1 Selection procedure of the study population

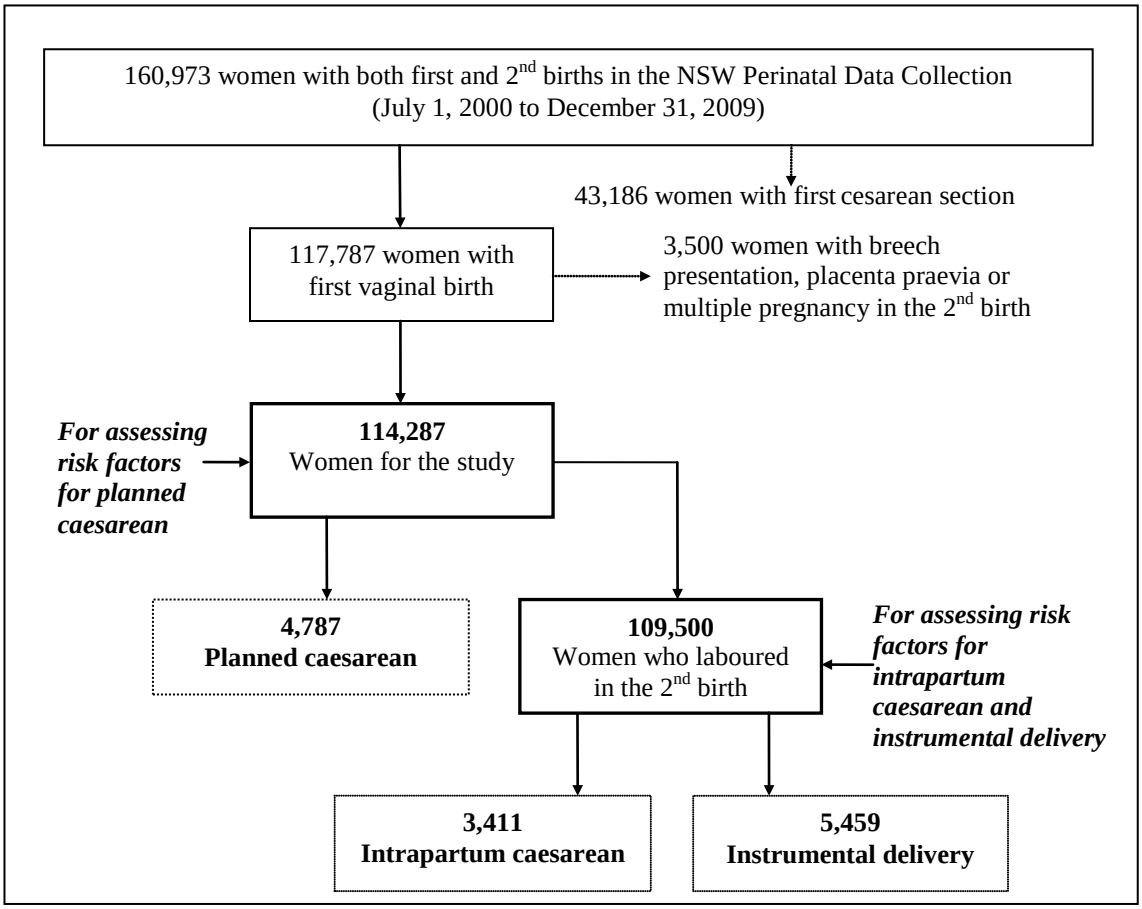

Table 1 Characteristics at first birth by mode of delivery at the second birth

	All women		Women who laboured at the second birth			
	All (N=114,287)	Planned caesarean (N=4,787)	All (N=109,500)	Intrapartum caesarean (N=3,411)	Instrumental delivery (N=5,459)	Spontaneous vaginal delivery* (N=100,630)
	%	%	%	%	%	%
Maternal age (years)						
<20	9.6	5.1	9.8	7.7	4.4	10.1
20 to <35	83.7	84.5	83.7	83.2	85.6	83.6
≥35	6.8	10.4	6.6	9.1	10.0	6.3
Hypertension	9.8	12.2	9.7	12.1	11.2	9.5
Diabetes	3.8	4.9	3.7	5.1	4.7	3.6
Induction	28.3	38.6	27.9	35.0	35.0	27.2
Oxytocin for augmentation	17.0	20.4	16.8	22.3	23.9	16.3
Epidural	31.8	45.4	31.2	44.4	52.9	29.6
Episiotomy	27.1	37.0	26.7	33.0	40.9	25.7
Instrumental delivery	27.0	48.1	26.1	41.3	59.0	23.8
3rd-4th degree tear	4.3	17.8	3.7	6.6	4.2	3.6
Maternal morbidity[17]	1.2	4.2	1.1	2.2	1.6	1.0
Preterm birth (<37 weeks)	5.7	7.7	5.6	11.8	8.6	5.2
Birth weight^						
<10th percentile	12.0	10.5	12.0	13.2	12.3	12.0
10th - 90th percentile	81.9	77.1	82.1	79.8	82.6	82.1
>90th percentile	6.2	12.4	5.9	7.0	5.1	5.9
Neonatal morbidity[18]	3.9	11.0	3.6	10.9	6.4	3.2
Perinatal death	0.3	1.3	0.2	1.2	0.7	0.2

^ Number of women with missing value in this variable=373 (0.3% of the 114,287 women). * Spontaneous vaginal birth without forceps or vacuum extraction.

Table 2 Risk factors for planned caesarean in the second birth following a first vaginal birth among all study women (N=114,287 women)

	Planned caesarean Rate*(%)	Adjusted OR^ [95% CI]
1st birth variables		
3rd-4th degree tear	17.4	5.0 [4.6, 5.4]
Neonatal morbidity[18]	11.8	3.2 [2.9, 3.6]
Perinatal death	19.6	3.2 [2.3, 4.4]
Maternal morbidity[17]	14.4	2.8 [2.3, 3.3]
Instrumental delivery	7.5	1.8 [1.7, 1.9]
Birth weight		
<10th percentile	3.7	1.0 [0.9, 1.1]
10th - 90th percentile	3.9	1.0 Reference
>90th percentile	8.4	1.5 [1.3, 1.7]
Induction	5.7	1.4 [1.4, 1.6]
Epidural	6.0	1.3 [1.2, 1.4]
Oxytocin for augmentation	5.0	1.2 [1.1, 1.3]
Episiotomy	5.7	1.1 [1.0, 1.2]
2nd birth variables		
Interval between 1st and 2nd births (per year)		1.1 [1.1, 1.1]
Year at 2nd birth (per year)		1.1 [1.0, 1.1]
Maternal age (years)		
<20	1.9	0.7 [0.6, 1.0]
20 to <35	3.8	1.0 Reference
≥35	6.3	1.3 [1.2, 1.4]
Hospital region + care type		
rural + private care	6.8	2.0 [1.8, 2.2]
urban + private care	5.7	1.5 [1.4, 1.6]
rural + public care	3.6	1.3 [1.2, 1.4]
urban + public care	3.2	1.0 Reference
Hypertension	6.0	1.2 [1.1, 1.3]
Diabetes	6.6	1.3 [1.1, 1.5]
Birth weight		
<10th percentile	4.0	1.2 [1.0, 1.3]
10th - 90th percentile	3.9	1.0 Reference
>90th percentile	6.2	1.3 [1.2, 1.5]
Antepartum haemorrhage/placental abruption	15.4	4.5 [3.8, 5.5]

* Rate of planned caesarean at second birth for women with a condition listed in the first column among the 114,287 study women.

^ Odds ratio (OR) – adjusted for all other variables in the column by logistic regression.

Table 3 Risk factors for intrapartum caesarean and instrumental delivery in the second birth following a first vaginal birth among 109,500 women who laboured for the second birth

	Intrapartum caesarean		Instrumental delivery	
	Rate*(%)	**Adjusted^ OR [95%CI]**	**Rate*(%)**	**Adjusted^ OR [95%CI]**
1st birth variables				
Perinatal death	15.9	2.7 [1.8, 4.0]	14.3	2.5 [1.6, 3.9]
Neonatal morbidity[18]	9.5	2.4 [2.1, 2.8]	8.9	1.6 [1.4, 1.8]
Instrumental delivery	4.9	1.9 [1.8, 2.1]	11.3	3.5 [3.3, 3.7]
Preterm birth (<37 weeks)	6.6	1.8 [1.6, 2.1]	7.6	2.2 [1.9, 2.5]
Oxytocin for augmentation	4.1	1.4 [1.2, 1.5]	7.1	1.2 [1.1, 1.3]
Induction	3.9	1.3 [1.2, 1.4]	6.3	1.1 [1.0, 1.2]
Birth weight				
<10th percentile	3.4	1.2 [1.1, 1.3]	5.1	1.3 [1.2, 1.4]
10th - 90th percentile	3.0	1.0 Reference	5.0	1.0 Reference
>90th percentile	3.7	0.8 [0.7, 0.9]	4.3	0.6 [0.5, 0.7]
3rd-4th degree tear	5.6	1.8 [1.6, 2.1]	5.7	1.1 [0.9, 1.2]
Maternal morbidity[17]	6.2	1.5 [1.2, 2.0]	7.0	1.1 [0.9, 1.4]
Epidural	4.4	0.9 [0.8, 1.0]	8.5	0.8 [0.8, 0.9]
2nd birth variables				
Interval between 1st and 2nd births (per year)		1.2 [1.1, 1.2]		1.2 [1.2, 1.2]
Maternal age (years)				
<20	2.7	1.1 [0.9, 1.5]	1.7	0.8 [0.6, 1.1]
20 to <35	2.9	1.0 Reference	4.5	1.0 Reference
≥35	4.1	1.2 [1.1, 1.4]	7.6	1.1 [1.1, 1.2]
Hospital region+private care				
rural + private care	3.7	1.2 [1.0, 1.4]	7.1	2.0 [1.7, 2.2]
urban + private care	3.3	0.7 [0.7, 0.8]	8.7	1.5 [1.4, 1.6]
rural + public care	3.0	1.2 [1.0, 1.3]	3.0	1.1 [1.0, 1.2]
urban + public care	3.0	1.0 Reference	3.3	1.0 Reference
Hypertension	5.2	1.3 [1.2, 1.5]	6.9	1.1 [1.0, 1.2]
Birth weight				
<10th percentile	3.7	1.3 [1.1, 1.5]	3.4	0.7 [0.6, 0.8]
10th - 90th percentile	2.7	1.0 Reference	4.9	1.0 Reference
>90th percentile	5.4	2.1 [2.0, 2.3]	6.8	1.5 [1.4, 1.6]
Antepartum haemorrhage /placental abruption	19.4	7.3 [6.0, 8.8]	9.3	3.0 [2.4, 3.9]
Induction	4.6	1.4 [1.3, 1.5]	7.6	1.3 [1.3, 1.4]
Epidural	7.1	3.5 [3.2, 3.8]	14.6	4.0 [3.8, 4.3]
Oxytocin for augmentation	5.6	1.5 [1.3, 1.7]	12.6	2.0 [1.8, 2.2]
Preterm birth (<37 weeks)	7.4	2.0 [1.7, 2.3]	2.8	0.5 [0.4, 0.7]

* Rate of intrapartum caesarean or instrumental delivery at second birth for women with a condition listed in the first column among the 109,500 study women.
^ Odds ratio (OR) – adjusted for all other variables in the column by multinomial logistic regression.

Table 4 Population attributable fraction (PAF) of first birth factors for planned caesarean, intrapartum caesarean and instrumental delivery at the second birth

	Planned caesarean	**Intrapartum caesarean**	**Instrumental delivery**
	PAF [95% CI] (%)	**PAF [95% CI] (%)**	**PAF [95% CI] (%)**
First birth variables			
Instrumental delivery	19.8 [17.5, 22.1]	16.3 [13.8, 18.7]	39.0 [37.0, 40.9]
3^{rd}-4^{th} degree tear	13.4 [12.3, 14.4]	2.8 [2.0, 3.7]	
Induction	10.9 [8.8, 13.0]	6.5 [4.0, 9.0]	2.9 [0.8, 4.9]
Epidural	8.5 [6.0, 11.0]		
Neonatal morbidity[18]	6.4 [5.6, 7.3]	5.0 [4.0, 6.0]	1.5 [0.9, 2.2]
Birth weight >90^{th} percentile	3.9 [2.9, 4.9]		
Episiotomy	3.6 [1.5, 5.8]		
Oxytocin for augmentation	3.1 [1.6, 4.6]	5.5 [3.7, 7.3]	3.1 [1.6, 4.6]
Maternal morbidity[17]	2.3 [1.8, 2.9]	0.7 [0.2, 1.2]	
Perinatal death	0.7 [0.4, 0.9]	0.5 [0.2, 0.8]	0.2 [0.1, 0.4]
Preterm birth (<37 weeks)		4.0 [2.9, 5.2]	3.8 [3.1, 4.5]
Birth weight <10^{th} percentile		1.8 [0.5, 3.1]	2.5 [1.6, 3.4]