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Highlights

- The review compared studies of births planned in hospital, birth centres and at home
- A specific instrument appraised quality of evidence in research on birth setting
- Studies varied in design, location, context and definition of key terms
- High quality studies found no statistically significant difference in infant mortality by setting
- Women have higher odds of normal vaginal birth at home or in birth centres

Maternal and perinatal outcomes by planned place of birth among women with low-risk pregnancies in high-income countries: A systematic review and meta-analysis

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Abstract

Background

The comparative safety of different birth settings is widely debated. Comparing research across high-income countries is complex, given differences in maternity service provision, data discrepancies, and varying research techniques and quality. Studies of births planned at home or in birth centres have reported both better and poorer outcomes than planned hospital births. Previous systematic reviews have focused on outcomes from either birth centres or home births, with inconsistent attention to quality appraisal. Few have attempted to synthesise findings.

Objective

To compare maternal and perinatal outcomes from different places of birth via a systematic review of high-quality research, and meta-analysis of appropriate data (Prospero registration CRD42016042291).

Design

Reviewers searched CINAHL, Embase, Maternity and Infant Care, Medline and PsycINFO databases to identify studies comparing selected outcomes by place of birth among women with low-risk pregnancies in high-income countries. They critically appraised identified studies using an instrument specific to birth place research and then combined outcome data via meta-analysis, using RevMan software.

Findings

Twenty-eight articles met inclusion criteria, yielding comparative data on perinatal mortality, mode of birth, maternal morbidity and/or NICU admissions. Meta-analysis indicated that women planning hospital births had statistically significantly lower odds of normal vaginal birth than in other planned settings. Women experienced ~~less~~ severe perineal trauma or haemorrhage at a lower rate in planned home births than in obstetric units. There were no statistically significant differences in infant mortality by planned place of birth, although most studies had limited statistical power to detect differences for rare outcomes. Differences in location, context, quality and design of identified studies render results subject to variation.

Conclusions and implications for practice

High-quality evidence about low-risk pregnancies indicates that place of birth had no statistically significant impact on infant mortality. The lower odds of ~~severe~~ maternal morbidity and obstetric

intervention support the expansion of birth centre and home birth options for women with low-risk pregnancies.

Keywords

Home childbirth, birthing centres, obstetric delivery, pregnancy outcome, infant mortality, postpartum haemorrhage

Introduction

The universal importance of maternal and newborn well-being is unquestioned. However, the impact of place of birth on safety and well-being is widely debated globally. Debate is fuelled by divergent conclusions from research on planned place of birth (de Vries et al. 2013) and is further complicated by national and regional variation in provision of maternity care across birth places.

Women are increasingly seeking greater choice in birth place, including options other than hospitals that offer fewer interventions and greater autonomy (Vedam, Stoll, et al. 2017). Yet, researchers vary in their conclusions about outcomes from different places of birth. Consequently, there is ~~fervent~~ keen interest in reliable research evidence comparing maternal and perinatal outcomes by place of birth, especially amongst clinicians, policy-makers, and childbearing women and their families. There is particular attention devoted to home as a safe place of birth. Study findings must take account not only of whether the mother and infant *survive* but also how well mother and infant *thrive* in different birthplaces. Diverse study designs and methods, and contradictory research findings create difficulty in synthesising outcomes to inform clinical decisions. Accordingly, government policy and professional guidelines in different countries vary in their support for birth centres and home births. Variation reflects differing beliefs about autonomy, safety, risk and childbirth, together with differing interpretations of the body of existing research (Roome & Welsh 2015).

Variation in birth setting

In many high-income countries, most women give birth in hospital. Access to alternative birth places varies within and between countries, although usually limited. In the Netherlands approximately 20% of births take place at home; elsewhere the proportion of planned home births

in high-income countries ranges between 0.3% in Australia (Hilder et al. 2014) and 3.3% in New Zealand (Shaw et al. 2016). Similarly, the rate of births in midwife-led birth centres (a term encompassing various models) varies from approximately 0.5% in the United States (MacDorman & Declercq 2016) to over 10% in New Zealand and the Netherlands (Shaw et al. 2016) and 11% in England (National Audit Office 2013). Variation in birthplace options is affected by the status, scope and role of the midwife in different jurisdictions, licensing and insurance issues, the extent of integration between maternity care options, funding issues and other sociocultural factors (Benoit et al. 2005; De Vries et al. 2002; Vedam et al. 2018).

The debate on safety

Several recent studies in high-income regions compared outcomes from births planned in hospitals and at home. They found no significant difference in risk of adverse perinatal outcomes for planned home births among women with low-risk pregnancies (de Jonge et al. 2015; de Jonge et al. 2009; Hutton et al. 2016; Janssen et al. 2009) and among low-risk parous women (Birthplace in England Collaborative 2011; Homer et al. 2014). Similarly, studies found no significant differences in adverse outcomes between births planned in labour wards and in birth centres (Birthplace in England Collaborative 2011; Gottvall et al. 2005; Homer et al. 2014; Laws, Tracy & Sullivan 2010). Further, many studies identified lower rates of intervention and/or maternal morbidity in births planned in birth centres and at home, compared with hospital births.

However, other investigators reported higher rates of adverse perinatal outcomes in planned home births than in planned hospital births (Grunebaum et al. 2014; Pang et al. 2002; Snowden et al. 2015; Wax, Lucas, et al. 2010). Some of these findings were reported ~~primarily~~ in countries where skilled birth attendants are not universally integrated across birth settings into regional health systems (e.g. Chang & MacOnes 2011; Kennare et al. 2010; Snowden et al. 2015). Other

results were from population-based studies that combined pregnancies with different levels of risk or used unreliable data sources for the reported outcome (e.g. Cheng et al. 2013; Evers et al. 2010; Grunebaum et al. 2013; Kennare et al. 2010; Pang et al. 2002; Wax, Pinette, et al. 2010). Others combined data from births with skilled and unskilled birth attendants (e.g. Chang & MacOnes 2011; Malloy 2010). Adverse results from a composite primary perinatal outcome were reported for nulliparous women planning home births in England (Birthplace in England Collaborative Group 2011).

Variation in the design and quality of research on place of birth inhibits the development of universally acceptable recommendations for provision of services across settings (Gyte et al. 2009; Michal et al. 2011; Nove, Berrington & Matthews 2012b; Vedam 2003; Vedam, Schummers & Fulton 2013).

Methodological challenges in research about place of birth

Researchers have delineated and discussed the unique features of studies into place of birth (Declercq 2013; Leslie & Romano 2007; Nove, Berrington & Matthews 2012b; Olsen & Clausen 2012; Vedam 2003; Zielinski, Ackerson & Kane Low 2015). These features include appropriately identifying intended (as distinct from actual) birth place, ensuring equivalence of risk status, controlling for confounding and mediating factors, dealing with adverse events that would have occurred regardless of setting (especially related to congenital abnormalities), and accounting for different providers in countries with different models of maternity provision.

When comparing outcomes across places of birth, consistent, standardised inclusion criteria across cohorts, reliable sampling methods, and relevant outcome measures are all imperative. For example, some research on place of birth is compromised by amalgamating data from unplanned home births (without skilled birth attendants) and from planned births at home within integrated

maternity systems (Gyte et al. 2010; Kirby & Frost 2011; Michal et al. 2011). All these factors, as well as the limits to randomisation, complicate appraisals of research quality and risk of bias (Nove, Berrington & Matthews 2012b; Vedam, Rossiter, et al. 2017).

Further, adequate sample sizes are essential to allow for comparisons between settings, especially when exploring rare outcomes such as mortality and severe morbidity. Relatively small numbers of women choose to give birth in birth centres or at home in most high-income countries. Typically, datasets with sufficient power can only be generated by large population-based studies conducted over several years, notwithstanding the limitations of using registry-based data (de Jonge et al. 2017), or through meta-analysis, where possible. Some studies have utilised a 'composite outcome' to group data on uncommon adverse outcomes to improve statistical power (Birthplace in England Collaborative Group et al. 2011). Finally, the diverse context of maternity provision in different countries generates inconsistencies in data availability, inclusion criteria and key definitions, further complicating research in this field.

Synthesising research findings

There have been few Cochrane reviews of place of birth outcomes. Olsen and Clausen attempted a systematic review comparing planned home versus hospital birth (2012) and were able to identify only one small study (n=11) that met inclusion criteria. Noting difficulties with recruiting women who will consent to randomisation, their discussion highlighted the importance of well-designed population-based observational studies. Another Cochrane review (Hodnett, Downe & Walsh 2012) incorporated 10 trials comparing 'alternative settings for birth' with conventional hospital labour wards, of which five examined alongside midwifery units. This review found no impact on adverse outcomes for mothers or infants across included settings, but women allocated to alternative settings had higher rates of spontaneous vaginal births and breastfeeding at six to

eight weeks, and lower rates of obstetric intervention than women giving birth in hospital units (Hodnett, Downe & Walsh 2012).

Other research syntheses about outcomes by place of birth have involved largely narrative analysis. Some compared data from hospital births with home births (Elder, Alio & Fisher 2016; Fullerton, Navarro & Young 2007; Leslie & Romano 2007; McIntyre 2012; Stotland & Declercq 2002; Zielinski, Ackerson & Kane Low 2015); others compared births in hospitals with birth centres (Alliman & Phillippi 2016; Dixon et al. 2012; McIntyre 2012; Muthu & Fischbacher 2004; Stewart et al. 2005; Stotland & Declercq 2002; Walsh & Downe 2004).

The varying quality of research has been a recurring theme in reviews (Campbell & MacFarlane 1986; Elder, Alio & Fisher 2016; McIntyre 2012; Olsen 1997; Vedam, Schummers & Fulton 2013). Some authors have specifically concluded that the limited quality or comparability of studies precludes undertaking meta-analysis (Blix et al. 2014; Stewart et al. 2005; Walsh & Downe 2004). Some systematic reviews indicate methods used to assess potential bias in selected studies (Alliman & Phillippi 2016; Blix et al. 2014; Stewart et al. 2005; Walsh & Downe 2004), although other reviews do not indicate how quality was determined. One systematic review and meta-analysis comparing planned home births and hospital births (Wax, Lucas, et al. 2010) reported that study quality was evaluated using a published instrument (Zaza et al. 2000) but did not report on the quality assessment of included studies. This meta-analysis has been widely criticised for methodological flaws (Gyte et al. 2010; Kirby & Frost 2011; Michal et al. 2011).

We did not identify any systematic review or meta-analysis that examined outcomes from studies across three places of birth (home, birth centre, hospital), using a validated rating tool to appraise the quality of included studies.

Objectives

This systematic review addressed the question: are perinatal and maternal outcomes significantly different from births planned at home, in birth centres or hospitals, for women with low-risk pregnancies? We reviewed original research from high-income countries (World Bank 2016) using a birthplace-specific quality appraisal instrument (Vedam, Rossiter, et al. 2017), and undertook meta-analysis of outcome data where possible.

Methods

The review examined the effect of *birth place* as distinct from model of maternity care, although often closely linked. The definition of place of birth varied between studies, depending on data availability, regional differences in provision and study design. We registered our protocol with Prospero international register of systematic reviews (http://www.crd.york.ac.uk/PROSPERO/) in July 2016 (CRD42016042291). This paper follows the PRISMA guidelines for reporting systematic reviews and meta-analyses (Moher, Liberati, Tetzlaff, Altman, et al. 2009).

Eligibility criteria

The systematic review included articles:

- published in peer-reviewed journals between 2000 and 2016;
- comparing outcomes from two or more places of birth;
- written in English.

We included articles which provided evidence on one or more of nine outcomes addressing important dimensions of perinatal mortality and morbidity, mode of birth and maternal morbidity (regardless of other outcomes examined):

1. intrapartum stillbirth

2. early neonatal mortality 0-7 days
3. admission to neonatal intensive care unit (NICU)
4. normal vaginal birth
5. instrumental birth
6. caesarean section
7. intact perineum after vaginal birth
8. severe perineal trauma (3rd or 4th degree tear) after vaginal birth
9. postpartum haemorrhage (PPH) ≥1000mL.

Table 1 indicates inclusion criteria following a ~~PICOS~~ framework comprising population, intervention, comparisons, outcomes and study design (PICOS) (Moher, Liberati, Tetzlaff & Altman 2009), giving examples of excluded study types.

INSERT TABLE 1 HERE

Information sources

We searched five databases during May 2016: CINAHL, Embase, Maternity and Infant Care, Medline and PsycINFO. We further scrutinised reference lists manually to identify other potential articles, and set up alerts from the databases used to receive notification of relevant articles published after the main data extraction. We updated the search in January 2017, to fully cover the period 2000-2016.

Search strategy

The review used a combination of search terms (Box 1) encompassing different concepts. The 'birth place terms' in column A were all combined with the Boolean term OR, as were all 'outcome terms' in column B. The resulting searches A and B were then combined with AND.

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TABLES

Table 1. Inclusion and exclusion criteria for articles in systematic review

Inclusion criteria	Exclusion examples
Participants	
Healthy women with low-risk pregnancies, assessed by the researchers using clear consistent criteria	• Non-human participants • Women with known antenatal risk factors e.g. twins, non-vertex presentation, previous caesarean section, pre-term labour, elective caesarean section, gestational diabetes, hypertension • Risk self-rated by study participants • Risk factors not comparable in all study cohorts
Women giving birth in a high-income country	• Women in low- or medium-income countries • Women in two or more high-income countries, where outcomes may be affected by variation between jurisdictions rather than place of birth
Intervention	
Intended place of birth, determined at or close to the onset of labour	• Model of care or provider type rather than birth place • Actual place of birth, regardless of intention • Intended birth place determined at booking, not close to onset of labour • Cohorts including births without skilled attendants • Cohorts including unplanned home births • Studies where intended place of birth is a comparator rather than the independent variable • Comparison of specific antenatal, intrapartum or postnatal interventions or management approaches
Comparison	
Comparison of two or more intended birth settings – home birth, birth in hospital obstetric unit or birth centre (including, where relevant, free-standing and alongside midwifery units)	• Studies of outcomes in one birth setting i.e. just home births or birth centres, without comparison cohort • Studies of modified rooms within hospital

	obstetric unit • (Meta-analysis excluded studies comparing birth centres with home births as the meta-analysis which uses hospital births as referent.)
Outcomes	
Maternal or neonatal outcomes related to labour and birth, specifically: • Perinatal mortality – intraparum stillbirth and early neonatal mortality (0-7 days postpartum) • Admission to NICU~~/SCN~~ • Mode of birth – ~~spontaneous~~ normal vaginal birth, instrumental birth, caesarean section • Perineal status – intact perineum, 3rd/4th degree perineal trauma • Postpartum haemorrhage ≥1000mL Many studies also investigated other outcomes not addressed here, as indicated in Table S1.	• Articles presenting study protocols rather than outcomes • Studies with place of birth as outcome • Articles which do not include data on at least one of these outcomes • Psycho-social outcomes only • Cost-related or other economic outcomes • Studies which only report satisfaction or other qualitative results
Study design	
Original research comparing outcomes from two or more birth place cohorts, prospectively or retrospectively determined	• Studies which don't compare outcomes from two or more places of birth • Opinion pieces, reports, case-studies, commentaries etc. • Systematic reviews and/or meta-analyses (individual studies may be included) • Studies not reported in peer-reviewed journals published between 2000 and 2016

Table 2: Summary of studies included in Systematic Review (N=28)

	First author. Publication date. Country	Study design	Source of data. Year/s	Population t eligibility criteria	Intervention t Planned place of birth	Comparator t Planned place of birth	Outcome measures t relevant to current review outcomes	Quality rating
				Abbreviations at foot of table				
1	Bernitz 2011. Norway	RCT	Admin data 2004-2010	1111 women with low-risk pregnancies = AMU eligibility.	MW-led AMU N=412	Normal birth unit (NU) N=417. Special birth unit (SU) N=282.	Operative birth, PPH, sphincter injuries, NICU admission	High
2	Birthplace in England Collaborative 2011. England	Prospective cohort study	Data collection forms. 2008-2010	64,538 women with low-risk pregnancies as per NICE guidelines. *Additional analysis of 57,127 women without complicating conditions at labour onset.*	Planned HB N=16,840 AMU N=16,710 FMU N=11,282	Obstetric Unit (OU) N=19,706	Composite PO = perinatal mortality + major intrapartum morbidity (defined). SO: 'normal birth' (SVB without IOL; anaesthesia; or episiotomy)	High
3	Blix 2012. Norway	Retrospective cohort study	Patient files + registry data. 1990-2007	17,941 low-risk pregnancies	Planned HB N=1631	Planned hospital birth N=16,310	PO: PPH >500mL. SO: perinatal and neonatal death rates	High
4	Bolten 2016. Netherlands	Prospective cohort study	Perinatal database + participant questions 2009-2011	3495 women with low-risk pregnancies in MW care at onset of labour	Planned HB N=2050.	MW-led OU birth N=1445	PO: SVB and perineal outcomes, PPH.	High
5	Burns 2012. England, Scotland, Northern Ireland	Prospective cohort study	Data collection forms. 2000-2008	8924 women "low risk" as per RCOG water immersion joint statement.	Water immersion in a birth pool in AMU N=2100. Combined FMU/HB (=community) N=2694.	Water immersion in a birth pool in OU N=4130	Maternal: mode of birth, perineal trauma, PPH. Neonatal: NICU admission, mortality	High
6	Byrne 2000. Australia	RCT	Case notes + participant questions 1993-1995	201 women with normal uncomplicated pregnancies.	Birth centre AMU. N=100	Hospital delivery suite N=101	CS, blood loss ≥300mL, ~~NICU~~ SCN admission	High

	First author. Publication date. Country	Study design	Source of data. Year/s	Population t eligibility criteria	Intervention t Planned place of birth	Comparator t Planned place of birth	Outcome measures t relevant to current review outcomes	Quality rating
				Abbreviations at foot of table				
7	Davis 2011. New Zealand	Comparative descriptive study	Perinatal database 2006-2007	16210 women with low risk pregnancies	Primary Unit (PU, like FMU) N=2877	Planned HB N=1830, Secondary hospital (SU) N=7380, Tertiary hospital (TU) N=4123	Mode of birth, perineal trauma (not defined), PPH ≥1000mL, NICU admission	High
8	Davis 2012 New Zealand	Retrospective cohort study	Perinatal database 2006-2007	16,210 women with low risk pregnancies	Planned PU birth N=2877	Planned HB N=1830 SU N=7308 TU N=4123	PPH ≥ 1000mL	High
9	de Jonge, 2013. Netherlands	Linked cohort study	Perinatal database + LEMMoN study data 2004-2006	146,752 women with low risk pregnancies.	Planned HB N=92,333	Planned OU birth N=54,419.	PO: Severe acute maternal morbidity (defined). SO: PPH ≥ 1000mL	High
10	de Jonge 2015. Netherlands	Retrospective cohort study	Linked national registry data. 2000-2009	743,070 women with low risk pregnancies in MW-led care	Planned HB N=466,112	Planned hospital birth (including AMU) N=276,958	Intrapartum and neonatal death, NICU admission	High
11	Dixon 2014. New Zealand	Retrospective cohort (aim to replicate BPiE in NZ)	NZ College Midwives Research Data. 2006-2010	61,072 women defined as low-risk using BPiE criteria)	Planned HB N=4921 Primary unit (PU) N=10,158	Hospital birth in either SU (N=29,027) or TU (N=16,966)	Perinatal mortality, NICU admission.	Moderate
12	Eide 2009. Norway	Prospective observational cohort study	Hospital data. 2001-2002	453 *nulliparous* women with low-risk pregnancies = MLW eligibility	MLW N=252	Conventional delivery ward (CDW) N=201	PPH, perineal trauma, mode of birth	High
13	Gaudineau 2012. France	Retrospective case-control study	Hospital data. 2005-2008	1206 women with low risk pregnancies.	Home-like BC N=316	Traditional labour ward (TLW) N=890	Mode of delivery, perineal trauma, PPH (≥500mL), adverse neonatal outcomes (including neonatal death).	Moderate
14	Halfdans-dottir 2015. Iceland	Retrospective cohort study – matched. Two methods	Hospital data + registry data. 2005-2009	*Method 1:* 1228 all HB + matched hospital births *Method 2:* 1112 women with no contraindications	Planned HB (1) N=307 (2) N=278.	Matched planned hospital birth (including AMU) (1) N=921 (2) N=834.	Operative birth, PPH, anal sphincter injury, NICU admission	High
15	Hiraizumi 2013. Japan	Retrospective cohort study	?Medical records. 2007-2011	508 women with low risk pregnancies	Planned HB under MW-led care N=168	Planned OU birth under MW (N=123) or under obstetrician (N=217).	Mode of birth, perineal trauma, PPH ≥ 1000mL	Moderate

	First author. Publication date. Country	Study design	Source of data. Year/s	Population t eligibility criteria	Intervention t Planned place of birth	Comparator t Planned place of birth	Outcome measures t relevant to current review outcomes	Quality rating
				Abbreviations at foot of table				
16	Homer 2000. Australia	Retrospective cohort study	Hospital data. 1995.	734 women with low-risk pregnancies	Birth centre N=367	Hospital labour ward N=367	Mode of birth, perineal trauma, neonatal outcomes.	Moderate
17	Homer 2014. Australia	Retrospective population-based cohort study (similar to BPiE)	Linked registry + hospital data. 2000-2008	258,161 women with low risk pregnancies. *Additional analysis for 235,611 women without complications at start of labour*	Planned HB N=742 BC N=14,483	Hospital labour ward N=242,936	PO: primary neonatal outcome (see BPiE Collaboration). SO: stillbirth + NND, mode of birth, perineal trauma, 'normal labour and birth' (defined)	High
18	Laws 2010. Australia	Retrospective population-based study	Perinatal database. 2001-2005	822,955 women. *Additional analysis of 498,023 women with term, low-risk pregnancies*	Planned BC birth N=22,222	Intended OU birth N=800,733 Low-risk group: N=475,791	Perinatal mortality, mode of birth, severe perineal trauma, SCN~~/NICU~~ admission	Moderate
19	Miller 2012. New Zealand	Retrospective matched case control study	Questionnaires to MW. 2006-2007	225 *nulliparous* women with low-risk pregnancies.	Planned HB N=109	Planned OU birth with same MW as HB group N=116	Type of birth, perineal status, PPH ≥500ml	Moderate
20	Nove 2012. UK	Observational study	Secondary analysis of maternity data. 1998-2000	273,872 women. Exclude high risk pregnancies (NICE guidelines)	Planned HB N=5998	Planned hospital birth N=267,874	PPH ≥1000ml	High
21	Overgaard 2011. Denmark	Cohort study with matched control.	Patient records and admin data. 2004-2008.	1678 women with low risk pregnancies (NICE guidelines) + healthy multips with uncomplicated obstetric history regardless of age and BMI.	Planned FMU birth. N=839	Hospital birth, women matched on 9 key factors. N=839	PO: CS. SO: NICU admission, perineal status, type of birth, PPH ≥500ml, perinatal mortality	High
22	Overgaard 2012 Denmark	Cohort study with matched control.	Secondary analysis of data from Overgaard et al 2011.	1678 women as above, stratified by educational disadvantage. *[460 women without post-secondary education]*	Planned FMU birth. N=839 *[Women without post-secondary education N=230]*	Hospital birth N=839 *[Women without post-secondary education N=230]*	Composite optimal birth outcome (uncomplicated SVB with good maternal and fetal outcomes), SVB, CS, NICU admission, perineal status.	High
23	Pang 2002. USA	Retrospective population-based cohort study	Birth registry data, linked with death records. 1989-1996	Singleton birth 34/40+ with no recorded complications (defined) N=16,726 women. *Additional analysis used infants 2500g+ or 37/40+ N=16,253.*	HB with health professional as attendant or certifier (not 'planned HB') N=5854 + attempted HB transferred to hospital N=279.	Hospital birth N=10,593. *Secondary analysis N=10,347*	Neonatal death, PPH (not defined)	Low

	First author. Publication date. Country	Study design	Source of data. Year/s	Population t eligibility criteria	Intervention t Planned place of birth	Comparator t Planned place of birth	Outcome measures t relevant to current review outcomes	Quality rating
					Secondary analysis N=6052			
24	Prelec 2014. Slovenia	Prospective case-control study	Hospital data 2013	497 low-risk *nulliparous* pregnancies (NICE guidelines).	MW-managed births in MLU N=154	OU births N=343	PO: CS SO: SVB, PPH≥ 500mL, perineal status, NICU admission	Moderate
25	Ryan 2005. Australia	Retrospective cohort study	Hospital records. 1995-1996	3683 women all with BC eligibility.	Planned BC birth N=720	Planned hospital labour ward (LW) N=2963	Type of labour and birth, perineal status, PPH≥ 600mL, perinatal death, SCN admission	Low
26	Thornton 2016. USA	Retrospective cohort study using prospective study data	Secondary analysis of data from AABC. 2006-2011	11,303 women attending BC for antenatal care, who chose hospital or BC birth.	FMU birth N=8776	Hospital birth N=2527	PO: Type of birth. SO: PPH, composite of severe newborn outcomes	High
27	Van der Kooy 2011. Netherlands	Population-based cohort – 2 methods	Perinatal Registry data. 2000-2007	679,952 women with low risk pregnancies in MW care. *[602,331 excluding labour <37/40 or >41/40, or earlier intrauterine death]*	Planned HB with MW 1) N=402,912 2) N=363,568	Planned hospital birth 1) N=219,105 2) N=190,098 OR unclear planned BP 1) N=57,935 2) N=48,665	Combined intrapartum death, neonatal death up to 24/24, neonatal death from 1-7 days.	High
28	Wiegerinck, 2015. Netherlands	Retrospective cohort study	Linked admin + Registry data. 2005-2008	Main study 83,289 women with singleton term pregnancies no elective CS, congenital abnormality or fetal death, at all risk levels. *Additional data on 52,629 women with low-risk pregnancies*	Planned HB following MW-led care N=23,323	Planned hospital birth after MW-led care (n=18,675) + obstetrician-led care of low-risk pregnancies (n=10,631) Total N=29,306	PO: Perinatal mortality SO: mode of birth, perineal trauma, PPH, admission to NICU	Moderate

Abbreviations at foot of table

Abbreviations:
AABC=American Association of Birth Centers; AMU=Alongside Midwifery Unit; BC=birth centre; BMI=Body Mass Index; BP=birth place; BPiE=Birthplace in England (Collaboration Group); CDW=conventional delivery ward; CLU=consultant led unit; CS=Caesarean section; FMU=Freestanding (stand-alone) Midwifery Unit; HB=home birth; HELLP = haemolysis, elevated liver enzymes, low platelet count; IOL=induction of labour; ITT=intention to treat; LW=labour ward; mL=millilitres; MLU=Midwifery Led Unit; MW=midwife; N=number in cohort; NICU=Neonatal Intensive Care Unit; NICE=National Institute for Health and Care Excellence; NND=neonatal death; NS=not significant; NU=normal unit; NZ=New Zealand; OU=hospital (obstetric unit); PO=primary outcome; PPH=postpartum haemorrhage;PU=primary unit; RCOG=Royal College of Obstetricians and Gynaecologists; RCT=randomised controlled trial; SCN=special care nursery; signif=significant; SO=secondary outcome; SU=special/secondary unit; SVB=spontaneous vaginal birth; TLW=traditional labour ward; TU=tertiary unit

Table 3: Meta-analysis of Infant Outcomes

Infant outcomes t planned homebirth vs hospital	Fig	No. of studies	Planned home birth n/N	Planned hospital birth n/N	Estimated odds ratio	95% confidence interval	Sensitivity analysis t High quality studies only		
							No. of studies	Est odds ratio	95% CI
Stillbirth	S1	5[a]	200/470497	278/526698	0.92	0.74 – 1.14	5	0.92	0.74 – 1.14
Stillbirth ç nulliparous	*S1a*	*3*	*113/198948*	*87/144273*	*1.20*	*0.32 ç 4.51*			
Stillbirth ç multiparous	*S1a*	*3*	*87/269031*	*45/149866*	*1.04*	*0.73 ç 1.50*			
Early neonatal death	S3	5[b]	167/468627	164/519202	0.98	0.77 – 1.25	5	0.98	0.77 – 1.25
ENND ç nulliparous	*S3a*	*3*	*95/198845*	*69/144193*	*0.99*	*0.73 ç 1.36*			
ENND ç multiparous	*S3a*	*3*	*72/268949*	*42/149823*	*1.03*	*0.69 ç 1.54*			
Admission to NICU	S5	4[c]	1123/472914	2694/335202	0.71	0.55 – 0.92	3	0.79	0.63 – 0.98
NICU admission ç nulliparous	*S5a*	*2*	*656/198476*	*499/137280*	*1.11*	*0.65 ç 1.89*			
NICU admission ç multiparous	*S5a*	*2*	*337/267687*	*272/140426*	*0.74*	*0.62 ç 0.87*			
Infant outcomes - planned birth in birth centre (BC) vs hospital	Fig	No of studies	Planned BC birth n/N	Planned hospital birth n/N	Estimated odds ratio	95% confidence interval			
Stillbirth	S2	6[d]	6/18837	148/237618	0.67	0.31 – 1.48	3	0.66	0.29 – 1.50
Early neonatal death	S4	6[e]	4/20609	54/230245	0.87	0.29 – 2.61	3	0.82	0.25 – 2.63
Admission to NICU	S6	6[f]	387/16540	2073/63507	0.82	0.62 – 1.08	4	0.88	0.59 – 1.32

Included studies:

a. Blix et al. 2012; Davis et al. 2011; de Jonge et al. 2015; Halfdansdottir et al. 2015; Homer et al. 2014. Parity data not available for two studies: Davis et al. 2011; Homer et al. 2014
b. Blix et al. 2012; Burns et al. 2012; de Jonge et al. 2015; Halfdansdottir et al. 2015; Homer et al. 2014. Parity data not available for two studies: Burns et al. 2012; Homer et al. 2014
c. Davis et al. 2011; de Jonge et al. 2015; Dixon et al. 2014; Halfdansdottir et al. 2015. Parity data not available for Davis et al. 2011; Dixon et al. 2014
d. Davis et al. 2011; Gaudineau et al. 2013; Homer et al. 2000; Homer et al. 2014; Overgaard et al. 2011; Ryan & Roberts 2005). Parity data only available for two studies with nil events for either cohort (Gaudineau et al. 2013; Overgaard et al. 2011
e. Burns et al. 2012; Gaudineau et al. 2013; Homer et al. 2000; Homer et al. 2014; Overgaard et al. 2011; Ryan & Roberts 2005. Parity data only available for one study with nil events for either cohort Gaudineau et al. 2013
f. Bernitz et al. 2011; Davis et al. 2011; Dixon et al. 2014; Overgaard et al. 2011; Prelec, Verdenik & Poat 2014. AMU data only for Burns et al. 2012 as FMU data merged with homebirth data.

Table 4: Meta-analysis of Maternal Outcomes

Maternal outcomes t planned homebirth vs hospital	Figure	No. of studies	Planned home birth n/N	Planned hospital birth n/N	Estimated odds ratio	95% confidence interval	Sensitivity analysis t High quality studies only		
							No. of studies	Estimated odds ratio	95% confidence interval
Normal vaginal birth	S7	9[a]	41473/45777	163523/300507	2.93	2.13 – 4.03	6	3.25	1.97 – 5.38
Caesarean section	S9	9[b]	1006/46935	31209/322166	0.35	0.27 – 0.46	6	0.36	0.24 – 0.53
Instrumental birth	S11	9[c]	2682/46935	46157/322166	0.37	0.24 – 0.58	6	0.33	0.21 – 0.51
Intact perineum	S13	2[d]	1632/3720	5284/12079	1.15	1.06 – 1.25	2	1.15	1.06 – 1.25
Severe perineal trauma	S15	9[e]	920/44625	9333/290389	0.57	0.40 – 0.81	6	0.49	0.30 – 0.81
PPH ≥1000mL	S17	6[f]	2853/102663	5231/336330	0.73	0.55 – 0.96	5	0.68	0.52 – 0.89
Maternal outcomes t planned birth in birth centre vs hospital	Figure	No. of studies	Planned BC birth n/N	Planned hospital birth n/N	Estimated odds ratio	95% confidence interval	No. of studies	Estimated odds ratio	95% confidence interval
Normal vaginal birth	S8	11[g]	53108/63443	322132/521925	1.92	1.59 – 2.32	7	2.05	1.60 – 2.63
Caesarean section	S10	15[h]	4061/81697	136964/782157	0.48	0.39 – 0.60	9	0.54	0.42 – 0.70
Instrumental birth	S12	14[i]	5731/72921	97916/780066	0.61	0.52 – 0.71	8	0.58	0.46 – 0.72
Intact perineum	S14	6[j]	2517/6912	7014/19361	1.20	0.98 – 1.47	3	1.04	0.82 – 1.30
Severe perineal trauma	S16	11[k]	1852/68328	14429/621185	1.01	0.96 – 1.07	7	0.93	0.87 – 0.99
PPH ≥1000mL	S18	5[l]	77/6378	238/17309	0.87	0.67 – 1.14	4	0.83	0.63 – 1.09

Included studies:

a. Birthplace in England Collaborative Group 2011; Blix et al. 2012; Bolten et al. 2016; Davis et al. 2011; Halfdansdottir et al. 2015; Hiraizumi & Suzuki 2013; Homer et al. 2014; Miller & Skinner 2012; Wiegerinck et al. 2016
b. Birthplace in England Collaborative Group 2011; Blix et al. 2012; Bolten et al. 2016; Davis et al. 2011; Halfdansdottir et al. 2015; Hiraizumi & Suzuki 2013; Homer et al. 2014; Miller & Skinner 2012; Wiegerinck et al. 2016
c. Birthplace in England Collaborative Group 2011; Blix et al. 2012; Bolten et al. 2016; Davis et al. 2011; Halfdansdottir et al. 2015; Hiraizumi & Suzuki 2013; Homer et al. 2014; Miller & Skinner 2012; Wiegerinck et al. 2016

d. Bolten et al. 2016; Davis et al. 2011
e. Birthplace in England Collaborative Group 2011; Blix et al. 2012; Bolten et al. 2016; Davis et al. 2011; Halfdansdottir et al. 2015; Hiraizumi & Suzuki 2013; Homer et al. 2014; Miller & Skinner 2012; Wiegerinck et al. 2016
f. Bolten et al. 2016; Davis et al. 2012; de Jonge et al. 2013; Halfdansdottir et al. 2015; Hiraizumi & Suzuki 2013; Nove, Berrington & Matthews 2012a
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