The final version of this paper has been published in *ANZJOG* 2016; 56:453-459.

FULL TITLE: Outcomes of Breech Birth by Mode of Delivery: A Population Linkage Study

SHORT TITLE: Outcomes of Breech Birth by Mode of Delivery

AUTHORS

Yu Sun BIN[1,2], Christine L. ROBERTS[1,2] , Jane B. FORD[,2], Michael C. NICHOLL[,3].

AFFILIATIONS

1. Clinical and Population Perinatal Health Research, Kolling Institute, St Leonards NSW Australia
2. Sydney Medical School, University of Sydney, Sydney, NSW Australia.
3. Department of Obstetrics and Gynaecology, Royal North Shore Hospital, St Leonards, NSW Australia

CONFLICTS OF INTEREST

None

CORRESPONDENCE DETAILS

Yu Sun Bin

Clinical and Population Perinatal Health Research

The Kolling Institute, University of Sydney

Building 52, Royal North Shore Hospital

St Leonards, NSW 2065, Australia

Telephone: +61 2 9462 9811

Fax: +61 2 9462 9058

Email: yusun.bin@sydney.edu.au

ALTERNATIVE CORRESPONDENCE DETAILS

Jane Ford

Email: jane.ford@sydney.edu.au

Fax: +61 2 9462 9058

WORD COUNTS

Main text = 2565 words

Abstract = 250 words

FINANCIAL SUPPORT

This work was supported by an Australian National Health and Medical Research Council (NHMRC) Centre for Research Excellence grant (1001066). JBF is supported by an Australian Research Council Future Fellowship (FT120100069). CLR is supported by an NHMRC Senior Research Fellowship (1021025). The funding sources had no involvement in the study design; collection, analysis, and interpretation of the data; or the decision to submit this paper for publication.

ACKNOWLEDGEMENTS

We thank the NSW Ministry of Health for access to the population health data and the Centre for Health Record Linkage (CHeReL) for linkage of the data sets.

ABSTRACT

Background: Trial evidence supports a policy of caesarean section for singleton breech presentations at term but vaginal breech birth is considered a safe option for selected women.

Aims: To provide recent Australian data on outcomes associated with intended mode of delivery for term breech singletons in women who meet conservative eligibility criteria for vaginal breech birth.

Materials and Methods: Birth and hospital records from 2009 to 2012 in New South Wales were used to identify women with non-anomalous pregnancies who would be considered eligible for vaginal breech birth. Intended mode of delivery was inferred from labour onset and management.

Results: Of 10,133 women with term breech singleton pregnancies, 5,197 (51.3%) were classified as eligible for vaginal breech delivery. Of these, 6.8% intended vaginal breech birth, 76.4% planned caesarean section, and intention could not be determined for 16.8%. Women intending vaginal delivery had higher rates of neonatal morbidity (6.0% vs. 2.1%), neonatal birth trauma (7.4% vs. 0.9%), Apgar <4 at 1 minute (10.5% vs. 1.1%), Apgar<7 at 5 minutes (4.3% vs. 0.5%), and NICU/SCN admissions (16.2% vs. 6.6%) than those planning caesarean section. Increased perinatal risks remained after adjustment for maternal characteristics. Severe maternal morbidity (1.4% vs. 0.7%) and postpartum readmission (4.6% vs. 4.0%) were higher in the intended vaginal compared to planned caesarean births but these differences were not statistically significant.

Conclusions: In a population of women classified as being eligible for vaginal breech birth, intended vaginal delivery was associated with higher rates of neonatal morbidity than planned caesarean section.

KEYWORDS: (1) breech presentation, (2) caesarean section, (3) term birth, (4) pregnancy outcome, (5) cohort study

INTRODUCTION

There has been a long debate over the best mode of delivery for breech presentation at term. The current evidence indicates planned caesarean section is safer for the baby than planned vaginal birth, although vaginal breech birth is still considered a safe option for some women. Cochrane review of the trial evidence shows caesarean section is associated with a >90% reduction in perinatal mortality and neonatal morbidity [1] and a recent systematic review and meta-analysis of 27 observational and intervention studies found planned caesarean section more than halved the risk for perinatal mortality and morbidity compared to planned vaginal delivery [2].

The lack of difference in long-term outcomes for infants between planned vaginal and caesarean delivery [1] and variations in the standard of care across different settings have been arguments against a policy of caesarean section for breech presentation at term [3]. In settings where planned vaginal delivery is common practice and eligibility for vaginal delivery follows strict criteria, the risks of serious neonatal morbidity have been shown to be no worse than those for caesarean section [3]. However, such studies include women ineligible for vaginal breech birth in the planned caesarean section group, thus potentially confounding indications for caesarean section with the mode of delivery itself.

Current RANZCOG guidelines state that "with adherence to strict criteria before and during labour, planned vaginal delivery of the singleton breech at term may be an option to offer to appropriately counselled and selected women where appropriate personnel and infrastructure to support such a birth are in place" [4]. There are however no recent Australian data that can be used to counsel women and inform decision-making. We therefore sought to examine the maternal and neonatal outcomes associated with intended mode of delivery for breech presentation at term in women who would be deemed eligible for vaginal breech birth.

MATERIALS AND METHODS

Data sources

Data for this study came from two population health datasets from New South Wales (NSW): the Perinatal Data Collection (birth records) and the Admitted Patient Data Collection (hospital records). The Perinatal Data Collection is a statutory surveillance system of all births in NSW of at least 20 weeks gestation or at least 400 grams birth weight. Information on maternal characteristics, pregnancy, labour, delivery, and infant outcomes are recorded by the attending midwife or doctor. The Admitted Patient Data Collection is a census of all NSW inpatient hospital discharges from public and private hospitals. Diagnoses and procedures associated with each hospital admission are coded by trained medical coders according to the International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, Australian Modification (ICD-10-AM) [5] and the Australian Classification of Health Interventions [6]. Probabilistic linkage of the birth, hospital, and death records was undertaken by the NSW Centre for Health Record Linkage (CHeReL) [7]. Personal identifiers were removed to preserve privacy and a linkage key was provided to researchers to merge relevant birth and hospital records in the current study.

Study population

The study population included women with non-anomalous singleton breech presentations at term who were classified retrospectively as eligible for vaginal breech birth (VBB). The selection of the study population is outlined in Figure 1. The initial population included all women who gave birth in NSW during the years 2009 to 2012 and who presented at term (≥37 weeks) with a singleton breech fetus. Our determination of eligibility for VBB was based on guidelines from RANZCOG [4] and SOGC [8] which recommend delivery in a

hospital with regular access to caesarean section (service level 3 or higher), and an infant with a birthweight between 2,500 to 4,000 grams, in addition to other favourable factors based on clinical judgement.

We took a conservative view of unfavourable factors for vaginal breech delivery and excluded women if they had any of the following: previous stillbirth, prior caesarean section (CS), maternal pelvic abnormality, pre-existing medical conditions (hypertension, diabetes, cardiovascular disease, renal disease, thyroid disease, autoimmune disease), pregnancy complications (pregnancy hypertension, gestational diabetes, antepartum haemorrhage, abruption, placenta praevia), the indication for caesarean was fetal distress in the absence of labour, intrapartum haemorrhage, antepartum stillbirth; or if the birth resulted in a small-for-gestational age infant, an infant with major congenital anomalies, or cord prolapse. Since the timing of cord prolapse was unknown, it was used as an exclusion criterion rather than an outcome. We also excluded women and infants for whom there was no linked hospital record of delivery or birth.

Intended mode of delivery

We inferred intended mode of delivery from a combination of information from the birth and hospital records. Women who *Intended VBB* were those with spontaneous labour and uncomplicated vaginal breech birth, those with evidence of labour or intent to labour, including use of induction or augmentation, spontaneous labour with caesarean delivery for failure to progress or fetal distress, or a failed trial of labour. Women with *Planned CS* were those without labour. A third group, *Intention Uncertain*, was created for women whose intention to labour was unknown. This group included women who had spontaneous labour onset but delivered by CS and for whom the indication for CS was non-specific ("other clinical" or "non-clinical").

Outcomes

Infant outcomes examined were severe neonatal morbidity and mortality, transfer to neonatal intensive care or a higher service level hospital, neonatal birth trauma, 1-minute and 5-minute Apgar scores, and length of stay after birth. The Neonatal Adverse Outcome Indicator (NAOI) was used as a composite measure of neonatal morbidity and mortality [9]. It includes mechanical ventilation, surgical procedures, and respiratory distress and has been previously shown to predict readmission and mortality in the first year of life [9]. Neonatal birth trauma potentially due to mode of birth was also ascertained in the hospital records (ICD-10 diagnosis codes P10 – P15) and included intracranial laceration, injuries to the central nervous system and skeleton, nerve paralysis or other brachial plexus birth injury, birth injury to the external genitalia, birth injury to the scalp, birth injury to other parts of the peripheral nervous system, and other birth injury [10].

Maternal outcomes of interest were maternal mortality, maternal morbidity, postpartum haemorrhage, genital tract trauma, and postpartum readmission within 6 weeks of delivery. Severe maternal morbidity was captured using the Maternal Morbidity Outcome Indicator (MMOI), a composite indicator developed and validated for use in routinely collected population health data and which includes both life-threatening conditions and procedures such as cardiac arrest, cerebrovascular haemorrhage, hysterectomy, and mechanical ventilation [11]. Genital tract trauma included 2^{nd}, 3^{rd} or 4^{th} degree tears, and episiotomies.

Covariates

Information on maternal and pregnancy characteristics came from the birth record. These included maternal age (in years), country of birth (Australian/overseas), parity (nulliparous/multiparous), smoking during pregnancy (any/none),morbid obesity (any/none),

patient type (private patient in private hospital/private patient in public hospital/public patient in public hospital), hospital region (urban/regional), and gestational age at birth (37/38/39/40/41-43 completed weeks).

Statistical Analysis

All analyses were conducted using SAS 9.3 (SAS Institute, NC). Maternal characteristics by intended mode of delivery were tabulated. Chi-square tests for categorical variables, Fisher's exact test for categorical variables with cell sizes less than 5, and one-way ANOVA for continuous variables were performed to examine differences between the Intended VBB, Planned CS, and Intention Uncertain groups.

Modified Poisson regression with robust error variance [12] was used to calculate the relative risk and associated 95% confidence for each outcome in the Intended VBB group relative to the Planned CS group. The models for each outcome were performed with and without adjustment for the covariates of maternal age, parity, gestational age, patient type, country of birth, hospital region, and smoking. The only exception to this was the model for Apgar score at 5 minutes which did not converge with the addition of gestational age. However, gestational age by itself was not associated with Apgar score, and the adjusted model for 5-minute Apgar score included all of the covariates except for gestational age.

Ethical approval

Ethics approval for the study was obtained from the NSW Population and Health Services Research Ethics Committee.

RESULTS

Of 10,133 women with breech-presenting term singletons, 5,197 (51.3%) were classified as eligible for vaginal delivery: 352 (6.8%) as Intended VBB, 3,970 (76.4%) Planned CS and Intention was Uncertain for the remaining 875 (16.8%).

Demographic and pregnancy characteristics of the intended mode of delivery groups are shown in Table 1. Women who Intended VBB were slightly younger and more likely to be Australian-born than those who Planned CS. About twice as many of the Intended VBB had a previous pregnancy compared to the Planned CS. Women who Intended VBB also tended to have higher rates of smoking and morbid obesity. As expected, more than half of those with Planned CS delivered at 39 weeks, while women who Intended VBB were more likely to deliver at or after 40 weeks of gestation.

The rates of infant and maternal outcomes by intended mode of delivery are shown in Table 2. The actual mode of delivery in the majority of women was caesarean section, which accounted for 93.2% of women deemed eligible for vaginal birth. Only 4.2% of women delivered vaginally. Of those who Intended VBB, 61.9% delivered vaginally but all of the women who Planned CS had a caesarean delivery.

The Intended VBB group had higher rates of severe neonatal morbidity, neonatal birth trauma, low Apgar score, and NICU/SCN admission than those in the Planned CS group. The 2- to 10-fold risk increase associated with Intended VBB remained with adjustment for maternal age, maternal country of birth, smoking, parity, gestational age, patient type, and hospital region. Mean length of stay after birth was shorter in the Intended VBB group than the Planned CS group (3.1 vs. 4.2 days, $t=9.23$, $p<0.001$).

The Intended VBB group appeared to have higher rates of maternal morbidity and postpartum readmission than the Planned CS group although there was no significant difference once maternal characteristics were taken into account. Genital tract trauma

occurred in 113 (32.4%) women who Intended VBB: 58 (16.5%) had a 2nd degree tear, 6 (1.7%) had a 3rd/4th degree tear and 57 (16.2%) had an episiotomy.

DISCUSSION

Summary of findings

In women with term singleton breech pregnancies at term, intended vaginal breech birth was associated with higher risks of neonatal morbidity, neonatal birth trauma, low Apgars, and NICU/SCN admission compared with planned caesarean section. The results show that even in women who meet strict criteria, vaginal breech birth is associated with higher risk for adverse neonatal outcomes than caesarean section. Maternal morbidity did not differ significantly between groups, except for higher risk of postpartum haemorrhage and genital tract trauma in women who intended vaginal delivery. We note, however, that these outcomes are not directly comparable because the threshold for haemorrhage is lower for vaginal deliveries than for caesarean sections with postpartum haemorrhage is classified as ≥500mL blood loss after vaginal delivery and ≥750mL after a caesarean delivery [5]. Similarly, genital tract trauma occurs only with vaginal delivery and is a disadvantage of vaginal breech because it is a common outcome.

Comparison to other studies

We found the relative risk for neonatal morbidity to be two times higher in those intending vaginal breech birth than those intending caesarean section. This is consistent with meta-analysis of the trial evidence [1] and meta-analysis of results from observational and intervention studies [13]. A population-based observational study from Canada published subsequent to these reviews has also demonstrated higher rates of adverse outcomes for

neonates associated with vaginal delivery compared to caesarean delivery without labour [10].

Only one previous Australian study has examined outcomes associated with breech birth; a study of 766 women selected for vaginal delivery in one New South Wales hospital [14]. That study found neonatal morbidity was higher in planned vaginal delivery compared to planned caesarean section for women eligible for vaginal birth (1.6% vs. 0.4%) and maternal morbidity was also increased (8.2% vs. 4.8%) [14]. Postpartum haemorrhage >1500mL was higher in the planned vaginal delivery group (0.8% vs. 0.4%). However, due to the small numbers involved, the results were not statistically significant, but are consistent with a higher rate of adverse maternal and neonatal outcomes associated with vaginal delivery.

Strengths and limitations

Major strengths of the current study are the large population-based sample, an analysis based on intended rather than actual mode of delivery, and the conservative selection of women. The stringent criteria ensured that only outcomes for women classified as low-risk for vaginal breech birth would be included. Furthermore, adverse outcomes due to indications for caesarean section such as placenta previa, antepartum stillbirth, and congenital anomalies were excluded and therefore were not mistakenly attributed to caesarean section itself.

The study is not without limitations. Intended mode of delivery was inferred retrospectively from health records and this was unclear for 17% of women. Intention of vaginal breech birth was based on the use of labour induction, augmentation, or intrapartum caesarean section for labour complications. Planned caesarean section was defined based on the absence of labour. Thus the women for whom intention was uncertain will include (a) those who planned caesarean section but who went into labour and (b) those women who

intended vaginal birth but who had an intrapartum caesarean section with no reported intrapartum complication. It is possible that some women in the planned caesarean section group delivered vaginally although this is likely to be few [14]. The Intention Uncertain group has maternal characteristics and outcomes that are between those of the Intended VBB and Planned CS groups, suggesting that it is a mix of the two patient types, and that our groupings are sound.

In addition, we do not know when a diagnosis of breech presentation was made. Women in the Intended VBB group may have included those where breech was only identified in labour, when then the opportunity for considered decision-making around mode of delivery has passed and this may have led to worse outcomes. In contrast, undiagnosed breech presentation in the Planned CS would have less effect on the outcomes. However we do not know the numbers of women for whom this may have been true. It is important to note that improved antenatal detection of breech presentation and increased use of external cephalic version may help to reduce the need for breech delivery and its attendant risks.

Lastly, we had no information on the providers' experience with vaginal breech birth. The results are indicative of the population-based risks associated with mode of delivery and suggest that even in a highly selected population of women, a policy of caesarean section would reduce neonatal morbidity. Based on this study, the number of caesarean sections needed to reduce 1 instance of neonatal morbidity in low-risk women is 26.

The current evidence suggests infants born to women who planned caesarean section do not differ in their development compared to those who planned vaginal delivery [1, 15] and mothers with planned caesarean section do not have worse medium to long-term outcomes than those who planned vaginal delivery [1]. However, caesarean deliveries are not without risk [16] and the impact of caesarean section on future fertility and pregnancies [17,

18] [19], and potential long-term benefits to the baby associated with vaginal delivery [20] must be considered in conjunction with women's personal preferences [21].

Conclusion

Planned caesarean section is associated with lower risks of neonatal morbidity than vaginal delivery in women classified as eligible for vaginal breech birth. These local data are important for counselling women and informing decisions around mode of delivery for breech presentation.

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Table 1. Maternal and pregnancy characteristics by intended mode of delivery (N=5197).

	Intended VBB	Planned CS	Intention Uncertain	Test statistic, p-value
N (% of total)	352 (6.8%)	3970 (76.4%)	875 (16.8%)	-
Maternal age (years; mean, SD)	30.0 (5.3)	30.6 (5.3)	29.8 (5.3)	$F(2,5194)=10.33$, $p<0.0001$
Maternal age				$X^2(4) = 5.92$,
<20 years	12 (3.4%)	101 (2.5%)	24 (2.7%)	$p=0.21$
20-34 years	269 (76.4%)	2933 (73.9%)	671 (76.7%)	
35+ years	71 (20.2%)	936 (23.6%)	180 (20.6%)	
Country of birth				$X^2(2) = 3.41$,
Overseas	98 (27.8%)	1294 (32.6%)	278 (31.8%)	$p=0.18$
Australia	254 (72.2%)	2676 (67.4%)	597 (68.2%)	
Parity				$X^2(2) = 109.65$,
Nulliparous	177 (50.3%)	2970 (74.9%)	586 (67.0%)	$p<0.0001$
Multiparous	175 (49.7%)	995 (25.1%)	289 (33.0%)	
Any smoking during pregnancy	49 (13.9%)	273 (6.9%)	105 (12.0%)	$X^2(2) = 44.69$, $p<0.0001$
Morbid obesity	x (0.6%)	15 (0.4%)	x (0.3%)	$p=0.77^{\#}$
Patient type				
Private	41 (11.7%)	1286 (32.4%)	200 (22.9%)	$X^2(4) = 101.34$,
Private patient & public hospital	50 (14.2%)	590 (14.9%)	117 (13.4%)	$p<0.0001$
Public patient & public hospital	261 (74.2%)	2094 (52.8%)	558 (63.8%)	
Hospital region				$X^2(2) = 20.22$,
Urban	272 (77.3%)	3178 (80.1%)	641 (73.3%)	$p<0.0001$
Regional	80 (22.7%)	792 (20.0%)	234 (26.7%)	
Gestational age at birth				$X^2(8) = 575.39$, $p<0.0001$
37 weeks	37 (10.5%)	272 (6.9%)	176 (20.1%)	
38 weeks	74 (21.0%)	1245 (31.4%)	306 (35.0%)	
39 weeks	93 (26.4%)	2070 (52.1%)	261 (29.8%)	
40 weeks	97 (27.6%)	308 (7.8%)	109 (12.5%)	
41 - 43 weeks	51 (14.5%)	76 (1.9%)	23 (2.6%)	

x Cell sizes <5 redacted. *Some numbers/percentages may not sum exactly to 100% due to missing data. #Fisher's exact test as some cell sizes <5. Post-hoc pairwise comparison of maternal age between groups showed mothers who Planned CS tended to be older than those who Intended VBB (0.6 years, t=2.00, p=0.05).

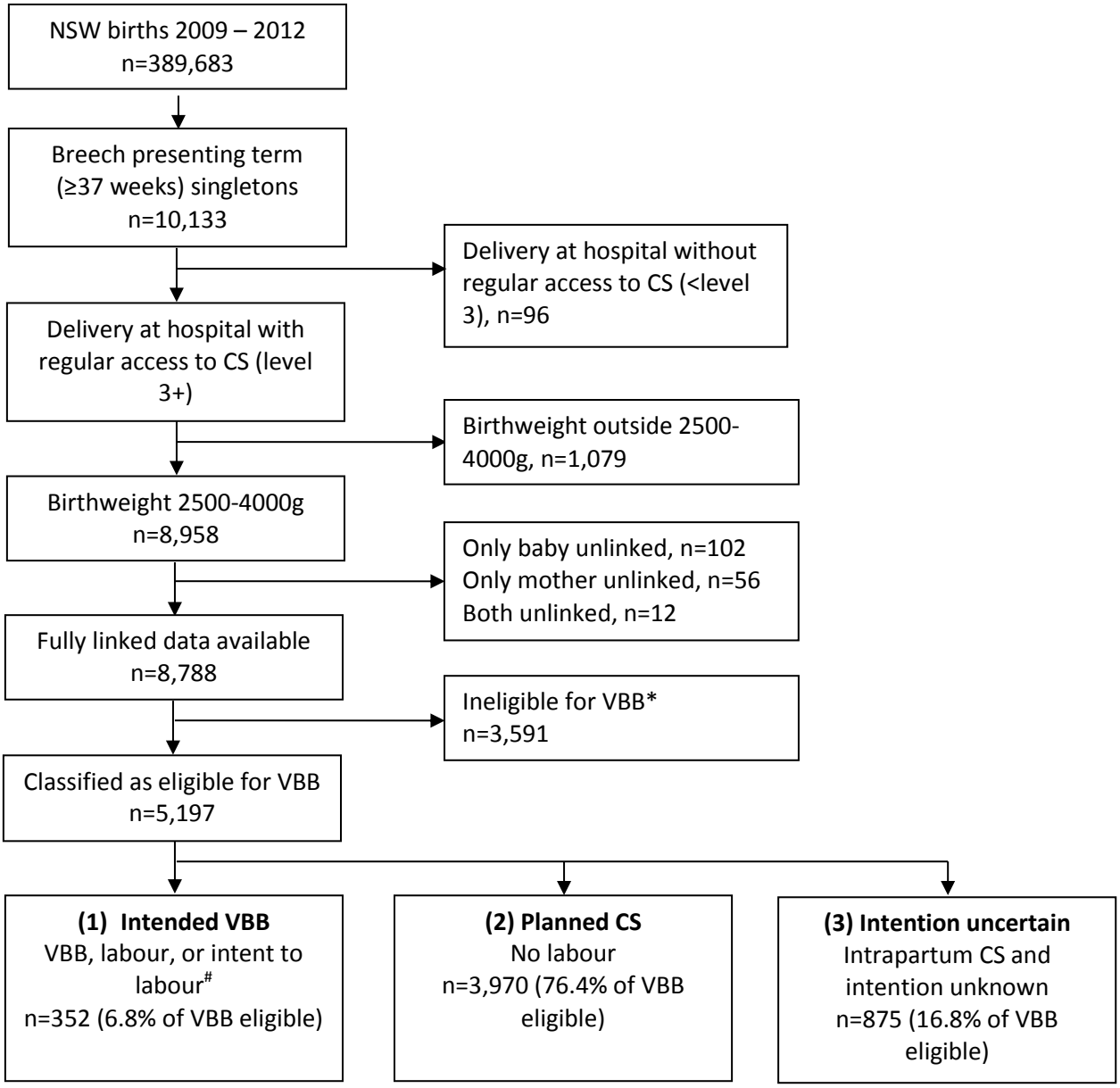
Table 2. Actual mode of delivery, and maternal and infant outcomes by intended mode of delivery (N=5197).

	Intended VBB	**Planned CS**	**Intention Uncertain**	**Intended VBB compared to Planned CS**	
	n=352 n (col%)	**n=3970** n (col%)	**n=875** n (col%)	RR (95% CI)	Adjusted RR (95% CI)[#]
Mode of delivery					
Vaginal birth	218 (61.9%)	None	None	-	
Caesarean section	134 (38.1%)	3970 (100%)	875 (100%)	-	
Neonatal outcomes					
Severe neonatal morbidity and mortality (NAOI)	21 (6.0%)	83 (2.1%)	21 (2.4%)	**2.85 (1.79 – 4.55)**	**2.16 (1.33 – 3.51)**
Neonatal birth trauma[*]	26 (7.4%)	36 (0.9%)	9 (1.0%)	**8.15 (4.98 – 13.33)**	**7.38 (4.33 – 12.59)**
Apgar1 <4	37 (10.5%)	44 (1.1%)	18 (2.1%)	**9.77 (6.45 – 14.80)**	**12.38 (7.89 – 19.43)**
Apgar5 <7	15 (4.3%)	18 (0.5%)	10 (1.1%)	**10.65 (5.54 – 20.48)**	**9.06 (4.76 – 17.24)**
NICU or SCN admission	57 (16.2%)	261 (6.6%)	85 (9.7%)	**2.46 (1.89 – 3.21)**	**1.83 (1.36 – 2.46)**
Transfer	9 (2.6%)	79 (2.0%)	20 (2.3%)	1.29 (0.65 – 2.54)	1.08 (0.54 – 2.16)
Length of stay post-birth (mean, SD)	3.1 (1.9)	4.2 (2.0)	4.1 (2.5)	-	
Maternal outcomes					
Severe maternal morbidity (MMOI)	5 (1.4%)	28 (0.7%)	13 (1.5%)	2.01 (0.78 – 5.18)	1.24 (0.44 – 3.52)
Postpartum haemorrhage	23 (6.5%)	132 (3.3%)	38 (4.3%)	**1.97 (1.28 – 3.02)**	**1.69 (1.07 – 2.68)**
Postpartum readmission	16 (4.6%)	157 (4.0%)	39 (4.5%)	1.15 (0.70 – 1.90)	1.21 (0.73 – 2.02)

[*] Neonatal birth trauma includes intracranial laceration, injuries to the central nervous system and skeleton, Erb's, Klumpke's, or phrenic nerve paralysis or other brachial plexus birth injury, birth injury to the external genitalia, birth injury to the scalp, birth injury to other parts of the peripheral nervous system, and other birth injury to the liver, spleen, sternomastoid, eye, subcutaneous fat, and unspecified birth injury (ICD-10 diagnosis codes P10 – P15). [#] Models compare Intended VBB and Planned CS groups only (N=4322) and are adjusted for maternal age, parity, gestational age, patient type, country of birth, hospital region, smoking (yes/no).

Post-hoc pairwise comparison showed baby's length of stay was significantly longer in Planned CS compared to Intended VBB group (1.1 days, t=9.23, p<0.001).

Figure 1. Flowchart for selecting study population and defining intended mode of delivery groups.



*Ineligible for VBB due to one or more of: prior caesarean (n=1,630), small-for-gestational age (665), any hypertension (n=593), any diabetes (n=699), cord prolapse (n=244), antepartum haemorrhage (n=156), placenta praevia (n=123), maternal pelvic abnormality (n=91), previous stillbirth (n=78), fetal distress indication for CS in the absence of labour (n=76), cardiovascular disease (n=47), major congenital anomalies (n=36), auto-immune disease (n=30), renal disease (n=22), thyroid disease (n=28), abruption

(n=13), intrapartum haemorrhage (n=12), antepartum stillbirth (or unknown timing) (n=4). Reasons for exclusion are not mutually exclusive.

[#]Labour or intention to labour includes: vaginal delivery (n=218), induced labour (n=94), induction/augmentation by ARM (n=70), induction/augmentation by oxytocics (n=77), induction/augmentation by prostaglandins (n=35), induction/augmentation by other method (n=7), spontaneous labour with caesarean delivery for failure to progress or fetal distress (n=47), or failed trial of labour (n=0). Reasons for inclusion are not mutually exclusive.