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Intrapartum Birthing Pool use in the United Kingdom

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Abstract

Over past centuries, childbirth has become increasingly medicalised, with a shift to hospital births and an overuse of interventions for women at low risk of childbirth complication. In response, there has been a move towards normalising birth which has grown in strength over recent years. In this thesis, I describe a programme of research which aimed to examine whether intrapartum birthing pool use could make an important contribution to normalising childbirth for low risk women.

Maternity stakeholders differ in their views of intrapartum birthing pool use, with some emphasising its potential to reduce interventions and increase spontaneous birth and others raising concerns that birthing pool use, particularly waterbirth, predisposes women and their newborn to an increased risk of adverse events and outcomes The focus of my programme of research was therefore on examining the efficacy and safety of intrapartum birthing pool use, and its potential contribution to normalising childbirth for healthy women.

In the first stage of my research programme, I analysed prospectively collected data for 8,924 nulliparous and multiparous women who used a birthing pool during labour in their planned place of birth. In the second stage, I explored the possibility of comparing intrapartum interventions and outcomes for women who used a birthing pool and women who could have, but chose not to use a birthing pool in one obstetric unit. Having found the unit was not representative of other obstetric units, in the third stage I used a bespoke dataset comprising routinely collected maternity data collated by Hospital Episode Statistics (HES) as a comparator for the birthing pool data.

This research found that, for the birthing pool sample, adverse maternal and newborn outcomes were rare, and there were no differences in interventions and outcomes between care settings for multiparae or newborn. Comparisons with HES data showed significantly more birthing pool women had a spontaneous birth.

This allays concerns over safety and supports the conclusion that intrapartum birthing pool use can make an important contribution to normalising birth.

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Acknowledgments

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Why study women's use of a birthing pool during labour and birth?

CHAPTER 1 – Why study women's use of a birthing pool during labour and birth?

1.1 Medicalisation of childbirth

Over past centuries, and increasingly in the 21st century, pregnancy and childbirth have become more medicalised with increasing involvement of obstetricians in the care of pregnant women, increased use of medical interventions and promotion of the hospital as the safest environment for childbirth. Over the last ten to fifteen years concern has focused in particular on the increasing use of a number of key intrapartum interventions in middle and high income countries, sometimes in the absence of maternal or fetal clinical need (Downe, 2004, Glantz, 2012, Johanson *et al.*, 2002, Wagner, 2001). These interventions include induction of labour, labour augmentation using intravenous infusion of oxytocin, epidural analgesia, and operative delivery. There is an interrelationship between these interventions because if a woman has an induction of labour, she is more likely to have an epidural, require labour augmentation and her labour to culminate in an operative vaginal delivery[1] or emergency Caesarean section (CS).

1.2 The drive to normalise birth

In response, the UK and several other high and middle income countries have initiated a drive to redress the balance by introducing a strategy to normalise birth, that is, to optimise the physiology of labour and birth whenever possible, particularly for healthy pregnant women. For the purpose of this thesis, healthy pregnant women are those who experience a straightforward pregnancy and are at low risk of childbirth complication. This population comprises the largest proportion of childbearing women (American College of Nurse Midwives, 2012, Australian College of Midwives, 2012, Canadian Association of Midwives, 2012, International Confederation of Midwives, 2011, New Zealand College of Midwives, 2012, World Health Organisation, 1996).

The financial cost of increasing medicalisation of childbirth has also contributed to a growing emphasis on the normalising birth agenda, which is particularly pertinent given the current global and national financial recession. Intrapartum interventions have financial implications. For example, it has been estimated that augmentation of labour and

[1] Operative vaginal delivery is the use of vacuum extraction (ventouse), and/or forceps (may be high, mid or low pelvic cavity) to deliver the baby.

epidural analgesia cost 159.11p, £319.49p respectively; an OASIS[2] repair costs £595.30p; an emergency CS costs £1,052.60; and an operative vaginal delivery (ventouse[3] £429.23p, forceps) costs £569.89p. In contrast, a spontaneous vaginal birth at £26.03 is more than sixteen times less expensive than an emergency CS, and forty times less expensive than an operative vaginal delivery (Schroeder *et al.*, 2011).

1.2.1 Reconfiguring maternity care provision to promote normalising childbirth

In the UK, the Royal College of Midwives (RCM) (Royal College of Midwives, 2009) has made a commitment to promote normality in childbirth focusing on a reduction in the inappropriate use of intrapartum interventions. Facilitating normality in childbirth is a central focus in a Department of Health report outlining its vision for midwifery care provision (Department of Health, 2010). The Royal College of Obstetricians and Gynaecologists (Royal College of Obstetricians and Gynaecologists, 2011) has also supported a shift towards normalising childbirth, proposing that maternity services be reconfigured to reduce the number of obstetric units and increase the number of midwifery led units, and advocating that these become routine care settings for healthy pregnant women to give birth.

Currently, there are four different care settings where healthy pregnant women in the UK can choose to give birth. These are:

1. Obstetric unit labour ward in a hospital (OU), which cares for women across the risk spectrum. Staffed by midwives, obstetricians, anaesthetists and paediatricians, it has facilities to cater for women with minor to major intrapartum complications – operating theatre and high dependency care for example. OU midwives are usually hospital based and often do not meet the women in their care before labour.
2. Alongside midwifery unit (AMU); a separate area within the maternity unit staffed by midwives. This offers women a midwifery led environment which focuses on optimising the physiology of labour and birth. AMU midwives are usually hospital based, and may or may not have met women before they present in labour

[2] OASIS refers to Obstetric Anal Sphincter Injuries, also known as extensive perineal trauma.
[3] Ventouse is a suction implement that is applied to the fetal head to enable traction to be applied to deliver the baby.

3. Freestanding midwifery unit (FMU); a geographically separate facility to the maternity unit staffed by a team of community based midwives, who usually know the women they care for during labour, and work to optimise the physiology of childbirth.
4. The women's home, cared for by their community midwife, as they would be in an FMU, and transferred to an OU as required.

As with AMU based midwives, those working in the community setting (FMU, home) may also be required to work in the OU labour ward when it is short staffed, and to divert women in their care to the OU.

The OU setting offers the full range of pharmacological intrapartum analgesia used in the UK. This includes epidural; a regional anaesthesia that is inserted by an anaesthetist, an intramuscular injection of an opioid, typically meperidine, and inhalational analgesia, which comprises a premixed combination of 50% nitrous oxide and 50% oxygen. A small number of OUs provide an aromatherapy service for women in labour; exact prevalence for this service is not known. Women who labour in an AMU, FMU or at home can also avail of all the OU pharmacological pain relief options with the exception of epidural. All midwives are expected to optimise women's physiological capacity to labour and give birth. However, a quintessential philosophical principle for those working in midwifery led settings is an expectation that they form a therapeutic relationship with women, and empower them to labour and birth with minimal intervention, thereby promoting normality.

A recent prospective observational study, the Birthplace study reported that healthy women in childbirth were more likely to have a *normal birth*[4] in midwifery led care settings than in obstetric units (OU: nulliparae 46%, multiparae 79%; AMU: nulliparae 63%, multiparae 91%; FMU: nulliparae 71%, multiparae 95%; Home: nulliparae 69%, multiparae 95%) (Hollowell *et al.*, 2011). Collation and analysis of routinely collected maternity data showed that in 2010/11, only 34% of nulliparae who gave birth in an OU or a midwifery led setting had a normal birth, and 49% of multiparae did so (Dodwell, 2012).

[4] Normal birth is a composite outcome, defined by the Maternity care Working Party as comprising a spontaneous labour onset, no epidural and a spontaneous vaginal birth with no episiotomy.

Although it is recommended that all healthy pregnant women have access to both an AMU and FMU as place of birth options (Department of Health, 2007, 2011), the map in Figure 1.1 showing their geographical spread in 2009, highlights variation in access to an AMU or FMU for significant sections of the North West, and more FMUs in rural parts of the country (Royal College of Obstetricians and Gynaecologists, 2011). In 2007, it was estimated that over 90% of women gave birth in an OU setting in the UK, with 3% at home, 3% in an AMU, and 2% in an FMU (Redshaw, 2011). There is a lack of information available to explain the very low overall proportion of women giving birth outside the OU setting, and disparate access to AMUs and FMUs. One suggestion is that this situation has evolved as a result of differences in regional funding allocation, local politics, policy and implementation (Redshaw, 2011). Whatever the reason, limited access to an AMU or FMU is likely to hinder the drive to normalise birth.

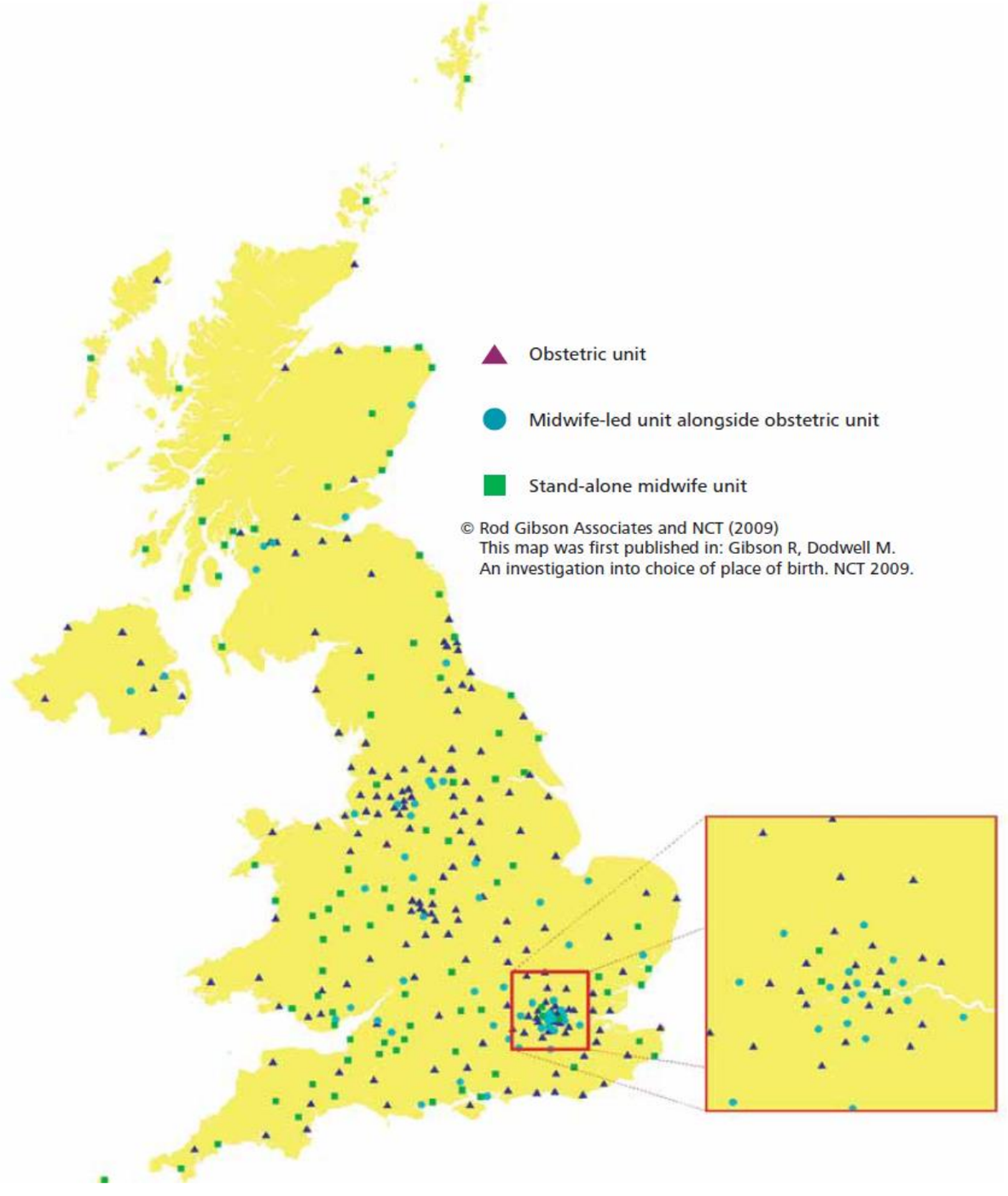


Figure 1.1: Location of OUs, AMUs and FMUs in the UK, 2009. P.14, Expert Advisory group Report, RCOG 2011

1.2.2 The role of the midwife and the drive to normalise birth

Midwives have a pivotal role in normalising childbirth. During the antenatal period, all healthy pregnant women in the UK are cared for by their community midwife, sometimes in partnership with their General Practitioner (GP) who may provide some of the antenatal checks. Midwives are the lead professional for healthy pregnant women and responsible for planning, delivering and reviewing care, referring to other professionals such as obstetricians, health visitors and social workers as required (Nursing and Midwifery Council, 2012). In the event of a pregnancy complication, or concern, the midwife or GP refers women to the local maternity unit for an obstetric review. They are a vital link, providing shared care for women who experience a problematic pregnancy, or have a pre-existing disease or mental health issue requiring specialist multiprofessional involvement, and may require some attendance at hospital based clinics. In this instance, the midwife's role as a pregnant woman's advocate is especially important. Midwives based in the community setting usually work in teams, which are geographically linked to particular health centres and children's centres and aim to provide women with a continuity of care model comprising a consistent carer and consistent advice.

Irrespective of women's planned or actual place of birth, midwives are also the lead professional for the care of healthy women in childbirth[5], again responsible for identifying and referring any complications to the appropriate healthcare clinician. They work in partnership with obstetricians, paediatricians and anaesthetists when caring for women with intrapartum complications (Nursing and Midwifery Council, 2010). It is estimated that at least 50% of women experience a straightforward pregnancy in the UK (National Collaborating Centre for Women's and Children's Health, 2007). This represents approximately 361,956 women based on the 723,913 births in 2011 for England and Wales (Office for National Statistics, 2012).

UK policy directives advocate an ethos wherein care provision during pregnancy and childbirth is woman centred; caters for a woman's individual physical, psycho-social and cultural needs; guarantees she have a named midwife (continuity of care model) for her antenatal and intrapartum care, and for healthy women, ensures ease of access to the full

[5] Healthy women in childbirth are women who do not have a pre-existing disease, are not obese, experience a straightforward pregnancy and labour at term gestation (37-42 weeks) with a singleton fetus presenting head first (cephalic).

range of birthplace care settings of their choice (Department of Health, 2004, 2007, 2009, 2011, Expert Maternity Group, 1993, National Collaborating Centre for Women's and Children's Health, 2007, 2010). All these policy directives provide fertile ground for further normalising childbirth.

During pregnancy and childbirth, women value being facilitated to participate in decisions about their care by friendly and supportive midwives, who communicate with them effectively and consistently (Green *et al.*, 2000, Morgan *et al.*, 1998). In order to effectively negotiate care with women, facilitate their active participation in decision making, and to gain their informed consent for procedures and interventions, it is incumbent upon midwives and the multiprofessional team to have a sound working knowledge of the best available evidence to support practice.

1.2.3 Intrapartum birthing pool use and the normalising birth agenda

In the early 1990's the Department of Health commissioned two reports, the Winterton Report and Changing Childbirth Report (Expert Maternity Group, 1993, House of Commons Health Committee, 1992), in response to women's and midwives dissatisfaction with an increasingly impersonal and intervention led maternity service. These reports stimulated a major review of maternity care provision, and called for a renaissance of the midwife's role as an autonomous practitioner who is accountable for the care she provides to women over the continuum of their pregnancy and early puerperium (Expert Maternity Group, 1993, House of Commons Health Committee, 1992).

The Winterton Report's recommendations centred on strengthening and developing community based maternity care provision, which would be women centred[6], provide pregnant women with choice regarding their planned place of birth, continuity of care[7], and control over decisions made about their care (House of Commons Health Committee, 1992). Among the recommendations made by Winterton in response to women's wishes expressed in interviews was that a birthing pool facility be available in all maternity units wherever practicable (House of Commons Health Committee, 1992). This suggestion was

[6] Woman centred care relates to care provision that is focused on and informed by the individual needs of pregnant women.
[7] Continuity of care relates to consistent support and advice provided by one (continuity of carer) or more caregivers.

reiterated in the Changing Childbirth report (Expert Maternity Group, 1993). Midwifery professional and regulatory organistations were prompt to respond to the recommendation to introduce birthing pools.

In 1994, the RCM published a position statement supporting the use of birthing pools for healthy women in childbirth (Royal College of Midwives, 1994), and the United Kingdom Central Council for Nursing (UKCC) included this care option as part of the Midwife's Role (United Kingdom Central Council for Nursing, 1994). In 1995, London hosted the first international waterbirth conference, which was attended by a wide range of interested women, midwives and medical practitioners, and stimulated activities to expand birthing pool use during labour (Beech, 1995). In 1996, the Royal Colleges of Midwives and Obstetricians and Gynaecologists issued a joint position statement with the RCM supporting the use of birthing pools for healthy women with a straightforward pregnancy and a singleton fetus. These eligibility criteria remain the same today (Royal College of Obstetricians and Gynaecologists and Royal College of Midwives, 2006). Birthing pool use during labour, including waterbirth is now integrated in UK policy for maternity services (Department of Health, 2004).

Birthing pool use is an important care option in the AMU[8], FMU[9] and homebirth setting which highlights its potential contribution to the normalising birth initiative. It has been suggested that birthing pool use during labour may increase the chance of *normal birth,* an outcome that the National Childbirth Trust and the normal birth consensus group have identified as an intrapartum care quality marker (Dodwell, 2010, Maternity Care Working Party *et al.*, 2007). The proposal to increase the number of midwifery led units and the recommendation that they be the routine place of birth for healthy women (Royal College of Obstetricians and Gynaecologists, 2011) is likely to result in greater intrapartum use of birthing pools.

All UK maternity units have a birthing pool facility and women can hire inflatable birthing pools for home use. However, despite recommendations that data be routinely collected at national level for birthing pool use during labour and waterbirth (Alderdice *et al.*, 1995,

[8] Alongside midwifery units are midwifery led settings located inside a maternity hospital
[9] Freestanding midwifery units are midwifery led settings, which are placed in a separate location from a maternity hospital

Gilbert and Tookey, 1999, Mead *et al.*, 2000), this has not happened. The last estimate for the prevalence of birthing pool use, indicated that 10% of women used one at some point during their labour, and 2.9% had a waterbirth (Healthcare Commission, 2007).

1.3 Are there clinical benefits to immersion in water?

The widespread provision and use of birthing pools reflects the high level of popularity amongst women that immersion in water has now reached. But while this popularity suggests that women perceive that immersion in water is beneficial to them, what this means in terms of clinical procedures, intrapartum events and outcomes is not clear.

The use of water immersion is based on the theory that the buoyancy, hydrostatic pressure, and associated thermal changes of being in water produces positive physiological effects for women. The buoyancy of being in water is relaxing and makes it easier for a woman to move around and feel more comfortable (Cefalo *et al.*, 1978, Edlich *et al.*, 1987). This can facilitate the neuro-hormonal interactions of labour, alleviating pain, and potentially optimising the progress of labour (Ginesi and Niescierowicz, 1998a, Ginesi and Niescierowicz, 1998b). Water immersion may be associated with improved uterine perfusion, less painful contractions, and a shorter labour (Geissbuehler *et al.*, 2004, Moneta *et al.*, 2001, Otigbah *et al.*, 2000, Thoeni *et al.*, 2005, Zanetti-Daellenbach *et al.*, 2007). Deep-water immersion may also enable a woman to more easily adopt an upright position which facilitates an easier birth by increasing the pelvic outlet (Lawrence *et al.*, 2013). In addition, the ease of mobility that water immersion offers women may optimise fetal position by encouraging flexion (Ohlsson *et al.*, 2001). Immersion in water also has marked physiological effects on the cardiovascular system (Cefalo *et al.*, 1978). Shoulder-deep warm water immersion reduces blood pressure due to vasodilatation of the peripheral vessels and redistribution of blood flow.

In addition to these direct effects of immersion in water, a birthing pool facility may also benefit women indirectly through the way in which it alters the environment in which they labour and give birth, introducing a larger version of the familiar bath at home, providing greater privacy and facilitating a greater sense of control (Hall and Holloway, 1998, Redwood, 1999, Richmond, 2003).

My own interest is in the use of birthing pools, and began when a birthing pool was first introduced to the hospital where I was working as a midwife, which was one of the first to have one installed in August 1990. I was aware of increasing discontent among women who felt that their childbirth was overly mechanised, and I also observed diminishing confidence among midwives in their skills to support women in childbirth without automatic and early recourse to technology. The use of a birthing pool appeared to have the potential to reduce the need for medical interventions and to make better use of midwives skills in supporting a more 'normal' birth. What I was particularly interested in exploring was whether the purported physiological effects of water immersion actually translated into clinical benefits for women and their newborn.

This interest provided the basis for the overarching research question for this thesis: Does using a birthing pool during labour contribute to normalising birth for healthy women in childbirth by reducing intrapartum interventions?

1.4 Thesis structure

In Chapter two, I present two reviews of the literature: the first examines the evidence on trends in the medicalisation of childbirth, and the other the evidence on intrapartum interventions and maternal and newborn outcomes for women who used a birthing pool during labour and had a land birth, and for women who had a waterbirth. The Chapter ends with a presentation of my programme of research.

In Chapter three, I expand on the methodology adopted to address my research questions by explaining why I undertook a prospective observational study and describing the positivist paradigm within which my research was embedded.

In Chapter four I present the methods and findings for the first phase of my research. This comprised a prospective observational study undertaken between 2000 and 2008 in the UK, which examined the characteristics for women who used a birthing pool during labour, some of whom had a land birth, and others a waterbirth, in their planned place of birth, the intrapartum events and interventions they experienced, and maternal and newborn outcomes. I intended to also collect data for women whose obstetric profile made them

eligible to use a birthing pool but who chose not to do so during the same time period when participating centres were collecting data for the birthing pool women. This would have provided a reliable control group for comparative analyses for intrapartum interventions and outcomes, enabling me to examine if there were differences in the incidence of *normal birth*, and interventions and outcomes for women and newborn between the two groups. However, only one study centre, an obstetric unit, agreed to collect data for a control group, and only for part of the time period during which it provided data for women who used a birthing pool.

In Chapter five I explore the feasibility of using the data from the single obstetric unit that collected data for women who used a birthing pool and women who could have but chose not to do so during the same time period, to carry out comparative analyses. However, sensitivity analysis comparing key intrapartum interventions and outcomes between this unit and other obstetric units in the birthing pool study identified differences, which indicated that it was not representative of the other obstetric units. Therefore, these data were not used for comparative analyses as implications drawn from this comparison would lack generalisability to intrapartum birthing pool use in other obstetric units.

Whilst the birthing pool study provided a useful and comprehensive insight into the 'natural course' of labouring in water and giving birth in water, and addressed my research question regarding interventions and outcomes in relation to birthing pool use, the absence of a comparison group of similar women who did not use a birthing pool during labour precluded being able to explore if birthing pool use may have the potential to reduce interventions, and contribute to the normalising birth agenda. It also precluded my ability to gauge if it may have a role to play in facilitating *normal birth.*

Chapter six describes and discusses procedures that I undertook to find an alternative comparator dataset. It outlines how I obtained a dataset of routinely collected intrapartum data collated by Hospital Episode Statistics (HES) for a cohort of women who gave birth between 2000 and 2008 who were identified as being at low risk of childbirth complications, and the checks I made to determine if this dataset could be used as a reliable comparator for the birthing pool data.

In Chapter seven I use the birthing pool and HES data samples to compare intrapartum interventions and maternal and newborn outcomes. Comparisons were constrained however by not being able to stratify by planned and actual place of birth, and by incomplete linkage between maternal and newborn care episodes.

In Chapter eight I discuss and debate the key findings, and the strengths and limitations of my research programme.

In Chapter nine I present my conclusions.

Literature Review

CHAPTER 2 – Literature Review

This Chapter examines the literature in relation to two topics. Firstly, it investigates research to see whether intrapartum interventions such as induction of labour, epidural analgesia and operative delivery have been used more commonly in recent decades, regardless of women's obstetric risk status. Trends in the use of these interventions are presented in relation to maternal or newborn outcomes. Secondly, this Chapter reviews research about birthing pool use during the first stage of labour and waterbirth. There is evidence to suggest that this care option might have the potential to play an important role in normalising childbirth for low risk women. However, there is limited high quality evidence available to support this claim, and further research is required on the topic.

2.1 Methods

In this section I describe the two literature searches for my literature review. Firstly I present my search strategy to identify studies on intrapartum factors that are associated with the medicalisation of childbirth, which is followed by my search strategy to access the evidence base for birthing pool use during labour and waterbirth.

2.1.1 Medicalisation of childbirth: research questions, eligibility for inclusion, and defining the search terms

My research questions were firstly, has childbirth become more medicalised? And secondly, has the medicalisation of childbirth resulted in better outcomes for women and their newborn?

In accordance with evidence-based practice methodology, and to optimise the search, I used the PICO (Participants, Intervention, Comparison, Outcomes) framework (Cochrane library, 2013, Craig *et al.*, 2001) which was developed to refine the formulation of research questions, and as a strategy to generate search terms (Cochrane library, 2013, Sackett *et al.*, 2000).

The research designs of studies eligible for this first literature review were randomised controlled trials, observational studies, and secondary analyses such as systematic reviews. Case reports were excluded because whilst they may add contextual information, they are largely anecdotal, also conference proceedings because these are often

preliminary reports and lack sufficient detail. Additional exclusions included papers that only reported results for anterior (labial), first or second degree perineal tears because I was interested in OASIS. Finally, for pragmatic, financial reasons, I excluded studies that were not reported in the English language.

The *participants* I was particularly interested in were those who experienced a straightforward pregnancy, and were at low risk of childbirth complication. However, an initial exploratory search indicated that it was hard to identify studies on this population, and I therefore looked for studies involving women across the risk spectrum. However, I excluded studies involving women who gave birth at a gestation of less than 37 completed weeks.

I focused my search on four key intrapartum *interventions*: induction of labour, epidural analgesia, Caesarean section and operative vaginal delivery. I selected these items because their overuse has been identified by obstetricians, midwives and women as key contributory factors to the medicalisation of childbirth.

Spontaneous labour onset offered a physiological reference for *comparison* with my four interventions.

To ensure that my search would capture any effects of the interventions, I included a range of maternal and newborn *outcomes*, which are associated with morbidity and mortality such as operative delivery, OASIS, and postpartum haemorrhage.

Using the MedLine database, I conducted a comprehensive search combining the terms summarised in Box 2.1 below, and utilising the Boolean operators “OR” to combine terms within a PICO concept, and “AND” to combine terms across concepts.

Box 2.1: summary of search terms used for the literature review for the medicalisation of childbirth

PARTICIPANTS – pregnan*, childbirth, nullipar*, primipar*, multipar*, gestation, newborn, neonat*

INTERVENTIONS – "induction of labo*", epidural, "Caesarean section", "cesarean section", C-section, CS, "operative delivery", "instrumental delivery", "operative vaginal delivery", forceps, vacuum, ventouse

COMPARISON – "spontaneous labo*"

OUTCOMES
Maternal – "maternal outcome*", "augmentation of labo*", "labo* dystocia", "slow progress" "failure to progress", "urinary tract trauma", "perineal trauma", "perineal tear", OASIS, "obstetric anal sphincter injur*", episiotomy, "postpartum haemorrhage"," postpartum hemorrhage", "maternal infant attachment", "emotional bonding".

Newborn – "newborn outcome*", neonatal, Apgar, "transient tachypno*", respiratory, breathing, resuscitation, "neonatal intensive care unit", NICU, "special care baby unit", SCBU, breastfeeding
Generic – infection, "perinatal morbidity", "perinatal mortality",

2.1.2 Birthing pool use during labour and waterbirth: research questions, eligibility for inclusion, and defining the search terms

Repeating the same process as for the medicalisation of childbirth, I examined the evidence for birthing pool use for labour and waterbirth. For this part of my review, my research questions were firstly, what intrapartum interventions and outcomes do women who use a birthing pool during the first stage of labour and have a land birth experience? And secondly, what intrapartum interventions and outcomes do women who use a birthing pool and have a waterbirth experience?

The research designs of studies eligible for this second literature review were randomised controlled trials, observational, and secondary analyses. I included publications in any language because as a Cochrane co-reviewer I was able to access translations of non-English language papers. As for the review on the medicalisation of childbirth, I excluded case reports and conference proceedings.

Using the PICO acronym, *participants* were nulliparous and multiparous women (and their newborn) who laboured at 37 or more completed weeks. As for the childbirth medicalisation search, this caveat was used to exclude confounding factor that prematurity presents in relation to maternal and newborn outcomes; for example, mode of delivery, and newborn complications such as resuscitation, respiratory problems, and NICU admission.

The *intervention* for this search was water immersion during the first stage and/or second stage of labour, and to reduce the chance of missing papers, I expanded the search terms for the water receptacle (see box 2.2).

The *comparison* for water immersion was no immersion to enable me to access studies that compared the effects of water immersion with no water immersion during labour. As for the review of childbirth medicalisation,

I selected morbidity and mortality linked maternal and newborn *outcomes.*

Using the MedLine database, I conducted a comprehensive search combining the terms summarised in Box 2.2 below, and utilising the Boolean operators “OR” to combine terms within a concept (PICO), and “AND” to combine terms across concepts.

Box 2.2: summary of search terms used for the literature review for birthing pool use for labour

PARTICIPANTS – pregnan*, childbirth, nullipar*, primipar*, multipar*, gestation, newborn, neonat*

INTERVENTION – "birthing pool*", tub*, pool*, bath, "water immersion", "first stage labo*", "second stage labo*"

COMPARISON – no birthing pool

OUTCOMES

Maternal – "maternal outcome*", "augmentation of labo*", "labo* dystocia", "slow progress" "failure to progress", epidural, delivery, waterbirth, "water birth", "birth in water", "perineal trauma", "perineal tear", OASIS, "obstetric anal sphincter injur*", episiotomy, "postpartum haemorrhage"," postpartum hemorrhage".

Newborn – "newborn outcome*", neonatal, Apgar, resuscitation, "transient tachypno* ", respiratory, breathing, drowning, "water aspiration", "neonatal intensive care unit", NICU, "special care baby unit", SCBU, breastfeeding

Generic – infection, "perinatal morbidity", "perinatal mortality",

2.2 Review of the literature on the medicalisation of childbirth

2.2.1 Induction of labour

Figure 2.1 shows the increasing rates for induction of labour and Caesarean section in England from 1993 to 2011, and correspondingly fairly static perinatal, neonatal and infant mortality rates for England and Wales from 1993 to 2011.

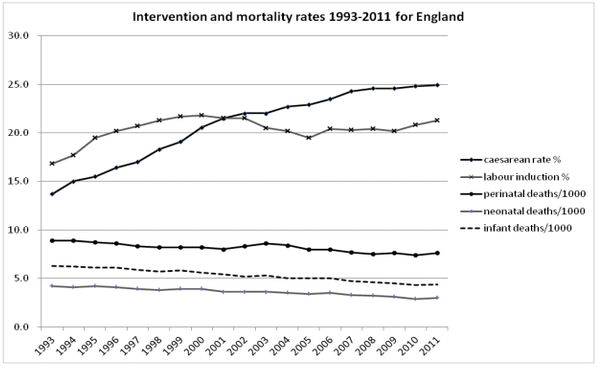


Figure 2.1: Induction of labour, Caesarean section, perinatal, infant and neonatal mortality for England from 1993 to 2011. Source of data: ONS, Hospital Episode Statistics Note: Mortality rates are for England and Wales but where comparisons are possible these differ by <0.1 per 1000 births from figures for England only (Dodwell, 2012).

Induction of labour is the most common intrapartum intervention; one in five women in the UK had an induction of labour between 2004 and 2005 (National Institute for Health and Clinical Excellance, 2008). There is wide variation between maternity units for induction; in England in 2010/11, the rate ranged from 8.1% to 37.2% (Dodwell, 2012). Other countries have also reported inter country variation (Dahlen *et al.*, 2012b, Glantz, 2012, Lutomski *et al.*, 2012). A national comparative study that analysed routinely collected intrapartum data for women living in Aberdeen explored the reasons for induction of labour for a sample 5,727 women (Humphrey and Tucker, 2009). Results following regression analyses to account for potential confounders, showed that reasons included BMI > 35.0, urinary tract infection, living at an intermediate or long distance from the OU, previous induction, and anxiety and depression (Humphrey and Tucker, 2009). Several countries have reported an increasing trend to induce labour when there is no medical reason (Cnattingius *et al.*, 2005, Martin *et al.*, 2006, Zhang *et al.*, 2010). These studies suggest that discrepancies in induction rates between maternity units are more likely to result from differences in practice than differences in maternal obstetric risk factors that may necessitate an induction of labour.

Prolonged pregnancy is the most common medical reason for induction of labour (Cheyne *et al.*, 2012, Gardosi *et al.*, 1997, National Institute for Health and Clinical Excellance, 2008). There is evidence supporting this recommendation from a systematic review of 22 randomised controlled trials of varying methodological quality, involving 9,383 women which reported that induction at a gestation of greater than 41 weeks reduces perinatal

deaths (the number needed to treat to benefit (NNTB) with a policy of induction of labour to prevent one perinatal death was 410 (95% CI 322 to 1492) and Caesarean section, but not newborn admission to a neonatal intensive care unit (NICU) (Gülmezoglu *et al.*, 2012). The recommendation to induce labour at 41 weeks or more is exploited however, and some women have an earlier induction for 'prolonged' pregnancy (Hilder *et al.*, 1998). A recent retrospective cohort study involving a UK sample of 1,271549 women with a singleton pregnancy of 37 or more weeks gestation, which compared outcomes following labour induction with spontaneous labour found that induction before 41 weeks was associated with a significantly increased risk of NICU admission adjusted odds ratio of 1.14 (99% confidence interval 1.09 to 1.20), 3605/44,778 (8%) versus 25,572/350,791 (7.3%) (Stock *et al.*, 2012). The authors calculated numbers needed to treat to prevent one perinatal death and found that at 40 weeks gestation, 1,040 women would require an induction of labour to prevent one perinatal death, and this would result in seven additional NICU admissions (Stock *et al.*, 2012). The sample in this study included women with a mixed obstetric risk profile (ranging from low to high risk). It was not therefore possible to extrapolate the outcomes for healthy pregnant women (low risk) who are quite distinct from those who develop a pregnancy related complication and/or have pre-existing disease, diabetes for example. Furthermore, because data were not analysed by parity, it was not possible to elicit the study's findings for nulliparae, who are more likely to have an emergency Caesarean section following an induction of labour than multiparae (Stock *et al.*, 2012).

A Canadian population study which examined the increasing trend of induction of labour for prolonged pregnancy over four different time periods (1988-1992, 1994-1998, 1999-2003, 2004-2008) reported a significant association between induction and severe neonatal morbidity, and no reduction in the risk of stillbirths or perinatal death over time (Allen *et al.*, 2012). Other research also reported an association between induction of labour and newborn complications such as requirement for resuscitation, and NICU admission (Boulvain *et al.*, 2001, MacDorman *et al.*, 2008).

There is evidence that induction of labour increases the risks of an emergency CS and operative vaginal delivery for women, including those who do not have pre labour risk factors, especially healthy nulliparae (Boulvain *et al.*, 2001, Dunne *et al.*, 2009, Johanson *et*

al., 2002, Maslow and Sweeny, 2000, Patterson *et al.*, 2011, Petersen *et al.*, 2011, Selo-Ojeme *et al.*, 2010, Seyb *et al.*, 1999, Thorsell *et al.*, 2011, Vahratian *et al.*, 2005). Several studies have recommended caution when deciding to induce labour for healthy nulliparae, having found a strong association between induction and emergency CS for this population, particularly when the cervix is unripe[10] at induction onset, which is more likely at a gestation of less than 41 weeks (Dunne *et al.*, 2009, Oros *et al.*, 2012, Rane *et al.*, 2003, Rayburn and Zhang, 2002, Vrouenraets *et al.*, 2005). The childbirth outcome for a nulliparous woman is especially important because it impacts on her subsequent childbearing: for example, a previous CS predisposes her to risk factors such as uterine scar rupture, placenta abruption, or praevia (Lydon-Rochelle *et al.*, 2001a, b), placenta accreta (Serena *et al.*, 2005, Smith *et al.*, 2002), and perinatal death (Smith *et al.*, 2002), and her fetus to antenatal stillbirth (Smith *et al.*, 2003). Induction of labour can also predispose healthy multiparous women to an increased risk of emergency Caesarean (Cnattingius *et al.*, 2005, Dahlen *et al.*, 2012a, Hoffman *et al.*, 2006, Jacquemyn *et al.*, 2012, Jonsson *et al.*, 2013, Tracy *et al.*, 2007a), and more of these healthy pregnant women are having their labour induced (Battista *et al.*, 2007, Clark *et al.*, 2009).

2.2.2 Epidural

Women who have an induction of labour are more likely to require epidural analgesia compared with women who labour spontaneously (Lancaster *et al.*, 2012). Epidural is another intrapartum intervention that has increased in recent years, particularly in middle and high income countries. In 2007/8 it was estimated that a third of women had an epidural during labour in the UK (Walsh, 2009), echoed by a study on its use in 2001 in Scotland (Bhattacharya *et al.*, 2006). In Australia the epidural rate rose from 17.2% in 1992 to 26.5% in 2008 (Lain *et al.*, 2008a), and in the US, it is estimated that 60% of women have an epidural during labour (Lancaster *et al.*, 2012). Whilst epidural analgesia can offer women effective pain relief during labour, its use is associated with a range of unwanted maternal and newborn side effects.

[10] Unripe cervix as measured using the Bishop score assessment on a continuum from 0 (completely unripe) to 10 (perfectly ripe), derived from position of the cervix in relation to presenting part of the fetus (posterior, central, anterior), consistency and length (effacement), and dilatation (0-10centimetres) on a continuum from 0 (completely unripe) to 10 (perfectly ripe)

Maternal side effects include an increased risk of a longer duration of labour, particularly for nulliparae (Kjaergaard *et al.*, 2008), maternal fever, labour augmentation, fetal malposition, and operative vaginal delivery (Anim-Somuah *et al.*, 2011). Epidural has a vaso-dilation physiological effect, and maternal fever is a well-known iatrogenic effect of its use during labour (Gonen *et al.*, 2000, Lieberman *et al.*, 1997, Philip *et al.*, 1999, Ramin *et al.*, 1995). Maternal pyrexia can predispose women and their newborn to further interventions such as antibiotics (McGrady and Litchfield, 2004). It has been suggested that epidural induced pyrexia can predispose healthy women, especially nulliparae to a greater risk of delivering a baby in an occipito-posterior position[11] (Osborne *et al.*, 2011). A systematic review of two trials (N=319 women) that examined the use of labour augmentation[12] to reduce operative vaginal delivery or emergency CS for women with epidural analgesia found it to be ineffective in reducing operative delivery (Costley and East, 2012). Labour augmentation has been cited as a risk factor for maternal and newborn morbidity (Buchanan *et al.*, 2012, Simpson and James, 2008). Other maternal side effects associated with intrapartum epidural include postpartum haemorrhage, backache and urinary retention (Lieberman and O'Donoghue, 2002).

For the newborn, apart from the risks associated with operative delivery, the current epidural drug of choice, which comprises an anaesthetic and opioid cocktail that readily crosses the placenta can inhibit newborn suckling at the breast for several hours following delivery, posing a threat to successful early breast feeding establishment (Ransjo-Arvidson *et al.*, 2001, Righard and Alade, 1990, Wiklund *et al.*, 2009)

2.2.3 Caesarean section

An escalating Caesarean section (CS) rate in middle and high income countries has not resulted in a concomitant improvement in perinatal mortality (Gibbons *et al.*, 2010, Johanson *et al.*, 2002, McLachlan *et al.*, 2012, National Childbirth Trust, 2011, Parliamentary Office of Science and Technology, 2002, Sufang *et al.*, 2007, Villar *et al.*, 2006, Wagner, 2001). The World Health Organisation recommended that a country's CS rate should not exceed 10% (Wagner, 1994), and it is suggested that a CS rate above 15%

[11] Occipito-posterior is a deflexed position whereby a greater fetal skull diameter presents, predisposing a woman to an increased likelihood of requiring an operative delivery.
[12] Labour augmentation involves the use of an intravenous infusion of oxytocin to accelerate labour by increasing the frequency and strength of uterine contractions.

confers no added benefit for women or their newborn (Althabe and Belizan, 2006, Althabe *et al.*, 2006).

There are wide variations in the emergency CS rate between obstetric units in the UK, and these are not related to maternal risk factors (Bragg *et al.*, 2010). In 2010/11, the rate for England ranged from 15.4% to 36.3% (Dodwell, 2012). Figure 2.2 shows the CS trend in the UK (Dodwell, 2012).

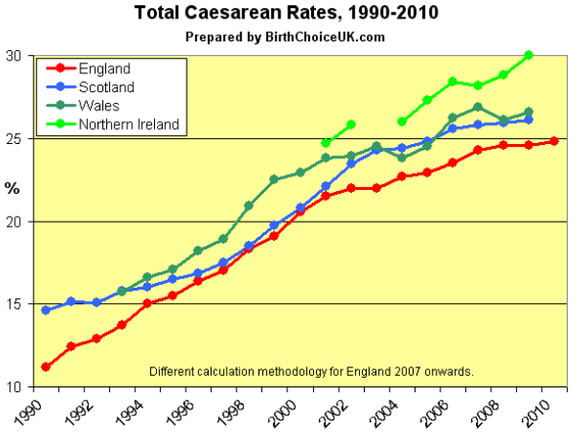


Figure 2.2: Caesarean section rates for the UK between 1990 and 2010

Maternal risks associated with delivery by Caesarean section include major haemorrhage, which may lead to hysterectomy (Castaneda *et al.*, 2000), placenta percreta or accreta (abnormal placental implantation into the uterine myometrium of a previous CS) (Boutsikou and Malamitsi-Puchner, 2011, Hemminki and Merilainen, 1996, Kennare *et al.*, 2007, Serena *et al.*, 2005), placenta abruption[13], or preavia[14] in a subsequent pregnancy (Hemminki and Merilainen, 1996, Lydon-Rochelle *et al.*, 2001b), infection and difficulty in emotional attachment with their newborn (Lavender *et al.*, 2012). A Caesarean section is major surgery, and as such, women take longer to recover from it, which results in a longer and hence more expensive hospital stay (National Institute for Clinical Excellence, 2004). Newborn who are delivered at term gestation by CS, particularly by elective CS, are more likely to experience respiratory problems than those born vaginally (Boutsikou and Malamitsi-Puchner, 2011, Hansen *et al.*, 2008, Zanardo *et al.*, 2004) and may be at greater

[13] Placenta abruption is premature partial or total separation of placenta from the uterine wall.
[14] Placenta praevia is abnormal placental implantation in the lower uterine segment

risk of stillbirth (Boutsikou and Malamitsi-Puchner, 2011, Kennare *et al.*, 2007, Smith *et al.*, 2003).

2.2.4 Operative vaginal delivery

As with induction of labour, epidural and Caesarean sections, there is wide inter and intra country variation in the rates of operative vaginal delivery. In England, in 2010, the operative vaginal delivery (by ventouse extraction and/or forceps application and traction) rate between maternity units ranged from 7.0% to 20.2% (Dodwell, 2012). Figure 2.3 shows the rates for operative vaginal delivery in the UK between 1990 and 2010 (Dodwell, 2012). The overall rates for Scotland, England and Wales did not increase substantially between 2008 and 2010. Although the rate of operative vaginal delivery for Wales decreased, as Figure 2.3 shows, their CS rate is the highest in the UK.

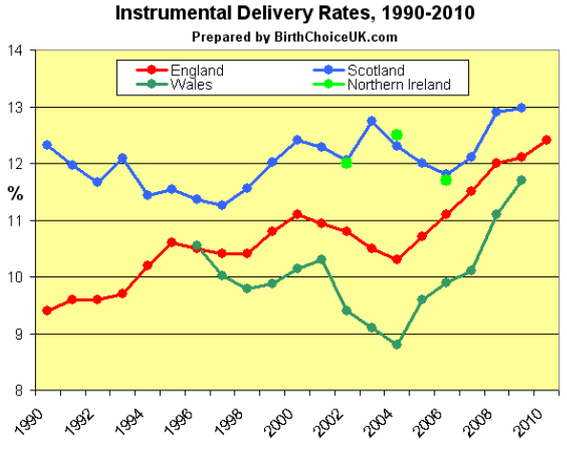


Figure 2.3: Operative vaginal delivery rates for the UK from 1990 to 2010

Risks associated with operative vaginal delivery include extensive perineal trauma, also termed OASIS[15] and urinary tract trauma, (Beucher, 2008 , Christianson *et al.*, 2003, Mulder *et al.*, 2012, Sheiner *et al.*, 2005), newborn facial nerve (Al Tawil *et al.*, 2010), and intracranial damage (Werner *et al.*, 2011). Reported rates of OASIS are increasing; for example, in Finland, there was a threefold increase between 1997 and 2007 (Raisanen *et al.*, 2010b). As with induction of labour, epidural, and operative delivery, there was wide variation between obstetric units for OASIS: 0.7% to 2.1% for nulliparae and 0.1% to 0.3%

[15] OASIS is acronym for obstetric anal sphincter injuries, which encompasses third and fourth degree perineal trauma, also known as extensive perineal trauma.

for multiparae (Raisanen *et al.*, 2010a). Risk factors identified for nulliparae sustaining OASIS were epidural analgesia, labour augmentation, operative vaginal delivery and newborn birth weight of 4000 grammes or more (large baby), and for multiparae, operative vaginal delivery, episiotomy and newborn birth weight greater than 4,000 grammes (Raisanen *et al.*, 2010a). Although proportionately few women overall incur OASIS in childbirth, it is a serious complication, which often leads to faecal incontinence and long term problems for their physical, psychological, sexual health and partner relationships (Fitzpatrick and O'Herlihy, 2005, Handa *et al.*, 2007, Wagenius and Laurin, 2003, Williams *et al.*, 2005).

The interrelationship between induction of labour, epidural, emergency CS and operative vaginal delivery (Bragg *et al.*, 2010, Dahlen *et al.*, 2012b, Johanson *et al.*, 2002, Overgaard *et al.*, 2011), is associated with the estimated duration of labour. For example, a national audit of CS rates found that dystocia[16] in either the first (primary) or second (secondary) stage of labour accounted for 20% of the emergency Caesarean sections performed during the three month period of the study (Thomas and Paranjothy, 2001). Labour dystocia is a major contributory factor for CS for women, and nulliparae in particular, for whom it is estimated to account for 50% of the intrapartum CS rate in the USA (Shields *et al.*, 2007). As with emergency CS in general, there is no evidence that the rise in primary CS is linked to pre-existing maternal or fetal risk factors for vaginal birth before labour onset (Declercq *et al.*, 2006).

Diagnosing primary or secondary dystocia is an inexact science for three key reasons. Firstly there is no internationally agreed definition for the latent phase of labour, which is the period that precedes the onset of established or active labour; the point from which labour duration is typically timed and plotted on a partogram[17]. Secondly, available evidence is unclear about what comprises a normal physiological rate or pattern of labour progress in either the first or second stage of labour, thus the duration of labour for healthy nulliparae and multiparae who laboured spontaneously (Albers, 1999, Albers *et al.*,

[16] Dystocia, also termed slow progress, or failure to progress during the first or second stage of labour.
[17] Partogram is a chart with hourly columns for a 12 to 24 hour time period (243 hour in the UK) in which maternal and fetal observations, cervical dilatation and fetal descent in the maternal pelvis are plotted.

1996, Chelmow *et al.*, 1993, Gross *et al.*, 2005, Lavender *et al.*, 2005, National Collaborating Centre for Women's and Children's Health, 2007, Neal *et al.*, 2010, Zhang *et al.*, 2002). Two factors emerging from recent research are that irrespective of maternal parity, cervical dilatation does not occur in a linear trajectory, and labour duration may be physiologically longer than hitherto believed (Albers, 1999, Lavender *et al.*, 2005, Neal *et al.*, 2010). Thirdly, labour progress determination is based primarily on the rate of cervical dilatation, as assessed by vaginal examination. However, dilatation is just one facet of intrapartum cervical physiology: application of the presenting part of the fetus to the cervix and degree of cervical effacement are not recorded on a partogram, which limits its usefulness as a tool to illustrate labour progress. Furthermore, vaginal assessment of cervical dilatation has limited inter and intra practitioner reliability (Buchmann and Libhaber, 2007, Huhn and Brost, 2004, Nizard *et al.*, 2009, Phelps *et al.*, 1995, Tuffnell *et al.*, 1989). These factors and existing uncertainty regarding physiological labour duration for nulliparae and multiparae challenge current use of arbitrary, fixed time definitions for primary and secondary labour dystocia for nulliparae and multiparae, and the ensuing intrapartum interventions that occur when practitioners diagnose dystocia. Studies examining outcomes for healthy nulliparae concluded that intervention to shorten the first or second stage of labour was not indicated for duration alone (Rouse *et al.*, 2009, Shields *et al.*, 2007).

However imprecise the measurement of labour duration, maternal parity is one maternal characteristic that is internationally acknowledged to affect the duration of the first and second stage of labour: nulliparae have a longer labour than multiparae. They are therefore more likely to experience the intrapartum interventions discussed in this Chapter than multiparae (Dahlen *et al.*, 2007, Neal *et al.*, 2010, Overgaard *et al.*, 2011, Raisanen *et al.*, 2010a, Rouse *et al.*, 2009, Shields *et al.*, 2007). This highlights the importance for researchers undertaking studies to provide information for nulliparae and multiparae separately.

Increasing challenge of the evidence base underpinning the wholesale medicalisation of pregnancy and childbirth, which has resulted in perpetuating a risk adverse care culture, and no concomitant improvement in maternal or newborn mortality or morbidity,

particularly for healthy pregnant women[18], has stimulated an initiative to redress the imbalance.

2.2.5 In summary

This review highlighted the relationship between induction of labour, epidural and operative delivery, and maternal and newborn outcomes. Few researchers presented their analyses by maternal parity or by maternal obstetric risk profile; an omission that limits the strength of their generalisability to healthy pregnant nulliparous and multiparous women, the childbearing population for who the medicalisation of childbirth is especially pertinent.

2.3 Review of the literature for birthing pool use for labour

For the purpose of this review, the term birthing pool refers to a receptacle that is of sufficient width, length and depth to enable a woman to adopt a range of positions. It may be a permanent, plumbed in fixture, or a portable model. I shall use the term 'pool' when there is uncertainty if the container in question fitted this birthing pool definition. I shall also differentiate the use of a birthing pool for labour only from waterbirth as birthing pool use for labour, and waterbirth

2.3.1 In relation to effects on analgesia, augmentation, mode of delivery and newborn outcomes

Several of the studies that examined the relaxation effects of birthing pool use during the first stage of labour found that it reduced the uptake of pharmacological analgesia (Aird *et al.*, 1997, Bodner-Adler *et al.*, 2002, Burke and Kilfoyle A, 1995, Chaichian *et al.*, 2009, Geissbuehler *et al.*, 2004, Rush *et al.*, 1996, Thoeni *et al.*, 2005, Torkamani *et al.*, 2010, Zanetti-Daellenbach *et al.*, 2007). These studies comprised randomised controlled trials (RCT) and observational.

[18] Healthy pregnant women are women who are not obese (Body Mass Index ≥30), do not have pre-existing disease and do not develop serious complications (for example, pre eclampsia, diabetes, fetal growth or other concern) over the course of their pregnancy.

Other positive findings included less labour augmentation (Bodner-Adler *et al.*, 2002, Chaichian *et al.*, 2009, Taha, 2001, Torkamani *et al.*, 2010, Waldenstrom and Nilsson, 1992), more spontaneous vertex birth (SVD) (Aird *et al.*, 1997, Geissbuehler *et al.*, 2004, Thoeni *et al.*, 2005), and no difference for maternal infection, or adverse newborn effects (Cluett *et al.*, 2004, Eriksson *et al.*, 1997, Ohlsson *et al.*, 2001, Rush *et al.*, 1996, Schorn *et al.*, 1993, Taha, 2001). One RCT (N=99 nulliparae), undertaken to examine the effectiveness of a birthing pool for dystocia during the first stage of labour showed that compared to controls, fewer women who used a birthing had an epidural and significantly fewer required labour augmentation using an intravenous infusion of oxytocin (Cluett *et al.*, 2004).

In contrast to the results above, some studies did not show that using a birthing pool reduced the uptake of pharmacological analgesia or operative delivery. One prospective observational study (N=629 women) found that more pool users had analgesia compared to non-pool users (Andersen *et al.*, 1996). Additionally, four RCTs (N=93, 110, 274 and 1,237 women respectively) showed no difference for analgesia uptake or mode of delivery between groups (Cammu *et al.*, 1994, Eckert *et al.*, 2001, Ohlsson *et al.*, 2001, Schorn *et al.*, 1993), although interestingly, Ohlsson (N=1,237 women) found that significantly fewer women who used the birthing pool delivered a baby with a deflexed (occipito posterior) position compared with non-pool users.

One RCT (N=274 women) reported a significant increase in resuscitation for newborn whose mothers had used a birthing pool during the first stage of labour, despite finding no difference for Apgar score assessment at one and five minutes, or for NICU admission, (Eckert *et al.*, 2001). This newborn result is misleading, because significance was only reached when all newborn resuscitation measures were combined (facial oxygen alone, oro-pharyngeal suction, bag and mask and IPPV via ETT[19]): there were no differences when they were compared separately. Also, notwithstanding that data were analysed by intention-to-treat, there was significant crossover between groups; 30% of birthing pool women did not bathe and 26% of the control group used the birthing pool, which reduced the strength of its effect. Additionally the capacity for the small sample in this trial to assess newborn morbidity has been questioned (Homer, 2002).

[19] IPPV via ETT=intermittent positive pressure ventilation via an endotracheal tube.

2.3.2 Reported effects of birthing pool use on the duration of labour

Studies reported differing results for the duration of labour; some found a shorter duration for birthing pool and pool users compared with controls (Chaichian *et al.*, 2009, Geissbuehler *et al.*, 2004, Otigbah *et al.*, 2000, Taha, 2001, Thoeni *et al.*, 2005, Zanetti-Daellenbach *et al.*, 2007), whilst others reported a longer second stage for birthing pool and pool users (Andersen *et al.*, 1996, Moneta *et al.*, 2001, Schorn *et al.*, 1993), and one trial found no difference in labour duration between groups (Eckert *et al.*, 2001). Birthing pool use for labour studies that included a sample of nulliparae and multiparae did not did not stratify analysis by parity, yet nulliparae tend to have a longer labour than multiparae and are more at risk of having co-interventions than multiparae (Bai *et al.*, 2002). For example, Schorn's trial (N=93 women) had more nulliparae than multiparae in the bathing group than in the control group (31% versus 21%), and this factor may have influenced the duration of second stage. Furthermore, measurement of the duration of labour is at best a crude estimation because it is impossible to know exactly when a woman establishes in labour, the moment her cervix reaches full dilatation, or the onset of the active phase of the second stage of her labour.

2.3.3 In relation to influence on maternal pain perception, link to anxiety, uterine contractions and cervical dilatation

Five RCTs compared maternal pain perception for women who used a birthing pool for labour with women who did not use a birthing pool (Cammu *et al.*, 1994, da Silva *et al.*, 2009, Kuusela *et al.*, 1998, Nikodem *et al.*, 1999, Taha, 2001). Interestingly all five found that women reported feeling less pain after being in the pool for one hour, compared to when they entered it, and two trials reported a significant pain reduction (N=57, and N=108 women respectively) (da Silva *et al.*, 2009, Taha, 2001). This is particularly relevant given that all participants in da Silva's study were nulliparae, as is the pain reduction reported by Cammu, whose participants were also nulliparae (N=110), (Cammu *et al.*, 1994). Nikodem (N=120 women) reported that pain not only lessened, but stabilised for women who used the birthing pool, and Taha found that women who used the birthing pool for labour had lower pain scores as late as 24 hours postpartum compared to controls (Nikodem *et al.*, 1999, Taha, 2001).

Maternal pain perception is subjective, and linked to anxiety and fear. Anxiety influences the hormonal interplay of labour; the more anxious and fearful a woman feels during labour, the higher her circulating levels of cortisol and catecholamines (adrenaline, nor-adrenaline and vasopressin); hormones which inhibit beta endorphins and pulsatile oxytocin release (Ginesi and Niescierowicz, 1998a, Ginesi and Niescierowicz, 1998b). This response diminishes the frequency of uterine contractions. A biologist who investigated the physiological effects of water immersion during labour by measuring hormone levels, maternal anxiety and pain perception, together with contraction frequency and duration pre and during water immersion to chest level, confirmed there was a correlation between a significant reduction in cortisol, reduced levels of vasopressin and oxytocin, reduction in maternal pain perception and less frequent contractions (Benfield *et al.*, 2010). This relationship was particularly evident between 45 and 60 minutes following water immersion, and the finding concurs with the reduced pain reported 60 minutes following water immersion across groups in the five RCTs (Cammu *et al.*, 1994, da Silva *et al.*, 2009, Kuusela *et al.*, 1998, Nikodem *et al.*, 1999, Taha, 2001).

Michel Odent also observed that uterine contractions eased in frequency around one hour following water immersion and recommended that women do not use a birthing pool for longer than this time period during labour (Odent, 1997). This suggestion is based on the belief that less frequent equates with less effective, posing a threat to timely labour progress. Benfield noted that as the frequency of uterine contractions eased, their duration lengthened, which questions current understanding of labour physiology among clinicians who are educated to expect contraction frequency to remain consistent during labour. If contractions ease, it is usually taken as a sign that a woman is experiencing dystocia and requires labour augmentation.

Eriksson (N=200 women) compared water immersion at two time points during the first stage of labour; birthing pool entry at a cervical dilatation of less than five centimetres versus greater than five centimetres (Eriksson *et al.*, 1997). He found that the group who immersed at less than five centimetres dilatation had more analgesia. However, this group had 12% more nulliparae than the group who entered the birthing pool when their cervix was greater than five centimetres, and unfortunately, the length of time that women spent in the pool was not reported. Nonetheless, this finding, coupled with observations of less

frequent contractions after water immersion led to a belief among clinicians, that to avoid dystocia, women should not use a birthing pool until their cervix is five or more centimetres dilated (Geissbuehler *et al.*, 2004, Thoeni *et al.*, 2005). A more recent trial (N=205 nulliparae), which compared the duration of labour for women who used a pool at five different cervical dilatations, showed that women who entered a pool with a cervical dilatation of three centimetres had a significantly shorter labour than any other dilatation, and no difference was found in labour duration between pool entry at six centimetres compared with controls (Malarewicz *et al.*, 2005). Therefore the effect of cervical dilatation at pool entry on labour duration is unclear.

2.3.4 Infection

A few case reports suggested that using a birthing pool during labour predisposes women and newborn to an increased risk of nonspecific infection (Hawkins, 1995, Rawal *et al.*, 1994, Rosevear *et al.*, 1993). However, investigation into whether pool water enters the vagina in pregnant and early postpartum women showed that irrespective of maternal parity, it did not do so (Siegal, 1960). Studies that investigated the effects of water immersion for labour on maternal infection found no association (Ohlsson *et al.*, 2001, Rush *et al.*, 1996, Schorn *et al.*, 1993, Waldenstrom and Nilsson, 1992), apart from one observational study (N=629 women), which reported a higher incidence of minor maternal bacterial infection among pool users (Andersen *et al.*, 1996).

2.3.5 Maternal satisfaction

Trials that collected data for maternal satisfaction consistently reported that women found birthing pool use helpful (Cammu *et al.*, 1994, Rush *et al.*, 1996). Cammu found that 90% of women would like to bathe in a subsequent labour, (Cammu *et al.*, 1994). Rush reported that women expressed a high satisfaction with bathing (Rush *et al.*, 1996). An early prospective observational study also reported that 90% of women would use a birthing pool again (Burke and Kilfoyle A, 1995). Explorations of the experience of using a birthing pool identified that women valued the control that they felt it offered them, and this was not dependent on them having a waterbirth (Hall and Bewley, 1999, Maude and Foureur, 2007). Control is a complex and quintessentially important attribute for women in childbirth because it increases their self-efficacy to labour and give birth (Meyer, 2012).

2.4 Review of the literature on waterbirth

2.4.1 In relation to hands on versus off delivery technique

There is debate as to the safety of adopting hands off delivery technique (midwife does not touch the fetus or the perineum during the delivery) because there is conflicting evidence suggesting that this may predispose women to sustaining OASIS for the perineum and compromise their newborn due to 'uncontrolled' delivery during land birth or waterbirth (Foroughipour *et al.*, 2011, Hals *et al.*, 2011, Mayerhofer *et al.*, 2002, McCandlish *et al.*, 1998, Pinette *et al.*, 2004). Some midwives report not being able to observe the perineum during waterbirth (Meyer *et al.*, 2010).

During waterbirth, midwives typically adopt hands off delivery technique, and do not touch the perineum, baby's head, or often shoulders, until they are born. The reasoning behind this approach is to reduce fetal stimuli in order to prevent premature gasping and possible water inhalation. A systematic review that included two RCTs (N=6,547 women) which investigated hands off compared with hands on during land birth, showed a significant reduction in episiotomy and no increase in OASIS or adverse newborn effects for hands off compared with hands on (using one hand, the midwife exerts a downward pressure on the fetal head as it advances towards crowning, and uses her other hand to press on the perineum. This is also known as the Ritgen manoeuvre (Aasheim *et al.*, 2011)

2.4.2 Perineal outcome

RCTs and prospective observational studies have consistently identified that compared with controls, waterbirth was associated with a higher likelihood of intact perineum, a reduction in episiotomy, with a higher proportion of first or second degree and labial tears, and no increase in OASIS (Garland and Jones, 1994, Garland, 2006, Geissbuehler *et al.*, 2004, Moneta *et al.*, 2001, Otigbah *et al.*, 2000, Thoeni *et al.*, 2005). An Italian economic evaluation of waterbirth based on a reduction in the incidence of perineal trauma for a sample of healthy nulliparae (N=110) who had a waterbirth compared with spontaneous birth on land, calculated that it offered a less expensive care option (Pagano *et al.*, 2010).
Two retrospective observational studies show conflicting results for OASIS at waterbirth: one found no increase (N=90 women) (Aird *et al.*, 1997), and one found a significant

increase (N=783 nulliparae) (Cortes *et al.*, 2011). Cortes reported an OASIS frequency of 4/160 (2.5%) for waterbirths and 8/623 (1.3%) for land birth (p=0.05), but stated erroneously that an incidence of 2.5% exceeded the national rate. The true prevalence for OASIS in childbirth in general is unknown: one study found that 3% of nulliparae and 0.8% multiparae were diagnosed as having sustained OASIS (Harkin *et al.*, 2003), whilst a more recent prospective study involving 2,754 women showed an OASIS incidence of 6.6% for nulliparae and 2.7% for multiparae (Smith *et al.*, 2013)

2.4.3 Postpartum haemorrhage

No studies involving women who had a waterbirth reported an increase in the incidence of minor or major[20] postpartum haemorrhage (PPH). In the absence of results reported for PPH in studies and trials which collected data for maternal outcomes, I am assuming that there was no associated increase in PPH in relation to water immersion during labour. It has been suggested that the relaxation induced by warm water immersion may cause the uterine contractions to be less efficient immediately postpartum, predisposing women who have a waterbirth to PPH (Church, 1989, Deans and Steer, 1995). There has been no case report to support this hypothesis. A recent retrospective cross sectional study comparing maternal outcomes following waterbirth versus spontaneous land birth against maternal birth position (N=6,144 women, 798 [12.9%] waterbirths) found that fewer women who had a waterbirth had a PPH compared with those who had land birth on a birthing stool (Dahlen *et al.*, 2012a). This is an interesting finding because 60% of the women overall had a physiological third stage; a practice common in waterbirth, and thought to be a risk factor for PPH (Begley *et al.*, 2010). In contrast, recent studies involving healthy women in childbirth, reported a lower incidence of major PPH for women who had a physiological compared with actively managed third stage of labour (Davis *et al.*, 2012, Dixon *et al.*, 2013, Fahy *et al.*, 2010).

[20] Minor PPH=estimated blood loss 500-999ml. Major PPH = ≥1,000ml

2.4.4 Infection

2.4.4.1 Maternal

Despite suggestions that the birthing pool environment predisposes women to an increased risk of infection during waterbirth (George, 1990, Loomes and Finch RG, 1990, Meyer *et al.*, 2010), no study has found that waterbirth presents a risk factor for maternal infection.

2.4.4.2 Newborn

None of the studies comparing birthing pool use for labour or for birth which are cited in this review identified an increase in the incidence of newborn infection between groups. Similarly, a survey of 4,032 waterbirths found no evidence that a birthing pool presented a risk factor for newborn infection (Gilbert and Tookey, 1999), which echoed the findings of an earlier survey birthing pool use during birth involving 2,885 women and newborn (Alderdice *et al.*, 1995). A systematic review included mention of three case reports of newborn pseudomonas aeruginosa infection following waterbirth (Pinette *et al.*, 2004). With regard to Group B streptococcal infection (GBS), it has been suggested that by diluting the Group B Streptococcus bacteria, which many people have in their intestines, and which may colonise in the vagina, the birthing pool environment may actually protect babies born in water from contracting newborn GBS (Cohain, 2010-11).

2.4.5 Umbilical cord snap and newborn respiratory difficulty

There have been reports of cord snaps happening during waterbirth (Cro and Preston, 2002, Gilbert and Tookey, 1999), and whilst this complication can occur at any birth, reports have not been published for this complication during land birth. It is perhaps more possible for a midwife to inadvertently apply undue traction on a short umbilical cord as she guides the baby's head above the water during waterbirth compared with land birth when she can see the cord more easily.

Gilbert and Tookey's survey that exmained the perinatal morbidity and mortality for waterbirth found no increase in perinatal mortality or morbidity following waterbirth compared with land birth for women who were at low risk of childbirth complication

(Gilbert and Tookey, 1999). There were two cases of water aspiration that they suggested may have been attributed to waterbirth (Gilbert and Tookey, 1999). The term 'near-drowning' has been used to describe a phenomenon whereby some babies born in water present with respiratory distress in the hours following birth; a condition that may self-resolve or require admission to NICU for oxygen therapy. In the term infant, this is usually caused by delayed lung aeration, and known as transient tachypnoea of the newborn (TTN) (Carpenter and Weston, 2012). There have been a few case reports of TTN following waterbirth (Kassim *et al.*, 2005, Mammas I N and Thiagarajan P, 2009, Nguyen *et al.*, 2002, Schroeter, 2004, Sotiridou *et al.*, 2010). There is debate among paediatricians about whether waterbirth predisposes newborn to a greater risk of TTN than land birth (Carpenter and Weston, 2012, Gilbert and Tookey, 1999, Pinette *et al.*, 2004). In contrast to this uncertainty in relation to waterbirth, there is evidence that term gestation infants born by elective Caesarean section are at significantly greater risk of TTN than any other mode of delivery (Alderdice *et al.*, 2005, Boon *et al.*, 1981, Levine *et al.*, 2001).

Neither of the largest observational studies for waterbirth, or the RCTs that involved waterbirths, reported cases of TTN (Chaichian *et al.*, 2009, Geissbuehler *et al.*, 2004, Nikodem *et al.*, 1999, Thoeni *et al.*, 2005, Torkamani *et al.*, 2010).

2.4.6 Thermo-regulation

There are gaps in our knowledge and understanding of fetal physiology during labour and newborn at birth and the immediate postpartum period inside or outside the birthing pool environment. We do know however, that maternal temperature can be a barometer of fetal wellbeing, because the fetus is up to one degree hotter than its mother, and excessive heat will compromise it (Johnson, 1996). Based on studies involving fetal lamb immersion in water, it is thought that an acidotic human fetus born in water may override its natural protective diving reflex involving chemoreceptors that inhibit ingestion, gasp and inhale water (Johnson, 1996). For this reason, it is recommended that birthing pool water temperature does not exceed normal body temperature (37 degrees Celsius) (Cluett and Burns, 2009). Geissbuehler argues that maternal and fetal temperature can self–regulate, and suggests that we should not be concerned about birthing pool temperature (Geissbuehler *et al.*, 2002), which may explain why babies born in the decidedly cool water of the Black sea do not appear to encounter a problem at birth. This self-regulation theory

runs counter however, to evidence that epidural analgesia can cause maternal fever and attendant ill-effects for women and their newborn (Apantaku and Mulik V, 2007, Leighton and Halpern, 2002, Mantha *et al.*, 2008, Philip *et al.*, 1999, Segal, 2010).

2.4.7 Maternal satisfaction

Nikodem reported that women who had a waterbirth felt more in control and satisfied with the pushing phase of their childbirth than controls who did not use the birthing pool (Nikodem *et al.*, 1999), and Torkamani found that 72% would use the pool again (Torkamani *et al.*, 2010). Woodward found no difference in maternal satisfaction between groups, which is interesting given that this feedback included women who exerted their preference to use a birthing pool (Woodward and Kelly, 2004). Some women who used the birthing pool did comment however, that they felt their midwife did not appear to like this care option. Midwives attitudes regarding birthing pool use for labour and waterbirth are known to vary (Russell, 2011).

2.4.8 In summary

Research on birthing pool use for labour showed that it reduced the uptake of pharmacological analgesia, reduced labour augmentation and increased the likelihood of spontaneous vaginal birth and an intact perineum, with no increased risk of maternal or newborn infection for healthy women. It also found that women rated using a birthing pool highly. There was uncertainty about the optimal cervical dilatation to recommending that a woman enter a birthing pool before her cervix was at least four centimetres dilated.

Research on waterbirth showed that women liked it, and would use a birthing pool for a subsequent labour. Waterbirth did not present an infection risk for healthy women or their newborn. There was conflicting evidence as to whether waterbirth presented a risk factor for OASIS for women, and concern that waterbirth may predispose newborn to TTN, and umbilical cord snap. There is a lack of evidence regarding third stage management and PPH for waterbirth.

2.5 Evidence limitations

2.5.1 Participants

With the exception of Ohlsson's trial, all the RCTs had small sample sizes (N=33 to N=785), particularly those that involved women who had a waterbirth, which limited their power, and the potential of those that investigated maternal and newborn outcomes to contribute new knowledge regarding rare adverse events.

Whilst all studies included healthy pregnant women, participant inclusion criteria did not always stipulate if women who had induction of labour, or healthy women who had a previous Caesarean section were included. For example, Eckert mentions in results that 20% of the birthing pool group and 21% of the control group had an induction of labour (Eckert *et al.*, 2001), and Geissbuehler alludes to women with a previous CS in her discussion (Geissbuehler *et al.*, 2004). It is important to know this because as explained in section 1.3, induction of labour and previous CS are associated with intrapartum complication, including operative delivery, and may therefore, have influenced findings.

Few studies that involved women of mixed parity presented their data by parity, which restricted the clinical relevance of the findings because as previously mentioned; parity is a predictor of childbirth outcomes.

2.5.2 Intervention

Several studies did not describe the receptacle that the participants used (Aird *et al.*, 1997, Andersen *et al.*, 1996, Chaichian *et al.*, 2009, Garland and Jones, 1994, Moneta *et al.*, 2001, Ohlsson *et al.*, 2001, Torkamani *et al.*, 2010). The design of the pool used in Rush's trial was one used for geriatrics, and women could only adopt a sitting position in it (Rush *et al.*, 1996). Although they did not specify that there was free maternal movement, three studies provided information for the size and shape of the birthing pools used in their studies (Geissbuehler *et al.*, 2004, Otigbah *et al.*, 2000, Thoeni *et al.*, 2005). Some studies provided pool information and stated that free movement was possible in their birthing pools (Cammu *et al.*, 1994, Cluett *et al.*, 2004, Eckert *et al.*, 2001, Eriksson *et al.*, 1997, Lenstrup *et al.*, 1987, Nikodem *et al.*, 1999, Schorn *et al.*, 1993).

Being unable to ascertain if all study participants could move freely in the pool they used is an omission because restricted movement may have contributed to discomfort and pain perception, which may have influenced analgesia uptake for example. Also, without comprehensive information about the level of water within the pool, for example, immersion that covered women's abdomen, it is not possible to know if immersion may have facilitated or thwarted the haemodynamic relaxation benefits suggested by Benfield (Benfield *et al.*, 2010). The time that women spent in the pool was another factor which several studies did not report. This omission is relevant because length of time immersed may influence maternal pain perception, as indicated by Benfield, and thus potentially the need for further analgesia.

2.5.3 Comparisons

Few trials or observational studies described the usual care provided in the control groups. This is highly relevant because in the absence of clear information about what comprised care for the control group, it is not possible to know what the birthing pool use was being compared to precisely. For example, were women who did not use a birthing pool able to adopt different positions during the first and/or second, or were they lying down on a bed? There is strong evidence that maternal mobility and positions adopted for birth can affect analgesia uptake and mode of delivery. A systematic review of 21 RCTs involving 3,709 women found that compared with recumbent position, maternal mobility during the first stage of labour reduced epidural analgesia (RR 0.83 95% CI 0.72 to 0.96). Another review involving 22 RCTs (N=7,280 women) that examined upright versus recumbent maternal position during the second stage of labour found a significant reduction in operative vaginal delivery (risk ratio (RR) 0.78; 95% CI 0.68 to 0.90; 19 trials, 6024 women) and in episiotomies (average RR 0.79, 95% CI 0.70 to 0.90, 12 trials, 4541 women) for nulliparae and multiparae who adopted upright positions (Gupta *et al.*, 2012)
Despite undertaking analysis by intention-to-treat, in some RCTs, the extent to which the experimental and control groups received the same intervention or standard care limited the external validity of results; for example, in Rush's trial, 183/393 (46%) of women allocated to the pool did not use it (Rush *et al.*, 1996). In Eckert's trial, there was a crossover for 41/137 (30%) and 27/137 (20%) of birthing pool and controls respectively (Eckert *et al.*, 2001). Eckert also performed secondary analysis for women who actually used the pool versus those who did not do so, which was not appropriate as their

characteristics may have been different. Only 25/40 (62.5%) of the women who were randomised to using the birthing pool in Woodward's pilot RCT actually did so, as did 5/10 (50%) of the birthing pool preference group (Woodward and Kelly, 2004).

Geissbuehler's prospective observational study did not analyse data by birthing pool use, which weakened the reliability of the positive results for waterbirth. Data for 647/782 (83%) of the women who used the birthing pool during labour but did not have a waterbirth were analysed together with women who did not use a birthing at all during their labour (Geissbuehler *et al.*, 2004). It was not possible therefore, to identify any potential linkage between outcome and birthing pool use versus no water immersion during labour.

The reliability of retrospective observational study design is weakened by its reliance on records and recollection. Dahlen's study was the first to examine the effect maternal birth position for women who had a land birth, compared with women who had a waterbirth, on perineal outcome and PPH, accounting for factors such as birthweight greater than 4,000 gr and maternal parity (Dahlen *et al.*, 2012a, Dahlen *et al.*, 2012b) . She did not however, state the maternal position(s) for the waterbirth group, which seriously limits the potential of this study. In adopting a retrospective design, she was dependent upon medical records for data, which may explain this omission.

2.5.4 Care setting

Apart from three studies, all research on birthing pool use during labour and waterbirth has been conducted in an obstetric unit setting. One trial (N=108 women) took place in a 'normal birth centre' with an average of 1,000 births each month. It was not clear if this was situated inside or away from a hospital, or who staffed it, for example, if staffing included obstetricians and/or paediatricians (da Silva *et al.*, 2009). An early report of 100 waterbirths took place in a freestanding birth centre, managed by an obstetrician, and it was not clear if women who used this centre were fee-paying or not (Church, 1989). The third study analysed data collected over a 12 year time period for 6,144 women who laboured in an alongside midwifery unit (Dahlen *et al.*, 2012a).

2.5.5 Outcomes

Safety data requires large numbers, particularly for studies involving healthy women in childbirth, yet most studies were under-powered to enable precise estimates for infrequent events such as PPH and neonatal resuscitation. There was scant research on women who used a birthing pool for labour and for waterbirth and gave birth in midwifery led units, or at home. Consequently, there were no prospective studies that compared intrapartum events, interventions and outcomes for women (and their newborn) who planned to give birth in the full range of care settings where they can use a birthing pool in the UK. This also meant there were no data for maternal and/or newborn transfer to hospital from an AMU, FMU or home: a key safety indicator. Finally, there was no evidence for *normal birth*. The thrust to normalise birth, and maternity stakeholder promotion of *normal birth* as a marker of quality care presented an important reason to explore the potential of intrapartum birthing pool use to contribute to the normalising birth agenda.

2.6 A rationale for further research

Given the current context of concern about the medicalisation of childbirth and the normalising birth agenda, it was important to explore if birthing pool use had the potential to normalise birth by reducing intrapartum interventions and adverse outcomes for healthy women in childbirth. Gaps and methodological limitations identified in available evidence for intrapartum birthing pool use comprised

- Little evidence to inform practitioners and women if birthing pool use for labour and waterbirth might have a role in reducing intrapartum interventions and facilitate *normal birth* for healthy women in childbirth
- A lack of research on birthing pool use outside the obstetric unit setting: a fundamental gap for the UK where birthing pools are commonly used in midwifery led units.
- Insufficient information about the demographic and obstetric characteristics of nulliparae and multiparae who used a birthing pool for labour and had a waterbirth. This is relevant because maternal age, parity and obstetric characteristics such as previous CS, and induction of labour can influence the likelihood of intrapartum interventions and outcomes as detailed in this Chapter.

- Insufficient information about the intrapartum events, interventions and outcomes for nulliparae and multiparae who chose to use a birthing pool for labour and for waterbirth (and their newborn) in their planned place of birth. Lack of analyses by maternal parity in most studies limited being able to ascertain the usefulness or otherwise of birthing pool use for labour for women; as a means of pain relief, particularly for nulliparae. Also, might using a birthing pool at a cervical dilatation of less than four centimetres predispose women, again principally nulliparae to primary dystocia? It was essential to examine safety concerns expressed by practitioners regarding typical waterbirth practices; namely anxiety that hands off delivery technique may predispose women to OASIS, physiological third stage to PPH, newborn to an increased risk of umbilical cord snap, TTN, admission to NICU and infection.

2.7 A research programme

On the basis of my review of previous research and the limitations I identified in it, I wanted to examine if birthing pool use during labour and waterbirth may have a role to play in the drive to normalise childbirth, so I defined a set of research questions to address in my own study.

My **primary research question** was could using a birthing pool during labour and/or waterbirth contribute to normalising birth for healthy women in childbirth, without an increase in adverse maternal or neonatal events?

My **secondary research questions** were:

1. What are the characteristics of women who use birthing pools and what intrapartum events, interventions and outcomes do they and their newborn experience?
2. Do nulliparous women who use a birthing pool have a different intrapartum experience to multiparae?
3. Does the experience differ between the care settings where nulliparous and multiparous women use a birthing pool and plan to give birth?

4. Does the intrapartum experience differ between women who use a birthing pool during labour and women who meet birthing pool eligibility criteria but choose not to do so?
5. Does induction of labour in healthy women who use a birthing pool during labour affect maternal and newborn outcomes?

Methodology

In this Chapter I describe the theoretical basis of my research design, discuss and provide the rationale for my decision to undertake a prospective observational study, outline its key elements and the relevant ethical issues.

3.1 Research paradigm

My programme of research was rooted in the paradigm commonly used in biomedical research. The ontological and epistemological foundations are therefore those of the biomedical sciences; positivism. It focusses on a series of medically defined characteristics, intrapartum and postpartum events, procedures and outcomes. Notwithstanding that childbirth is a deeply meaningful experience for women and their families, and that the nature of this profound life experience is shaped by psychological, social and cultural factors, the focus of this research is not on the perspectives of those involved, but on the incidence of medically defined clinical factors in relation to labour, birth and the early puerperium.

The term Positivism originates from the 18th century French philosopher and social theorist, Auguste Comte whose quintessential belief was that knowledge should be based on tangible observation, and aim to be of use to society (Pickering, 1993). Ontologically, positivist research holds that there exists an external reality which can be deciphered, and the epistemological process by which this can be achieved is through methodically observing and measuring objective, tangible items to generate new knowledge (Bowling, 2009, Wahyuni, 2012). The credibility of knowledge gained in this way centres on objectivity, which requires that data variables are measured according to clearly defined and commonly agreed criteria, for example definitions of mode of delivery, or criteria for severity of perineal trauma, and that the researcher sets aside personal values as far as possible and only reporting the data that she/he collects and analyses (Wahyuni, 2012).

3.2 Research design

3.2.1 Rationale for observational design

In order to address my research questions, I required quantitative observational data that provided a description of the 'natural course' of labouring in a birthing pool and giving birth in water in the full range of naturally occurring circumstances.

Observational research can capture the incidence of what typically happens to a particular population in a selected context over a pre-specified period of time (Mann, 2003). A prospective study of sufficient size and breadth, such as the one I undertook, provides a wealth of data, and an opportunity to explore and generate hypotheses. Kerlinger described hypotheses as 'the working instruments of theory' and identified how a theory is initially generated through collecting observational data, and exploring them for associations, which can then be tested more specifically (Kerlinger, 1986). For example, as the literature review in chapter two identified, one concern about water immersion during the first stage of labour is the risk that if a woman enters a birthing pool before her cervix is less than four centimetres dilated, she may be more likely to require her labour to be augmented (Odent, 1997). Another concern identified in the literature review is that waterbirth may increase the incidence of OASIS(Cortes *et al.*, 2011). The data collected in my observational study provided a basis for exploring these relationships.

Observational research is susceptible to selection bias and confounding factors. A prospective study enables data to be collected as the events occur, ensuring that data for a wide range of variables could be collected using a pre-specified data form. This helps to ensure standardisation of data collected and minimisation of missing data. A retrospective observational study whereby data were collected from case records for example, would have limited data completeness and range of variables for which data would be available to answer my research questions.

An observational study can also allow the researcher to explore data by doing exploratory analyses. For example, although I did not expect to find women who had an induction of labour included in my birthing pool sample because in the UK, birthing pool use is recommended for women who are at low risk of childbirth complication, a small overall

number did have an induction, and a higher proportion of nulliparae who planned to give birth in an OU than in the other care settings did so. As this intervention presented a confounder for epidural and maternal and newborn outcomes for nulliparae in the OU setting, I performed exploratory analyses for the subset women who had a spontaneous labour onset to explore how this affected similarities and differences between the care settings for outcomes. I also did exploratory analyses for the subset of women who had a spontaneous labour onset in the birthing pool and HES comparisons. Although results arising from these analyses cannot be interpreted as hypothesis proving, they are useful for hypothesis generating, which can be used in subsequent studies.

Whilst an observational study can yield useful descriptive and exploratory information, in generating and refining knowledge for clinical practice, and future research, it cannot be used to infer causality. This is because it has limited *internal* validity due to the lack of control over confounders (Mann, 2003, Walter, 2005). A randomised controlled trial (RCT) is the strongest design for inferring causality.

It can be argued that observational design has greater *external* validity than an RCT because with a cohort study, clinical practice takes place as usual without any imposed treatment assignment as with an RCT. In that way, it is more reflective of real world practice. However, selection bias is a potential threat to the *internal* validity of findings. For example, the care setting where women plan to give birth may be a confounding factor for mode of delivery and episiotomy. Indeed, there is RCT evidence showing that women who labour and give birth in midwifery led units are more likely to have a spontaneous birth and are less likely to have an episiotomy compared with a similar low risk population who labour in an OU (Hodnett *et al.*, 2012). The uptake of epidural analgesia could present another possible confounder a woman who chooses to use a birthing pool, as a non-pharmacological mode of pain relief, might be less likely to accept the idea of having an epidural compared with a woman who opts not to do so.

An RCT would have been an alternative design appropriate for my research questions, but given the key evidence limitations, the cost of undertaking an RCT, and the potential ethical and practical issues in relation to maternal choice and practitioner resistance, particularly in midwifery led care settings, I considered that a prospective observational

study was a more appropriate first step, as this would advance the knowledge base, and results could be used as a basis for further research.

3.2.2 Birthing pool prospective observational study

It was timely to undertake a prospective observational study because my review of the evidence in chapter two identified gaps in relation to the characteristics of nulliparous and multiparous women who used a birthing pool[21] during labour and had a land birth, and for those who had a waterbirth, the intrapartum events, interventions and outcomes they experienced and outcomes for their newborn. It was also necessary to gather data across the range of natural settings where women use birthing pools during labour because there was virtually no research for birthing pool use outside the obstetric unit care setting, yet they are used widely in midwifery led settings. It was therefore important to present findings by maternal parity and planned place of birth.

3.2.3 Sampling

My sampling strategy was based on a number of considerations. First, I wanted a sample of women that was representative women who used a birthing pool during labour. I needed to recruit a sample of care settings which represented the places where women used a birthing pool; these included obstetric unit labour wards (OU), alongside midwifery units (AMU), freestanding midwifery units (FMU), and women's homes. Secondly, I wanted to ensure that I recruited across suburban, urban and rural areas to secure a nationally representative sample.

My sample size calculation was based on a number of factors. I wanted to be able to estimate proportions of intrapartum events, interventions and maternal and newborn outcomes with a high degree of precision for this sample of healthy pregnant women. However, at the time, it was not possible to reliably extrapolate from literature the incidence of adverse intrapartum events for this population, as research included women with a mixed obstetric profile. I therefore aimed to recruit a sample of a minimum of 1,000 women per care setting in order to measure rare events such as postpartum haemorrhage,

[21] Birthing pool is a permanent fixture or a portable receptacle that is sufficiently deep and wide to enable a woman who is at term gestation (38-42 weeks pregnant) to fully immerse her abdomen in water, and to adopt different positions.

OASIS, newborn resuscitation and admission to neonatal intensive care unit (NICU), with adequate precision, i.e. within a 95% confidence interval of ± 2.5%.

3.2.4 Analyses

Continuous data variables were checked for their distribution using histograms. The data distribution governed the choice of summary statistic. For normally distributed continuous variables, for example, maternal age, gestation, newborn birthweight, the mean and standard deviation were used. Categorical data frequencies were summarised using the number and proportion (percentage). As both types of data followed an approximate normal or binomial distribution, it was possible to determine the level of precision of the summary estimates using 95% confidence intervals to calculate the variability around the mean for continuous data and average for categorical data. This meant that I could be sure that my values would fall within the confidence interval with 95% accuracy. Relative risk was also used to estimate differences between groups.

Inferential statistics were used for two purposes; firstly to make comparisons between groups, for example, between the characteristics, intrapartum events, interventions that nulliparae and multiparae and their newborn experienced, and the care settings where they planned to give birth. Inferential statistics were also used to explore relationships between independent variables, for example cervical dilatation at the point when women entered the birthing pool and use of intravenous infusion of oxytocin to augment labour. Again, the type of the data and distribution determined the appropriate test used. The underlying assumptions for using the independent t-test to evaluate comparisons involving continuous data was met as the observations were independent of each other and the data distribution was normal. Likewise, requirements were met for using the Pearson chi-squared (χ^2) test for categorical data: the sample size was sufficiently large to avoid the risk of making a Type ll error, there were adequate expected cell counts – that is, a minimum of five or more in all cells of a 2-by-2 table, the observations were independent of one another, and all women in the study sample had an equal probability of selection. In accordance with common practice, a p value of <0.05 was used to indicate significance. The relative risk was also calculated to present significance. Missing data were excluded from all analyses.

3.2.5 Ethical considerations

In 2000 when data collection started, the university had no formal ethics committee. I received verbal approval to conduct the study as audit. In 2002, I submitted the original proposal for the birthing pool study to the Chair of newly formed Research Ethics Review Group (RERG). This committee took the view that my study was still classified as audit, and therefore did not require NHS research ethics approval. I was advised to ensure that participating centres sought permission from their appropriate Local Research Ethics Committee (LREC), or managers, and provide me with the anonymised data about birthing pool use during labour for analysis purposes [see Appendix 1]. Because it was regarded as audit, study centres were not asked to gain consent from individual women. However, some did so.

As with the data received from the birthing pool participating centres, the bespoke HES data that I obtained also contained no individual identifiers such as name or NHS number. I signed a data re-use agreement with the National Information Centre under the terms set out in the HES data protocol. All data and analyses were stored in accordance with the 1998 Data Protection Act (Gov.UK, 1998).

To fulfil an ethical obligation to disseminate research, a paper was published for the results from the birthing pool study, and the contribution from participating centres acknowledged.

Who uses birthing pools and what happens to women who use them?

This Chapter is the first of several to make a case for the potential role of intrapartum birthing pool use in normalising childbirth by examining who uses a birthing pool, and describing their intrapartum events, interventions and maternal and newborn outcomes. It draws on data from a large international study undertaken between 2000 and 2008, and expands on a paper involving data for the UK, published in Birth (Burns *et al.*, 2012).

To explore the potential of birthing pool use during labour and waterbirth to normalise birth in all settings where it is used, I needed to examine the characteristics of nulliparous and multiparous women who use a birthing pool during labour and what intrapartum events, interventions and outcomes they experience in their planned place of birth. I also explored relationships between birthing pool use during labour and waterbirth and intrapartum interventions and outcomes, for which there is practitioner concern. Lastly, to remove induction of labour as a confounding factor for interventions and outcomes, I examined interventions and outcomes for a subgroup of women who had a spontaneous labour onset.

4.1 Research questions and objectives

1) Who uses a birthing pool?

A priori objective (drafted in advance of data collection and analysis)

Compare obstetric characteristics between women who use a birth pool in the obstetric unit, alongside midwifery unit and community (freestanding midwifery unit and home) settings

2) What intrapartum events, interventions and outcomes do nulliparous and multiparous women who use a birthing pool experience, and do they vary between the care settings where they plan to give birth?

A priori objective

Compare intrapartum events, interventions and maternal and newborn outcomes by care setting and by parity

3) What are the intrapartum events, interventions and outcomes that women who do not have an induction of labour experience

Exploratory analysis

To compare interventions and maternal and newborn outcomes by care setting and by parity for women who had a spontaneous labour onset and used a birthing pool.

4.2 METHODS

4.2.1 Recruitment

I recruited study centres that represented the full range of care settings where women can use a birthing pool in the UK. These included obstetric units, alongside midwifery units, freestanding midwifery units and women's homes. I circulated an invitation flyer to all Heads of Midwifery who were registered with the Royal College of Midwives, London, UK. I also invited managers and practice development midwives who had attended the first international water birth conference (Beech, 1995) and were working in obstetric and midwifery led units which had a birthing pool. Further participating centres were recruited using a snowball sampling technique.

Care settings comprised

- Obstetric units staffed by midwives, obstetricians, anaesthetists and paediatricians.
- Alongside midwifery units staffed by midwives and situated inside the hospital building
- Freestanding Midwifery units staffed by midwives and located away from the hospital site
- Midwife attended homebirths.

When potential recruits responded to the invitation, I sent each a letter, which expanded on the study's purpose to collect and analyse data for consecutive women (to reduce selection bias) who used a birthing pool during their labour in their planned place of birth, from the point at which they entered the pool up to and including their seventh postnatal day. I requested a profile for participating centres. Background information requested included each units' number of births per year; models and number of birth pool facilities (to ensure the pools were sufficiently large to enable a woman to adopt a range of different positions, and differentiate from the use of ordinary domestic baths), and the care settings

in which they were situated; how long each unit had a birth pool and the number of women using it per year, including those who left before the birth (if available). To check consistency of maternal obstetric characteristics, I also enquired about eligibility criteria for women wishing to use the pool, and requested a copy of each unit's birthing pool guidelines. Finally; I asked if interested units would allocate a link midwife to be the interface between myself and her colleagues who cared for women using the birth pool, and with whom I could establish a modus operandi regarding data collection, collation and entry.

4.2.2 Ethics

As the university had no formal ethic committee when data collection commenced, verbal approval to conduct the study as audit was given which was formally acknowledged in 2002 by the Research Ethics Review Group (RERG). The participating centres sought permission from their appropriate Local Research Ethics Committee (LREC), or managers, and provided me with the anonymised data. A copy of the approval letter from the RERG [Appendix 1] was enclosed with the invitation letter sent to potential study centres requesting background information about intra-partum birthing pool use and the eligibility criteria for their birthing pool guidelines.

4.2.3 Data collection

Data were collected for a convenience sample comprising all consecutive women in labour who chose to use a birthing pool at any point during labour, and for any length of time. Midwives prospectively recorded data on a standardised form [Appendix 2] whilst caring for the women during labour and birth. The link midwife in each unit coordinated data collection, collated and checked the data forms for completeness, and entered data onto an Excel database. I trained the link midwives how to record the data on the proforma and the database, which mirrored the same variables, and included free text columns for some items (reason women left the pool pre delivery, birth position for waterbirth, and maternal and newborn complication). Each unit had a pilot phase to clarify understanding of terms and definitions, and so that as principal investigator, I could gauge data quality, particularly that all events were recorded. I requested that each unit send me data at least

six monthly, so that I could check the datasets and facilitate link midwives to track missing data as contemporaneously as possible.

I also asked participating units if whilst collecting data for women who used a birthing pool during labour, they would also collect the same data (bar pool specific) for women who fitted the birthing pool eligibility criteria, but chose not to use it.

Data were collected for internationally acknowledged maternal and newborn intrapartum related safety indicators (Box 4.1) and data for maternal and neonatal complications were collected up to and including the seventh postnatal day.

Box 4.1: data variables for maternal characteristics, intrapartum events, interventions and outcomes

Maternal characteristics: parity, age, gestation, spontaneous or induced labour onset, previous Caesarean section

Intrapartum events and interventions: analgesia (pharmacologic/non pharmacologic), augmentation by artificial rupture of the membranes (ARM) and augmentation by intravenous infusion of oxytocin (IVI).

Maternal outcomes: mode of delivery, type of third stage management, manual removal of placenta (MROP), duration of labour, perineal outcome, postpartum haemorrhage (PPH) graded as minor (500-1,000 ml) and major (≥ 1000ml), infection, pyrexia, readmission, and death

Neonatal outcomes: Apgar scores (at one, five and ten minutes), birth weight, resuscitation, respiratory difficulty requiring support (TTN), umbilical cord snap, shoulder dystocia, infection, admission to neonatal intensive care unit (NICU),

4.2.4 Sample size

A target sample of 1,000 women per care setting is large enough to observe at least two rare events occurring with an incidence of 5 in 1,000, with a probability of 95%. Rare outcomes to be observed were major postpartum hemorrhage, OASIS, NICU admission and perinatal mortality.

Because there were few planned homebirths in the study sample, a sensitivity analysis using all maternal variables was undertaken to examine if the home or FMU setting affected results. The purpose here was to establish if data for women who planned to give birth in an FMU or at home could be pooled, to form one community group of sufficient size to enable meaningful analyses.

4.2.5 Data preparation for analysis

When each study centre completed data collection, I coded the free text entries in the Excel Databases as follow

- Non pharmacologic analgesic options were assigned separate codes (aromatherapy, massage, acupuncture, hypnotherapy)
- Reason for leaving the pool pre delivery were divided into maternal (choice – embracing uncomfortable, too hot or too cold, more analgesia, slow first stage, slow second stage, to mobilise, pyrexia, bleeding, raised blood pressure, to perform vaginal examination or to pass urine, medic/midwife request, premature pushing, previous PPH), and fetal (fetal distress, fetal bradycardia, fetal tachycardia, meconium stained liquor, malposition, shoulder dystocia)
- Reasons for transfer to hospital from alongside midwifery units or the community were collapsed into intrapartum (analgesia, slow first or second stage, retained placenta, fetal concern, and 'other' - elevated blood pressure, pyrexia, prolonged rupture of membranes, malpresentation, group B streptococcal infection), and PPH, for suturing of perineal trauma/episiotomy, newborn)
- Birth positions for women who had a waterbirth and a land SVD were collapsed into upright (semi recumbent, squatting, kneeling forward), or lying down (left/right lateral, supine)
- Maternal complications up to and including the seventh postnatal day were assigned individual codes (for example, labour augmentation, PPH, OASIS, infection, readmission to hospital)
- Newborn complications up to and including the seventh postnatal day were also assigned individual codes (resuscitation, respiratory difficulty requiring treatment (TTN), umbilical cord snap, infection, birth injury, congenital anomaly, jaundice requiring phototherapy treatment, feeding problem, admission/readmission to hospital postnatal ward, or NICU, death)

Additional data preparation included creating new variables for the management of third stage to encompass the three practice variations observed. These comprised active, defined as umbilical cord clamped and cut, oxytocic injection administered pre placental delivery by controlled cord traction; uninterrupted physiological, defined as no cord clamping or oxytocic injection pre placental delivery by maternal effort, and mixed physiological, defined as delayed cord clamping, and no oxytocic injection pre placental delivery by maternal effort.

4.2.6 Data analysis

I transferred the Excel files into SPSS, and using version 17.0 (SPSS, 2009), analysed data for the sample as a whole, and by planned place of birth, stratified by parity.

A disparity in the proportion of women who had an induction of labour between care settings prompted exploratory subgroup comparisons for interventions and outcomes for women who had a spontaneous labour onset, stratified by parity.

I also explored a series of hypotheses in relation to intrapartum birthing pool use for two reasons. Firstly, I wanted to explore if there was an association between using a birthing pool during labour and the incidence of *normal birth*, and my second reason was to test associations which have been suggested by clinicians in relation to birthing pool use during labour, for which there is little, and/or conflicting evidence.

These hypotheses were

1) Is waterbirth associated with having a *normal birth* for nulliparae and multiparae?
2) Is there an association between the cervical dilatation at which nulliparae and multiparae enter a birthing pool and the requirement for labour augmentation?
3) Is there an association between hands off delivery technique and OASIS[22] for nulliparae and multiparae who have a waterbirth?
4) Is there an association between giving birth to a large baby[23] in water and OASIS?

[22] OASIS is an acronym for obstetric anal sphincter injuries, which encompasses third and fourth degree perineal trauma, also known as extensive perineal trauma.
[23] Large baby is a birth weight of 4,000 grammes or more

5) Is there an association between third stage management and PPH for nulliparae and multiparae who have a waterbirth?
6) Is there an association between transient tachypnoea of the newborn and waterbirth?

Frequency, percentage and 95% confidence interval were calculated for categorical data. Appropriate measures of central tendency (mean, median) and dispersion (SD, range) were calculated for continuous data after assessing the distribution of the data. Missing data were excluded from analysis. Univariate analyses were undertaken to test differences between care settings, and associations between different factors (i.e. explore hypotheses) using Pearson χ^2 test, or Fishers Exact if cell counts were five or less. Significance was set at 0.05. Estimation of differences between groups was conducted using relative risk (RR) with 95% confidence interval (CI).

4.3 RESULTS

4.3.1 Sample size, participating centres and geographical distribution

A total of 8,924 women who used a birthing pool during labour were recruited across 26 National Health Service Hospital Trusts in England, Scotland and Northern Ireland, consisting of 15 obstetric units (OU), 5 alongside midwifery units (AMU), 9 freestanding midwifery units and 155 women's homes (community), between 2000 and 2008. No unit from Wales responded to the invitation to participate. Also, only one study centre, an obstetric unit, collected data for women whose obstetric characteristics matched those for birthing pool eligibility criteria but who chose not to do so, and only for part of the time period during which it also collected data for women who used the birthing pool.
The obstetric unit was the setting for the highest proportion of women, and the fewest planned to give birth in an AMU.

Figure 4.1 shows the distribution of the sample of birthing pool women between three care settings: OU, AMU, and community (FMU and homebirth merged).

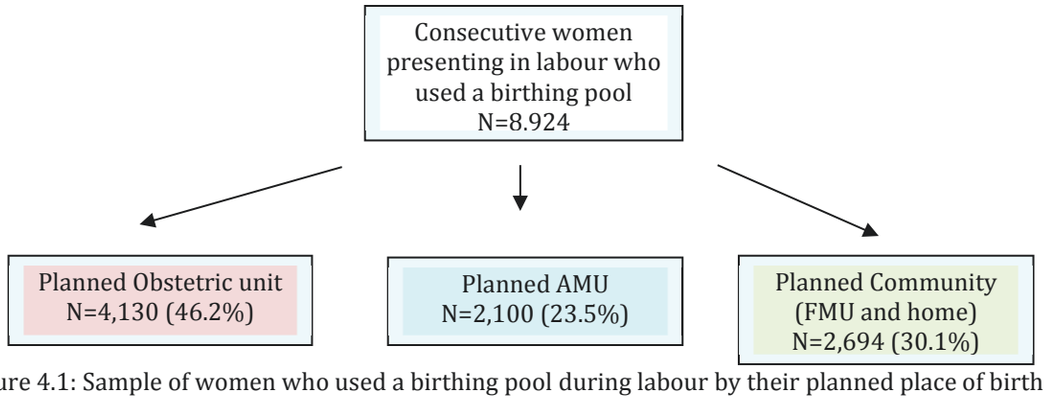


Figure 4.1: Sample of women who used a birthing pool during labour by their planned place of birth

The map below illustrates that study centres were recruited across diverse rural and urban regional areas (Figure 4.2)

Figure 4.2: Geographical distribution of participating centres

The largest proportion of women who planned to have a home birth lived in the London region (116, 74.8%), 19 (12.2%) were in the South East and, with the exception of one woman in Scotland, the remaining 19 (12.2%) were scattered over the other English regions. Sample size in participating centers ranged from 50 to 764 women (median 240) (Table 4.1)

Table 4.1: Geographical distribution of participating centres by care setting and births per year

Geographical region	Care setting	*Number of births per year
England		
South East	†Obstetric unit x 3 ‡Alongside midwifery unit x 2 Freestanding midwifery unit x 1	1, 2, 3 B,D A
South West	Obstetric unit x 5 Alongside midwifery unit x 1 Freestanding midwifery unit x 3	3, 4 x 2 C B, B C
London	Obstetric unit x 1 Alongside midwifery unit x 1	2 D
East Midlands	Obstetric unit x 1	2
West Midlands	Obstetric unit x 1	3
East of England	Obstetric unit x 2	2, 3
East Yorkshire	Obstetric unit x 1 Freestanding midwifery unit x 1	3 C
North West	Obstetric unit x 1 Freestanding midwifery unit x 1	2 B
Northern Ireland		
Antrim	Alongside midwifery unit x 1	A
Scotland		
Central	Freestanding midwifery unit x 3	A, B, B
Strathclyde	Obstetric unit x 1	2

*Numbers in this table represent available data for the number of births during participant recruitment time periods. †Births per year for obstetric units have been coded: 1 = <3,000, 2 = 3000-5000, 3 = >5000.
‡Births per year for alongside and freestanding midwifery units have also been coded: A= <200, B= 200-400, C= >400-500, D=>500.

Recruitment periods ranged from 8 to 72 months (median 27). All but one study centre took part for a minimum of a year and participated for as long as they were able. Birthing pool operational problems and staff shortages meant that in three obstetric units, data were collected from two consecutive series of women with a break between them. The median interruption time was 14 months (range 11– 32). Before pooling the data from the 29 study centres, I examined the proportion of women receiving an epidural, episiotomy or spontaneous vaginal birth by study centre to see if these changed over time. These elements were selected because I felt that in response to the thrust to normalise birth, any changes in practice would be reflected in one or more of these outcomes. I also conducted a sensitivity analysis by care setting, removing one study centre at a time from the pooled analysis to see if any one centre disproportionately affected results.

4.3.2 Maternal and obstetric characteristics

The birth pool eligibility criteria were similar across the study centres, and as per UK birth pool use recommendations (Royal College of Obstetricians and Gynaecologists and Royal College of Midwives, 2006), all women had a singleton fetus, were at term gestation and had experienced a straightforward pregnancy. Of the 8,924 women, 4,953 (55.5%) were nulliparae, 3,970 (44.4%) multiparae (Table 4.2). There were significantly fewer nulliparae in the community setting compared with the OU (p<0.001), and AMU settings (p<0.001). There was no significant difference in the parity ratio between OUs and AMUs (p=0.13). In all settings, the mean age for multiparae was two years older than for nulliparae. Each setting had a similar small overall proportion of multiparae who had a previous CS. There were significant differences for the incidence of induction of labour between settings. Significantly more women who planned to give birth in the OU setting had an induction of labour compared to those in an AMU, or the community (p<0.001) (Table 4.2).

Table 4.2: Characteristics for women who used a birthing pool by planned place of birth and parity

Binary: n (%)[CI 95%] Continuous: mean (SD)	Obstetric unit N=4,130 (46.2)		Alongside midwifery unit N=2,100 (23.5)		Community N=2,694 (30.1)	
	Nulliparae	Multiparae	Nulliparae	Multiparae	Nulliparae	Multiparae
Parity*	*n*=2433 (59) [57, 60]	*n*=1697 (41) [39, 43]	*n*=1195 (57) [55, 59]	*n*=905 (43) [41, 45]	*n*=1325 (49) [47, 51]	*n*=1368 (51) [49, 53]
Age: year Mean (SD)	*n*=2373 28 (5.54)	*n*=1664 31.3(5.11)	*n*=1195 28 (5.50)	*n*=905 31.5 (5.13)	*n*=1315 27.5(5.47)	*n*=1364 31.2(5.06)
Gestation: completed wks. Mean (SD)	*n*=1495 39.7(1.07)	*n*=1093 39.8(1.06)	*n*=1195 39.8(1.09)	*n*=905 39.8 (1.10)	*n*=1258 39.8(1.05)	*n*=1354 39.8(1.01)
Induction of labour	*n*=2433 93 (3.8) [3.1, 4.7]	*n*=1697 77 (4.5) [3.6, 5.6]	*n*=1195 17 (1.4) [0.8, 2.3]	*n*=905 25 (2.8) [1.8, 4.1]	*n*=1325 7 (0.5) [0.2, 1.1]	*n*=1368 7 (0.5) [0.2, 1.0]
Previous CS	*n*=2433 0	*n*=1697 14 (0.8) [0.4, 1.4]	*n*=1195 0	*n*=905 6 (0.7) [0.2, 1.4]	*n*=1325 0	*n*=1368 5 (0.4) [0.1, 0.8]

*Parity missing for one community woman. *N*=sample size; *n*=number of women analysed for each variable – women with missing data excluded from analysis.

4.3.3 Intrapartum events and interventions

Irrespective of care setting, fewer multiparae had labour augmentation by ARM or IVI oxytocin than nulliparae (Table 4.3). Overall comparisons between care settings showed that significantly more labour augmentation occurred in OUs than in AMUs, or the community (p=<0.001), and significantly fewer women received labour augmentation in the community compared with those who planned to give birth in an AMU (p=<0.001). There was no significant difference in the overall epidural use between the OU and AMU setting, but significantly fewer women who planned to give birth in the community had an epidural compared to those in either the OU and AMU settings (p=<0.001) (Table 4.3).

Few women used non pharmacological pain relief overall; a total of 193 (3.8%) nulliparae and 142 (3.5%) multiparae did so before entering a birthing pool and 108 (2.2%) and 90 (1.8%) respectively, after using the birthing pool. Aromatherapy was the most frequently used non pharmacological form of pain relief: 138 (71.5%), nulliparae and 107 (75.3%) multiparae used aromatherapy pre entering and 79 (73.1%) and 68 (75.5%) respectively, after using the birthing pool.

Regardless of maternal parity, significantly fewer AMU women had an uninterrupted physiological third stage[24] than did women who planned to give birth in the OU or community setting, with the highest proportion occurring in the community (p=<0.001) (Table 4.3). Overall, significantly more OU women had active third stage management[25] than those in the community (p=<0.001). The OU, AMU difference was not significant (p=0.52). Mixed physiological[26] third stage management occurred most frequently in AMUs. Irrespective of maternal parity, women who used a birthing pool in an AMU spent significantly less time in the birth pool than those in either the OU or community (p=<0.001) (Table 4.3).

[24] Uninterrupted physiological third stage was defined as no oxytocic injection or umbilical cord clamping before delivery of the placenta by maternal effort.
[25] Active third stage includes oxytocic injection, umbilical cord clamped and cut, and controlled cord traction employed to deliver the placenta.
[26] Mixed physiological was defined as delayed cord clamping, no oxytocic injection pre delivery of the placenta by maternal effort.

Table 4.3: Intrapartum events and interventions for women who used a birthing pool by planned place of birth and parity

Binary: n (%)[CI 95%] Continuous: mean (SD)	Obstetric unit N=4,130 (46.2)		Alongside midwifery unit N=2,100 (23.5)		Community N=2,694 (30.1)	
	Nulliparae	Multiparae	Nulliparae	Multiparae	Nulliparae	Multiparae
Parity*	*n*=2433 (59) [57, 60]	*n*=1697 (41) [39, 43]	*n*=1195 (57) [55, 59]	*n*=905 (43) [41, 45]	*n*=1325 (49) [47, 51]	*n*=1368 (51) [49, 53]
Augmentation †ARM	*n*=2429 639 (26.3) [24.5,28.1]	*n*=1696 324 (19.1) [17.2,21.0]	*n*=1195 271 (22.7) [20.3,25.2]	*n*=904 111 (12.3) [10.2,14.6]	*n*=1317 149 (11.3) [9.6, 13.1]	*n*=1362 138 (10.1) [8.5, 11.8]
≠IVI oxytocin	*n*=2433 81 (3.3) [2.6, 4.1]	*n*=1697 9 (0.5) [0.2, 1.0]	*n*=1195 87 (7.3) [5.9, 8.9]	*n*=905 7 (0.8) [0.3, 1.6]	*n*=1325 62 (4.7) [3.6, 5.6]	*n*=1368 10 (0.7) [0.3, 1.3]
Epidural	*n*=2432 419 (17.2) [15.7,18.8]	*n*=1697 60 (3.5) [2.7, 4.5]	*n*=1195 205 (17.2) [15.1,19.4]	*n*=905 25 (2.8) [1.8, 4.0]	*n*=1322 100 (7.6) [6.2, 9.1]	*n*=1368 16 (1.2) [0.7, 1.9]
Shoulder dystocia	*n*=2433 18 (0.7) [0.4,1.1]	*n*=1697 21 (1.2) [0.7,1.8]	*n*=1195 8 (0.7) [0.2,1.3]	*n*=905 5 (0.6) [0.1,1.2]	*n*=1322 13 (0.98) [0.5,1.6]	*n*=1368 19 (1.4) [0.8,2.1]
Third stage management	*n*=2428	*n*=1696	*n*=1195	*n*=905	*n*=1319	*n*=1365
‡Physiological	340 (14.0) [12.6,15.4]	367 (21.6) [19.7,23.7]	43 (3.6) [2.6, 4.8]	69 (7.6) [5.9, 9.6]	388 (29.5) [27.0,32.0]	562 (41.1) [38.5,43.8]
≠Mixed physiological	224 (9.2) [8.1,10.4]	251 (14.8) [13.1,16.6]	261 (21.8) [19.5,24.3]	277 (30.6) [27.6,33.7]	73 (5.5) [4.3,6.9]	92 (6.7) [5.5,8.2]
§Active	1864 (76.7) [76.7,78.4]	1078 (63.6) [61.2,65.8]	891 (74.4) [71.9,76.9]	559 (61.8) [58.5,64.9]	655 (49.6) [46.9,52.4]	711 (52.1) [49.4,54.8]
Left pool before delivery	*n*=2426 1388 (57.2) [55.2,59.1]	*n*=1691 429 (25.3) [23.2,27.5]	*n*=1191 729 (61.2) [58.3,63.9]	*N*=905 257 (28.3) [25.4,31.4]	*n*=1317 624 (47.3) [44.6,50.1]	*n*=1365 276 (20.2) [18.1,22.4]
Pool time (mins.) mean (SD)	*n*=2133 158 (108.37)	*n*=1558 100 (75.93)	*n*=1163 145 (117.60)	*n*=885 86 (66.38)	*n*=1273 190 (143.12)	*n*=1343 102 (83.85)

*Parity missing for one community woman. *N*=sample size; *n*=number of women analysed for each variable – women with missing data excluded from analysis.
†ARM=artificial rupture of membranes. ≠IVI = intravenous infusion.
‡ Physiological third stage was defined as no oxytocic injection or cord clamping before delivery of the placenta by maternal effort. ≠Mixed physiological = cord clamped and cut pre placental delivery, no oxytocic injection. §Active = Active third stage = oxytocic injection, umbilical cord clamped and cut, and controlled cord traction employed to deliver the placenta.

4.3.3.1 Reasons why women left the birthing pool before delivery

Irrespective of parity and care setting, maternal choice and request for further analgesia were the main reasons why women left the birthing pool before delivery, followed by slow progress during the first or second stage of labour. However, compared with women in the OU and AMU settings, a markedly lower proportion of nulliparae and multiparae in the community left the birthing pool for further analgesia, and a notably higher proportion left it to mobilise (Table 4.4). Four OU nulliparae (0.4%) and three multiparae (0.7%) left the birthing pool because they had a premature urge to push, and three multiparae (two OU, and one Community) left because they had a previous PPH. A total of six women left the birthing pool because of an elevated blood pressure (three OU, one AMU, and one FMU). The presence of meconium stained liquor was the main fetal reason why women were asked to leave the birthing pool.

Table 4.4: Reasons why women left the birthing pool before delivery

Binary: n (%)[CI 95%] Continuous: mean (SD)	Obstetric unit N=4,130 (46.2)		Alongside midwifery unit N=2,100 (23.5)		Community N=2,694 (30.1)	
	Nulliparae	Multiparae	Nulliparae	Multiparae	Nulliparae	Multiparae
Parity*	*n*=2433 (59) [57, 60]	*n*=1697 (41) [39, 43]	*n*=1195 (57) [55, 59]	*n*=905 (43) [41, 45]	*n*=1325 (49) [47, 51]	*n*=1368 (51) [49, 53]
	n=1,284	*n*=429	*n*=723	*n*=253	*n*=624	*n*=276
Maternal						
Choice	308 (23.9) [21.7,26.4]	156 (36.3) [31.8,41.1]	178 (24.6) [21.5,27.9]	106 (41.8) [35.7,48.2]	175 (28.0) [24.5,31.7]	138 (50.0) [43.9,56.0]
More analgesia	432 (33.6) [31.0,36.3]	106 (24.7) [20.6,29.1]	185 (25.5) [22.4,28.9]	33 (13.0) [9.1, 17.8]	103 (16.5) [13.6,19.6]	28 (10.1) [6.8, 14.3]
Slow first stage of labour	106 (8.3) [6.8, 9.8]	45 (10.4) [7.7, 13.7]	141 (19.5) [16.7,22.6]	36 (14.2) [10.1,19.1]	128 (20.5) [17.4,23.9]	23 (8.3) [5.3, 12.2]
Slow second stage of labour	138 (10.7) [9.1, 12.5]	23 (5.4) [3.4, 7.9]	57 (7.8) [6.0, 10.1]	11 (4.3) [2.1, 7.6]	54 (8.6) [6.5, 11.1]	9 (3.3) [1.5, 6.1]
To mobilise	38 (2.9) [2.1, 4.0]	9 (2.1) [0.9, 3.9]	32 (4.4) [3.0, 6.2]	8 (3.1) [1.3, 6.1]	39 (6.3) [4.4, 8.4]	19 (6.8) [4.1, 10.5]
Pyrexia	13 (1.0) [0.5, 1.7]	6 (1.4) [0.5, 3.0]	3 (0.4) [0.1, 1.2]	1 (0.3) [0.1, 2.1]	7 (1.1) [0.4, 2.2]	1 (0.4) [0.0, 2.0]
Blood loss	6 (0.5) [0.1, 1.0]	2 (0.5) [0.5, 1.7]	4 (0.5) [0.1, 1.4]	2 (0.7) [0.9, 2.8]	2 (0.3) [0.3, 1.1]	3 (1.0) [0.2, 3.1]
Vaginal exam or to pass urine	55 (4.3) [3.2, 5.5]	11 (2.6) [1.2, 4.5]	38 (5.2) [3.7, 7.1]	17 (6.7) [3.9, 10.5]	45 (7.2) [5.3, 9.5]	8 (2.9) [1.2, 5.6]
Medic/midwife request	12 (0.9) [0.4, 1.6]	10 (2.3) [1.1, 4.2]	4 (0.5) [0.1, 1.4]	4 (1.6) [0.4, 3.9]	3 (0.5) [0.1, 1.3]	4 (1.4) [0.4, 3.7]
Fetal						
Fetal distress	35 (2.7) [1.9, 3.8]	10 (2.3) [1.1, 4.2]	16 (2.2) [1.2, 3.5]	4 (1.6) [0.4, 3.9]	12 (1.9) [0.9, 3.3]	13 (4.7) [2.5, 7.9]
Fetal bradycardia	31 (2.4) [1.6, 3.4]	17 (3.8) [2.3, 6.2]	36 (4.9) [3.5, 6.8]	11 (4.3) [2.1, 7.6]	5 (0.8) [0.2, 1.8]	4 (1.4) [0.4, 3.7]
Fetal tachycardia	15 (1.2) [0.6, 1.9]	2 (0.5) [0.5, 1.7]	6 (0.8) [0.3, 1.7]	1 (0.3) [0.1, 2.1]	7 (1.1) [0.4, 2.2]	2 (0.7) [0.1, 2.5]
Meconium stained liquor	75 (5.8) [4.6, 7.2]	18 (4.2) [2.5, 6.6]	19 (2.6) [1.5, 4.1]	10 (3.9) [1.9, 7.1]	37 (5.9) [4.2, 8.1]	16 (5.7) [3.3, 9.2]
Malposition/	9 (0.7) [0.3, 1.3]	6 (1.4) [0.5, 3.0]	1 (0.1) [0.0, 0.7]	2 (0.7) [0.9, 2.8]	4 (0.6) [0.2, 1.6]	0
Shoulder dystocia	5 (0.4) [0.2, 0.9]	2 (0.5) [0.5, 1.7]	2 (0.2) [0.3, 0.9]	7 (2.7) [1.1, 5.6]	2 (0.3) [0.3, 1.1]	7 (2.5) [1.0, 5.1]

*Parity missing for one community woman. *N*=sample size; *n*=number of women analysed for each variable – women with missing data excluded from analysis.

4.3.4 Maternal outcomes

4.3.4.1 Mode of delivery

Significantly more spontaneous vertex births (SVD) occurred in the community setting compared with either the AMU or OU (p<0.001), with no difference between AMU and OU (Table 4-5). Irrespective of parity, significantly more women who used a birthing pool in the community setting had a waterbirth compared with nulliparae and multiparae who did so in an OU or an AMU (p<0.001), with no difference between AMU and OU (p=0.12). Regardless of parity, the incidence of operative vaginal delivery and emergency CS were lowest for women who planned to give birth in the community (Table 4-5). Significantly fewer community nulliparae had an emergency Caesarean section compared with nulliparae in the OU or AMU setting (p<0.001).

Table 4-5: Mode of delivery by planned place of birth and parity

Binary: No. (%)[CI 95%] Continuous: mean (SD)	Obstetric unit N=4,130 (46.2)		Alongside midwifery unit N=2,100 (23.5)		Community N=2,694 (30.1)	
	Nulliparae	Multiparae	Nulliparae	Multiparae	Nulliparae	Multiparae
Parity*	*n*=2433 (59) [57, 60]	*n*=1697 (41) [39, 43]	*n*=1195 (57) [55, 59]	*n*=905 (43) [41, 45]	*n*=1325 (49) [47, 51]	*n*=1368 (51) [49, 53]
Mode of delivery	*n*=2426	*n*=1691	*n*=1191	*n*=905	*n*=1317	*n*=1365
¥SVD overall	1,923 (79.2) [77.5,80.8]	1,644 (97.2) [96.3,97.9]	942 (79) [76.6,81.3]	883 (97.5) [96.3,98.4]	1,172 (88.9) [87.1,90.6]	1,351 (98.9) [98.2,99,4]
Waterbirth	1,038 (53.9) [51.7,56.2]	1,262 (76.7) [74.6,78.7]	462 (49.0) [45.8,52.2]	648 (73.3) [70.3,76.2]	693 (59.1) [56.2,61.9]	1,089 (80.6) [78.3,82.6]
Land birth	885 (46.0) [43.7,48.2]	382 (23.2) [21.2,25.3]	480 (50.9) [47.7,54.1]	235 (26.6) [23.7,29.6]	479 (40.8) [38,43.7]	262 (19.3) [17.3,21.6]
Operative vaginal	331 (13.6) [12.3,15.0]	29 (1.7) [1.1,2.4]	176 (14.7) [12.8,16.9]	10 (1.1) [0.5,2.0]	101 (7.6) [6.2,9.2]	9 (0.6) [0.3,1.2]
Emergency CS	172 (7.1) [6.1, 8.2]	17 (1.0) [0.5, 1.6]	73 (6.1) [4.8, 7.6]	11 (.92) [0.6, 2.2]	42 (3.1) [2.3, 4.3]	5 (.36) [0.1, 0.8]

*Parity missing for one community woman. *N*=sample size; *n*=number analysed. N=sample size; *n*=number of women analysed for each variable – women with missing data excluded from analysis. ¥SVD = spontaneous vaginal birth. †MROP = manual removal of placenta. **PPH=Postpartum haemorrhage. ‡Minor PPH= 500-1,000ml estimated blood loss. §Major PPH=≥1,000 ml. estimated blood loss.

4.3.4.2 Perineal trauma

Few women overall sustained OASIS, and similar proportions had a first or second degree perineal tear (Table 4.6). A total of 10.4% (429) OU women had either a vaginal wall only tear (107, 2.6%), labial only (272, 6.6%), or a labial and vaginal wall tear (50, 1.2%). For AMU women, 88 (4.2%) had a vaginal wall tear, 125 (5.9% a labial, and 31 (1.5%) had a labial and vaginal wall tear only (total 11.6%). A slightly higher proportion of community had these tears (12.6%): 103, 3.8% vaginal wall only, 204, 7.6% labial only, and 34, 1.3% labial and vaginal wall.

4.3.4.3 Intact perineum

Irrespective of parity, significantly more community women had an intact perineum with no perineal trauma at all compared with the other care settings ($p<0.001$), with no difference between OU and AMU ($p=0.72$).

4.3.4.4 Episiotomy

Significantly fewer community nulliparae and multiparae had an episiotomy compared with nulliparae in either the AMU or OU setting ($p<0.001$).

4.3.4.5 Minor and major postpartum haemorrhage (PPH)

Overall, a small proportion of women had a minor or major PPH, and there were no significant differences between settings for major PPH (Table 4-5), and significantly fewer women who planned to give birth in the community had a minor PPH ($p<0.001$).

4.3.4.6 Normal Birth

Irrespective of parity, significantly more community women had a normal birth compared with AMU or OU nulliparae and multiparae ($p<0.001$).

Table 4.6: Perineal trauma, normal birth, PPH, MROP, and labour duration by planned place of birth and parity

Binary: No. (%)[CI 95%] Continuous: mean (SD)	Obstetric unit N=4,130 (46.2)		Alongside midwifery unit N=2,100 (23.5)		Community N=2,694 (30.1)	
	Nulliparae	Multiparae	Nulliparae	Multiparae	Nulliparae	Multiparae
Parity*	*n*=2433 (59) [57, 60]	*n*=1697 (41) [39, 43]	*n*=1195 (57) [55, 59]	*n*=905 (43) [41, 45]	*n*=1325 (49) [47, 51]	*n*=1368 (51) [49, 53]
Perineal trauma	*n*=2,430	*n*=1,697	*n*=1,195	*n*=905	*n*=1,321	*n*=1,365
1 degree	302 (12.4) [11.0,13.8]	367 (21.6) [19.6,23.6]	135 (11.2) [9.5,13.2]	199 (21.9) [19.3,24.8]	226 (17.1) [15.1,19.2]	310 (22.7) [20.5,25.0]
2 degree	814 (33.4) [31.6,35.4]	478 (28.1) [26,30.3]	385 (32.0) [29.5,34.9]	242 (26.6) [23.8,29.7]	424 (32.1) [29.5,34.6]	274 (20) [17.9,22.2]
OASIS 3 degree	74 (3.1) [2.3,3.8]	20 (1.2) [0.7,1.8]	50 (4.3) [3.1,5.4]	9 (1.0) [0.4, 1.8]	26 (1.9) [1.2,2.8]	6 (0.4) [0.1,0.9]
4 degree	1 (0.04)	0	0	0	0	0
Episiotomy	404 (16.6) [15.1,18.1]	45 (2.6) [1.9,3.5]	210 (17.5) [15.4,19.8]	13 (1.4) [0.7,2.4]	116 (8.7) [7.3,10.4]	15 (1.1) [0.6,1.8]
Intact perineum nil else	347 (14.3) [12.9,15.7]	616 (36.3) [34.0,38.6]	176 (14.7) [12.8,16.9]	352 (38.9) [35.7,42.2]	278 (21.0) [18.9,23.3]	619 (45.3) [42.7,48.0]
∞Normal birth	1276(52.6) [50.5,54.6]	1274(75.1) [73.2,77.4]	662 (55.4) [52.7,58.4]	743 (82.2) [79.4,84.5]	978 (74.4) [71.8,76.6]	1190(87.5) [85.3,88.9]
**PPH	*n*=2,394	*n*=1,694	*n*=1,195	*n*=905	*n*=1,274	*n*=1,347
‡Minor	365 (15.2) [13.8,16.7]	107 (6.3) [5.2,7.5]	175 (14.6) [12.6,16.7]	64 (7.0) [5.4,8.9]	130 (10.2) [8.5,11.9]	89 (6.6) [5.3,8]
§Major	31 (1.2) [0.8,1.8]	5 (0.2) [0.0,0.6]	15 (1.2) [0.7,2]	5 (0.5) [0.1,1.2]	10 (0.7) [0.3,1.4]	14 (1.0) [0.5,1.7]
†MROP n=8,923	*n*=2433 50 (2.1) [1.5,2.7]	*n*=1697 16 (1.0) [0.5,1.5]	*n*=1195 17 (1.4) [0.8,2.2]	*n*=905 14 (1.5) [0.8,2.5]	*n*=1325 25 (1.9) [1.2,2.7]	*n*=1368 15 (1.1) [0.6,1.8]
Labour duration (min) Mean (SD) n=8637	*n*=2298 574 (309.60)	*n*=1667 322 (200.87)	*n*=1149 562 (280.85)	*n*=897 309 (183.15)	*n*=1279 596 (317.18)	n=1346 329 (183.15)

*Parity missing for one community woman. *N*=sample size; *n*=number of women analysed for each variable – women with missing data excluded from analysis.
**PPH = postpartum haemorrhage. ‡Minor PPH= 500-1,000ml estimated blood loss. §Major PPH=≥1,000 ml. estimated blood loss

4.3.5 Maternal transfer to an obstetric unit

Very few women required transfer to an obstetric unit from either the community or an AMU for fetal concern (Table 4.7). Significantly fewer community nulliparae required transfer compared with nulliparae in AMUs ($p<0.001$), and there was no difference in the transfer rate for multiparae ($p=0.66$). Significantly more community women were transferred because of slow progress in the first stage of labour compared with AMU women ($p=0.05$). There were no significant differences in transfer for slow second stage or for perineal repair (Table 4.7)

Table 4.7: Maternal transfer to hospital by parity

Reasons for maternal transfer	Alongside midwifery unit N=2,100 (23.5)		Community N=2,694 (30.1)	
No. (%) [CI 95%]	Nulliparae	Multiparae	Nulliparae	Multiparae
Parity	*n*=1195 (57) [55, 59]	*n*=905 (43) [41, 45]	*n*=1325 (49) [47, 51]	*n*=1368 (51) [49, 53]
Transferred to hospital	370 (31) [28.3, 33.7]	53 (5.9) [4.4, 7.6]	265 (20) [17, 22.2]	57 (4.2) [3.2, 5.4]
Reasons for transfer	*n*=1,192	*n*=905	*n*=1,323	*n*=1,368
During labour				
More analgesia	65 (5.4) [4.2, 6.9]	9 (1.0) [0.4, 1.9]	18 (1.3) [0.8, .005]	2 (0.2) [0.0, 0.5]
Slow first stage of labour	101 (8.5) [6.9, 10.2]	13 (1.4) [0.8, 2.4]	96 (7.2) [5.9, 8.8]	13 (1.0) [0.5, 1.6]
Slow second stage of labour	105 (8.8) [7.3, 10.6]	5 (0.6) [0.2, 1.3]	74 (5.5) [4.4, 7.0]	9 (0.7) [0.3, 1.2]
Retained placenta	9 (0.8) [0.3, 1.4]	8 (0.8) [0.4, 1.7]	17 (1.3) [0.7, 2.0]	15 (1.1) [0.6, 1.8]
†Miscellaneous	3 (0.3) [0.0, 0.7]	3 (0.3) [0.3, 1.0]	8 (0.6) [0.2, 1.1]	0
Fetal concern	47 (3.9) [2.9, 5.2]	7 (0.8) [0.0, 1.6]	23 (1.7) [1.1, 2.6]	3 (0.2) [0.0, 0.6]
Postnatal				
Postpartum haemorrhage	7 (0.6) [0.2, 1.2]	3 (0.3) [0.0, 1.0]	3 (0.2) [0.0, 0.7]	9 (0.7) [0.3, 1.2]
For suturing	26 (2.2) [1.4, 3.2]	5 (0.6) [0.2, 1.3]	18 (1.3) [0.8, 2.1]	4 (0.3) [0.1, 0.7]
Neonatal	4 (0.3) [0.1, 0.8]	0	5 (0.4) [0.2, 1.0]	2 (0.1) [0.2, 0.9]

*Parity missing for one community woman. †Miscellaneous included raised blood pressure, pyrexia, prolonged rupture of membranes, malpresentation, Group B Streptococcal infection.
N=sample size; *n*=number of women analysed for each variable – women with missing data excluded from analysis

4.3.6 Newborn outcomes

Neonatal outcomes were similar across care settings Overall, few newborn had a low Apgar score at 5 or 10 minutes, and few required resuscitation at birth (Table 4.8).

Similar proportions of women in each care setting had a baby that weighed 4,000 grammes or more, and more multiparae than nulliparae had a large baby (Table 4.8).

A total of 143 (1.6%) babies were admitted to a neonatal intensive care unit (NICU) with an average length stay of 2.5 days (SD 0.8); 110 (1.2%) babies required resuscitation, and 66 (0.73%) developed respiratory difficulties. There were 20 (0.22%) umbilical cord snaps, 18 (90%) of which occurred during water birth. Three babies with cord snap were admitted to a neonatal intensive care unit, and one required a blood transfusion. All were discharged home without further problems. Thirty-five (0.39%) newborn had pyrexia, as defined by the unit, or suspected infection, none of which resulted in a positive culture.

Seventeen (0.19%) were readmitted to hospital, for breastfeeding support, or phototherapy for jaundice.

One stillbirth occurred following alongside midwifery unit transfer to hospital, and one in the community (freestanding midwifery unit). One obstetric unit neonatal death occurred four days following a spontaneous birth on land. No post-mortem was performed. The other neonatal death (freestanding midwifery unit) occurred two hours following an operative vaginal delivery in hospital.

Table 4.8: Newborn outcomes by planned place of birth and parity

Binary: No. (%)[CI 95%] Continuous: mean (SD)	Obstetric unit N=4,130 (46.2)		Alongside midwifery unit N=2,100 (23.5)		Community N=2,694 (30.1)	
	Nulliparae	Multiparae	Nulliparae	Multiparae	Nulliparae	Multiparae
Parity*	*n*=2433 (59) [57, 60]	*n*=1697 (41) [39, 43]	*n*=1195 (57) [55, 59]	*n*=905 (43) [41, 45]	*n*=1325 (49) [47, 51]	*n*=1368 (51) [49, 53]
Apgar 7 or < at 5 min	*n*=2,423 31(1.2) [0.8,1.8]	*n*=1,693 18 (1.1) [0.6,1.6]	*n*=1,195 21(1.7) [1,2.6]	*n*=905 8 (0.9) [0.3,1.7]	*n*=1,316 18 (1.3) [0.8,2.1]	*n*=1,362 17 (1.2) [0.7,1.9]
Apgar 7 or < at 10 min	*n*=2,430 10 (0.4) [0.1,0.7]	*n*=1,696 4 (0.2) [0.1,0.6]	*n*=1,194 2 (0.1) [0.0,0.6]	*n*=9,052 (0.2) [0.0,0.7]	*n*=1,323 9 (0.6) [0.3,1.2]	*n*=1,367 2 (0.1) [0.0,0.5]
Birthweight (g) mean (SD)	*n*=2,428 3,472 (412.9)	*n*=1,693 3,647 (443.3)	*n*=1,195 3,459 (411.8)	*n*=905 3,604 (434.7)	*n*=1,311 3,447 (438.6)	*n*=1,358 3,633 (452.0)
Birthweight ≥4,000 grammes (large baby)	261 (10.7) [9.5, 12.0]	370 (21.8) [19.8, 23.8]	116 (9.7) [8.1, 11.5]	166 (18.3) [15.8,21.0]	131 (9.8) [8.3, 11.6]	289 (21.1) [19.0, 23.4]
Resuscitation required	*n*=2433 37 (1.5) [1,2]	*n*=1697 22 (1.2) [0.8,1.9]	*n*=1195 13 (1.08) [0.5,1.8]	*n*=905 4 (0.4) [0.1,1.1]	*n*=1325 21 (1.5) [0.9,2.4]	*n*=1368 13 (0.9) [0.5,1.6]
†TTN requiring support	*n*=2433 20 (0.8) [0.5,1.2]	*n*=1697 7 (0.4) [0.1,0.8]	*n*=1195 16 (1.3) [0.7,2.1]	*n*=905 3 (0.3) [0.1,0.9]	*n*=1325 12 (0.9) [0.4,1.5]	*n*=1368 8 (0.5) [0.2,1.1]
Umbilical cord snap	*n*=2433 2 (0.08) [0.0,0.2]	*n*=1697 4 (0.2) [0.0,0.6]	*n*=1195 3 (0.3) [0.0,0.7]	*n*=905 2 (0.2) [0.0,0.7]	*n*=1325 6 (0.4) [0.1,0.9]	*n*=1368 3 (0.2) [0.0,0.6]
Pyrexia/infection	*n*=2433 10 (0.4) [0.1,0.7]	*n*=1697 4 (0.2) [0.0,0.6]	*n*=1195 5 (0.4) [0.1,0.9]	*n*=905 4 (0.4) [0.1,1.1]	*n*=1325 10 (0.7) [0.3,1.3]	*n*=1368 2 (0.1) [0.0,0.7]
Jaundice requiring treatment	*n*=2433 9 (0.36) [0.1,0.7]	*n*=1697 3 (0.17) [0.0,0.5]	*n*=1195 9 (0.7) [0.3,1.4]	*n*=905 1 (0.1)	*n*=1325 2 (0.15) [0.0,0.5]	*n*=1368 0
NICU admission	*n*=2433 47 (1.9) [1.4,2.5]	*n*=1697 13 (0.7) [0.4,1.3]	*n*=1195 33 (2.7) [1.9,3.8]	*n*=905 6 (0.6) [0.2,1.4]	*n*=1,324 30 (2.2) [1.5,3.2]	*n*=1368 14 (1.0) [0.5,1.7]
Time in NICU (days) mean (SD)	*n*=2,405 2.61(.737)	*n*=1,691 2.67(.516)	*n*=1,169 2.15(.881)	*n*=905 2.33(.816)	*n*=1,309 2.76(.752)	*n*=1,362 2.50(.548)

*Parity missing for one community woman. NICU = neonatal intensive care unit. N=sample size; *n*=number of women analysed for each variable – women with missing data excluded from analysis. †TTN (transient tachypnoea of the newborn) = incomplete lung aeration requiring an episode of oxygen therapy

4.3.7 Subgroup comparisons for women who had a spontaneous labour onset by care setting and by parity

4.3.7.1 Epidural and labour augmentation

Significantly fewer community nulliparae had an epidural compared with AMU and OU nulliparae (p<0.001) (Table 4.9). There was no difference between OU and AMU for epidural analgesia (p=0.95). Nulliparae who planned to give birth in the community were also significantly less likely to have an artificial rupture of the membranes (ARM) than AMU or OU nulliparae (p<0.001). Conversely, significantly fewer nulliparae who planned to give birth in an OU received an intravenous infusion of IVI oxytocin to augment their labour compared to AMU nulliparae (p<0.001), and there was no significant difference between OU and community (p=0.06).

Overall, few multiparae who had a spontaneous labour onset had an epidural, but for those who did, there were significantly fewer community multiparae compared to those who planned to give birth in an AMU or OU (p=0.01). There was no difference between OU and AMU (p=0.14) (Table 4.9).

4.3.7.2 Mode of delivery and episiotomy

Significantly more community nulliparae had a spontaneous birth (SVD) than AMU, or OU nulliparae (p<0.001). There was no difference between OU and AMU (p=0.58). AMU and OU nulliparae were significantly more likely to have either an operative vaginal delivery or an emergency CS than community nulliparae (p<0.001) There was no difference between OU and AMU for operative vaginal or emergency CS (p=0.24). Significantly fewer community nulliparae who had an SVD had an episiotomy compared to AMU and OU nulliparae (p<0.001). There was no difference between OU and AMU (p=0.09) (Table 4.9).

The majority of multiparae had an SVD across all settings, although significantly more community multiparae did so, compared with those in the OU setting (p<0.001) (Table 4.9). There was no difference between AMU and community or OU and AMU multiparae for operative vaginal delivery (p=0.94 and p=0.36 respectively). There was no significant difference between care settings for emergency CS for multiparae.

Although few multiparae who a spontaneous birth had an episiotomy, significantly fewer in the community did so, compared to multiparae in the OU (p<0.001). Again, there was no difference between OU and AMU multiparae for episiotomy (p=0.09).

Table 4.9: Interventions and outcomes for the subgroup of women who had a spontaneous labour onset by parity and planned place of birth

Binary: No. (%)[CI 95%] Continuous: mean (SD)	Obstetric unit N=3,960		Alongside midwifery unit N=2,058		Community N=2,679	
Parity	Nulliparae *n*=2340 (59.0) [57.5, 60.6]	Multiparae *n*=1620 (40.9) [39.3, 42.4]	Nulliparae *n*=1178 (57.2) [55.0,59.3]	Multiparae *n*=880 (42.7) [40.6,44.9]	Nulliparae *n*=1318 (49.1) [47.2, 51.1]	Multiparae *n*=1361 (50.8) [48.8, 52.7]
Epidural	n=2339 397 (17.0) [15.4, 18.6]	n=1608 58 (3.6) [2.7, 4.6]	n=1178 201 (17.1) [14.9,19.3]	n=874 22 (2.5) [1.5, 3.7]	n=1315 99 (7.5) [6.1, 9.0]	n=1356 15 (1.1) [0.6, 1.8]
Augmented labour						
ARM	*n*=2336 596 (25.5) [23.7, 27.3]	*n*=1608 269 (16.7) [14.9, 18.6]	*n*=1178 262 (22.2) [19.8,24.7]	*n*=874 102 (11.7) [9.6, 13.9]	*n*=1315 146 (11.1) [9.4, 12.9]	*n*=1350 132 (9.8) [8.2, 11.4]
IVI oxytocin	*n*=2340 78 (3.3) [2.6, 4.1]	*n*=1620 9 (0.6) [0.2, 1.0]	87 (7.4) [5.9, 9.0]	6 (0.7) [0.2, 1.5]	60 (4.6) [3.4, 5.8]	10 (0.7) [0.3, 1.3]
Type of delivery	n=2333	n=1597	n=1174	n=879	n=1311	n=1352
*Spontaneous	1868(79.8) [78.3, 81.7]	1561(97.7) [96.8, 98.4]	931 (79.3) [76.8,81.5]	855 (97.2) [95.9,98.2]	1165 (88.8) [87.0, 90.5]	1341(99.1) [98.5, 99.5]
Operative vaginal	308 (13.2) [11.8, 14.6]	28 (1.7) [1.1, 2.5]	172 (14.6) [12.6,16.8]	11 (1.3) [0.6, 2.2]	103 (7.8) [6.4, 9.4]	8 (0.6) [0.2, 1.1]
Emergency CS	157 (6.7) [5.7, 7.8]	8 (0.9) [0.2, 0.9]	71 (6.0) [4.7, 7.6]	13 (0.8) [0.7, 2.5]	43 (3.3) [2.3, 4.3]	3 (0.3) [0.1, 0.6]
Episiotomy (Spontaneous vaginal birth only)	n=1865 178 (9.5) [8.1, 10.8]	n=1571 33 (2.1) [1.4, 2.9]	n=931 71 (7.6) [6.0, 9.5]	n=859 10 (1.2) [0.5, 2.1]	n=1162 48 (4.1) [3.0, 5.4]	n=1341 8 (0.6) [0.2, 1.2]

*Spontaneous vaginal birth = spontaneous vertex birth on land or in water and spontaneous breech birth on land or in water. N=sample size; *n*=number of women analysed for each variable – women with missing data excluded from analysis.

Results for newborn outcomes for the subgroup of women who did not have an induction of labour showed similar low proportions for low Apgar score assessment at five minutes, resuscitation, TTN, and NICU admission between care settings. As with the overall sample (Table 4.8), a higher proportion of multiparae than nulliparae had a large baby (Table 4.10).

Table 4.10: Newborn outcomes for the subgroup of women who had a spontaneous labour only by parity and by planned place of birth

Binary: No. (%)[CI 95%] Continuous: mean (SD)	Obstetric unit N=3,960		Alongside midwifery unit N=2,058		Community N=2,679	
Parity*	Nulliparae n=2340 (59.0) [57.5, 60.6]	Multiparae n=1620 (40.90) [39.3, 42.4]	Nulliparae n=1178 (57.2) [55.0,59.]	Multiparae n=880 (42.7) [40.6, 44.9]	Nulliparae n=1318 (49.1) [47.2,51.1]	Multiparae n=1361 (50.8) [48.8, 52.7]
Apgar ≤7 at 5 min	n=2331 29 (1.2) [0.8, 1.8]	n=1616 18 (1.1) [0.6, 1.7]	21 (1.8) [1.1, 2.7]	8 (0.9) [0.3, 1.7]	n=1309 18 (1.4) [0.8, 2.1]	n=1357 17 (1.3) [0.7, 1.9]
Birthweight	n=2335 3463 (408.9)	n=2616 3639 (441.1)	3458 (411.7)	3599 (431.8)	n=1304 3447 (438.7)	n=1351 3631 (451.0)
Birthweight ≥4,000 gr (large baby)	221 (9.4) [8.3, 10.7]	327 (12.5) [18.3, 22.2]	109 (9.2) [7.6, 11.0]	152 (17.2) [14.8, 19.9]	128 (9.8) [8.2, 11.6]	271 (20.0) [17.9, 22, 2.]
Resuscitation required	36 (1.5) [1.0, 2.1]	21 (1.3) [0.8, 1.9]	13 (1.1) [0.5, 1.9]	4 (0.5) [0.1, 1.2]	21 (1.6) [0.9, 2.4]	13 (1.0) [0.5, 1.6]
Transient tachypnoea of the newborn	20 (0.9) [0.5, 1.3]	7 (0.4) [0.1, 0.9]	16 (1.4) [0.8, 2.2]	3 (0.3) [0.1, 0.9]	12 (0.9) [0.5, 1.6]	8 (0.6) [0.2, 1.1]
NICU admission	46 (2.0) [1.4, 2.6]	13 (0.8) [0.4, 1.4]	33 (2.8) [1.9, 3.9]	6 (0.7) [0.2, 1.5]	30 (2.3) [1.5, 3.2]	14 (1.0) [0.5, 1.7]

* Parity missing for one community woman. N=sample size; *n*=number of women analysed for each variable – women with missing data excluded from analysis.

4.3.8 Exploring hypotheses

1) Is waterbirth associated with having a *normal birth* for nulliparae and multiparae?

A very high proportion of nulliparae who had a waterbirth had a *normal birth* (1882/2190, 85.9%), and significantly more did so compared with nulliparae who gave birth on land (1034/2747, 37.6%): p = <0.001; RR 2.3 [95% CI 2.2, 2.4].

A very high proportion of multiparae who had a waterbirth had a *normal birth* (2623/2994, 87.6%), and significantly more did so compared with multiparae who gave birth on land (584/966, 60.5%): p = <0.001; RR 1.4 [95% CI 1.4, 1.5].

2) Is there an association between the cervical dilatation at which nulliparae and multiparae enter a birthing pool and requirement for labour augmentation by means of IVI oxytocin?

Labour augmentation was required for 6.2% (49/785) nulliparae who had a cervical dilatation of less than four centimetres at birthing pool entry, compared with 4.5% (160/3518) who entered the pool when their cervix was four or more centimetres dilated. The difference was statistically significant: *p*= 0.05; RR 1.4 [95% CI 1.0, 1.9].

Labour augmentation was required for 1% (4/405) multiparae who had a cervical dilatation of less than four centimetres at birthing pool entry, compared with 0.6% (17/2682) who entered the pool when their cervix was four or more centimetres dilated. The difference was not statistically significant: *p*= 0.42; RR 0.6 [95% CI 0.2, 1.9].

3) Is there an association between hands off delivery technique[27] and OASIS for nulliparae and multiparae who have a waterbirth?

Of the 1866 nulliparae who had hands off delivery for waterbirth, 2.7% (51) sustained OASIS compared with 1.4% (4/287) who had hands on delivery technique. The difference was not statistically significant: *p*=0.19; RR 1.9 [95% CI 0.7, 5.4].

Of the 2531 multiparae who had hands off delivery for waterbirth, 0.7% (18) sustained OASIS compared with 0.9% (4/447) who had hands on delivery technique. The difference was not statistically significant: *p*=0.67; RR 0.8 [95% CI 0.3, 2.3].

4) Is there an association between giving birth to a baby weighing ≥4,000 grammes (large Baby) in water and OASIS?

Of the 187/2186 (8.5%) nulliparae who had a waterbirth and a large baby, 4.3% (8) incurred OASIS compared with 2.4% (47/1999) who did not have a large baby and had OASIS. The difference was not statistically significant: *p*=0.11; RR 1.8 [95% CI 0.9, 3.8].

[27] Hands off delivery technique meant that the midwife did not touch the fetal head or perineum during the delivery.

5) Is there an association between third stage management and PPH for nulliparae and multiparae who have a waterbirth?

Active third stage and minor PPH

For nulliparae who had a waterbirth and a minor PPH, 9.8% (98/1002) had an active third stage compared with 9.6% (111/1162) who did not have an active third stage. There was no significant difference: *p*=0.9; RR 1.0 [95% CI 0.8, 1.3].

For multiparae who had a waterbirth and a minor PPH, 7.1% (98/1388) had an active third stage compared with 5.7% (91/1594) who did not have an active third stage. There was no significant difference: *p*=0.13; RR 1.2 [95% CI 0.9, 1.6].

Active third stage and major PPH

For nulliparae who had a waterbirth and a major PPH, significantly more had an active third stage compared with those who did not have an active third stage 1.3% (13/1002) versus 0.3% (3/1162): *p*=0.01, RR 5.0 [95% CI 1.4, 17.0].

For multiparae who had a waterbirth and a major PPH, 0.7% (10/1388) had an active third stage compared with 0.3% (5/1594) who did not have an active third stage. The difference was not statistically significant: *p*=0.13; RR 2.3 [95% CI 0.8, 6.7].

Physiological third stage[28] and minor PPH

For nulliparae who had a waterbirth and a minor PPH, 9.9% (59/596) had a physiological third stage compared with 9.6% (150/1596) who did not have a physiological third stage. There was no significant difference: *p*=0.82; RR 1.0 [95% CI 0.8, 1.4].

For multiparae who had a waterbirth and a minor PPH, 6.6% (60/905) had a physiological third stage compared with 6.2% (128/2076) who did not have a physiological third stage. There was no significant difference: *p*=0.63; RR 1.1 [95% CI 0.8, 1.5].

[28] Physiological third stage was defined as no oxytocic injection or umbilical cord clamping before the placenta was delivered by maternal effort

Physiological third stage and major PPH

For nulliparae who had a waterbirth and a physiological third stage, 0.2% (1/596) had a major PPH compared with 1.0% (15/1567) who did not have a physiological third stage. There was no significant difference: *p*=0.09; RR 0.2 [95% CI 0.02, 1.3].

For multiparae who had a waterbirth and a major PPH, 0.5% (11/2076) had a physiological third stage compared with 0.4% (4/905) who did not have a physiological third stage. There was no significant difference: *p*=0.76; RR 10.8 [95% CI 0.3, 2.6].

6) Is there an association between transient tachypnoea of the newborn (TTN) and waterbirth?

For women who had a waterbirth, 0.6% (31) of their newborn had TTN compared with 0.9% (35) newborn who had TTN following a land birth. The difference was not significant: *p*=0.07; RR 0.6 [95% CI 0.4, 1.0].

4.4 DISCUSSION

4.4.1 Key results

4.4.1.1 Maternal

This study found that a high overall proportion of nulliparae (59.1%) and multiparae (81.0%) who used a birthing pool during labour had a *normal birth*. For the subgroup of nulliparae and multiparae who had a waterbirth, the overall *normal birth* rate rose to 85.9% and 87.6% respectively. More community nulliparae had a *normal birth*, and the difference was 19% between community and AMU nulliparae, and 21.8% between community and OU nulliparae. More multiparae who planned to give birth in the community also had a *normal birth*, and the difference was 5.3% between community and AMU multiparae, and 12.4% between community and OU multiparae. The Birthplace study found similar differences for the incidence of *normal birth* between settings; for the subgroup of women with no risk factors at the onset of labour, 62.2%, of those who planned to give birth in an OU, 77.1% in an AMU, 84.1% in an FMU and 89.0% at home had a *normal birth (Birthplace in England Collaborative Group, 2011a)*. It is useful to have results for this important outcome from another prospective study that examined intrapartum interventions and outcomes by planned place of birth.

A low proportion of nulliparae and multiparae had an emergency CS, and similar to overall Birthplace results between care settings for this outcome (Birthplace in England Collaborative Group, 2011a, Burns *et al.*, 2012).

Few nulliparae and multiparae who used a birthing pool had labour augmentation using intravenous infusion of oxytocin overall, and hypothesis testing found no significant association between the cervical dilatation at which multiparae entered the birthing pool and augmentation. Although, significantly more nulliparae who used the birthing pool when their cervix was less than four centimetres received augmentation, the significance of this association was not strong. The proportions of birthing pool women who required IVI augmentation were markedly lower than overall results for the Birthplace study, particularly for the OU setting (birthing pool nulliparae 3.3%, multiparae 0.5% versus Birthplace overall 23.5%) (Birthplace in England Collaborative Group, 2011a, Burns *et al.*,

2012). Differences between the two studies were similar for epidural analgesia: birthing pool planned OU, nulliparae 17.2%, multiparae 3.5% versus Birthplace overall 30.7%; community nulliparae 7.6%, multiparae 1.2% versus Birthplace FMU overall 10.6%, home 8.3% (Birthplace in England Collaborative Group, 2011a, Burns *et al.*, 2012).

Few women in either the birthing pool or Birthplace study sustained OASIS, and only one woman in the birthing pool sample had a fourth degree perineal tear[29] (Birthplace in England Collaborative Group, 2011a, Burns *et al.*, 2012). Exploring hypotheses for nulliparae and multiparae who had a waterbirth found no association between adopting hands off delivery technique and OASIS. Despite evidence from two RCTs which were evaluated in a systematic review showing no association between hands off delivery technique and OASIS (Aasheim *et al.*, 2011)as mentioned in Chapter two, practitioners have expressed concern regarding hands off delivery technique for spontaneous vaginal birth (SVD). The birthing pool study was the first to collect data for hands off delivery technique for waterbirth. Interestingly, exploring the relationship between giving birth to a large baby in water versus on land and OASIS found no difference for nulliparae, but showed that multiparae who gave birth to a large baby were significantly more likely to sustain OASIS. This could be a chance finding, and is in contrast to evidence suggesting that whether or not they have a large baby, nulliparae are at greater risk of OASIS than multiparae (Christianson *et al.*, 2003, de Leeuw *et al.*, 2001, Ekeus *et al.*, 2008, Laine *et al.*, 2012, Smith *et al.*, 2013). Data were not collected for previous perineal trauma for multiparae, and it is possible that some may have had an episiotomy and/or OASIS before, which would have predisposed them to suffering OASIS.

It is important to highlight that research into what may cause women to have OASIS in childbirth lacks information on contextual aspects of care provision that may have influenced findings. For example, there is evidence that the style of pushing that midwives engage women in, namely directed (closed glottis, also known as Valsalva manoeuvre involves directing the woman to take a deep breath and to push whilst holding it for as long as she can during a uterine contraction, repeating the process two to three times throughout the contraction's duration) versus supportive (open glottis, which involves

[29] Fourth degree perineal tear is trauma that involves a total rupture of the anal sphincter with extension in the rectal epithelium (included in OASIS definition).

encouraging and supporting the woman to push as and when she has the urge to push during the second stage), maternal mobility during the second stage of labour, and maternal and fetal birth position can influence mode of delivery, perineal outcome, postpartum maternal pain, and postpartum pelvic floor function (Albers and Borders, 2007, Bloom *et al.*, 2006, Caldeyro-Barcia *et al.*, 1981, Coppen R, 2005, Gupta *et al.*, 2012, Hastings-Tolsma *et al.*, 2007, Roberts and Hanson, 2007, Schaffer *et al.*, 2005, Senecal *et al.*, 2005, Soong and Barnes, 2005). Although I collected data for maternal birth position, I did not ask participating centres for style of pushing information. Data for the birth position for waterbirth nulliparae who had OASIS were available for 47/54 cases: the highest proportions were 21 (44.6%) for semi-recumbent, and 16 (34.0%) for kneeling forwards or on all fours. For waterbirth multiparae who had OASIS, the birth position was semi-recumbent for 3 (17.6%) and 9 (34.0%) for kneeling forward or on all fours. A UK survey of midwives to gauge the use of different birth positions showed that semi-recumbent (also known as the bed position) was the most commonly used position (Royal College of Midwives, 2010). There is research to indicate that the all fours position (Soong and Barnes, 2005), and left or right lateral (Albers and Borders, 2007) may reduce perineal trauma, whilst sitting on a birth stool and lithotomy position may increase perineal trauma, including OASIS (Dahlen *et al.*, 2012a, Hastings-Tolsma *et al.*, 2007). This was the first birthing pool study to report maternal birth position for waterbirth. However, two recent publications would suggest that data for maternal birth position at waterbirth may not be collected or that birth position was somehow not relevant to waterbirth. One of these was a survey that examined maternal birth positions in relation to prevalence of use (Royal College of Midwives, 2010), and the other was a retrospective cohort study that investigated birth positions and perineal outcomes (Dahlen *et al.*, 2007); both simply stated 'waterbirth' among birth positions. More studies that collect a comprehensive range of data variables are required to advance our understanding about factors relating to the occurrence and type of perineal trauma in childbirth in general, as well as in relation to waterbirth.

Similar low proportions had an episiotomy across all care settings in the birthing pool and Birthplace studies, with the community, FMU and home as the settings where fewest episiotomies were performed (Birthplace in England Collaborative Group, 2011a, Burns *et al.*, 2012, Smith *et al.*, 2013).

Very few women had a major[30] PPH, and overall proportions for OU and FMU planned place of birth were similar to those reported for a Danish observational study that compared intrapartum interventions and outcomes for women who planned to give birth in an FMU versus an OU (Burns *et al.*, 2012, Overgaard *et al.*, 2011). The low overall occurrence of minor and major PPH is interesting and encouraging, given the context of a higher use of physiological third stage compared with active management for nulliparae and multiparae who used a birthing pool in the community setting (Table 4.3). It also corroborates the findings of other studies involving healthy women that compared third stage management to the incidence of PPH and found a higher incidence of major PPH in the OU setting where the third stage was more often actively managed than in the home setting where more women experienced a physiological their stage (Davis *et al.*, 2012, Fahy *et al.*, 2010). A further recent population study of over 500,000 women found that women who planned to give birth at home were less likely to have a PPH (Nove *et al.*, 2012).

Subgroup analysis of data from the Birthplace study for maternal transfer to an OU, which reported results by parity showed that strikingly more Birthplace nulliparae (40.4%) and multiparae (13.1%) who planned to give birth in an AMU were transferred compared with birthing pool nulliparae and multiparae (Table 4.7). Likewise, there were notably more Birthplace FMU to OU transfers; nulliparae 36.4%, multiparae 9.0% compared with birthing pool women in the community setting (Table 4.7) (Birthplace in England Collaborative Group, 2011a, Burns *et al.*, 2012, Dodwell, 2010, Rowe *et al.*, 2012). The Danish study (N=1,678 women) reported a similar transfer rate for nulliparae and multiparae to the Birthplace study (Overgaard *et al.*, 2011).

4.4.1.2 Newborn

There were few overall adverse events newborn, and these were similar between care settings (Burns *et al.*, 2012). Hypothesis testing showed no difference for the incidence of TTN between newborn following waterbirth compared with newborn following land birth. Significantly fewer (42%) waterbirth newborn were admitted to NICU compared with land birth newborn. These are reassuring results for waterbirth practitioners and women. A small number of newborn had umbilical cord snap, and almost all these cases occurred

[30] Major PPH is an estimated blood loss of 1,000 millilitres or more.

during waterbirth (Burns *et al.*, 2012); an outcome previously reported in relation to waterbirth (Cro S and Preston, 2002, Gilbert and Tookey, 1999, Pinette *et al.*, 2004).

4.4.2 Representativeness of the study population and care settings for intrapartum birthing pool use in the UK

Maternal characteristics for women who used a birthing pool indicated that they were healthy and at low risk of childbirth complication, as per UK recommendations for birthing pool eligibility, which did not alter over the study's time period (Royal College of Obstetricians and Gynaecologists and Royal College of Midwives, 2006). The low overall proportions of adverse maternal and newborn outcomes were also as one would expect for healthy women in childbirth. The geographical spread, together with the range and size of participating care settings, indicated that the study comprised a representative national sample (Healthcare Commission, 2008).

4.4.3 Differences between care settings

In contrast to the leitmotif of similar findings for the OU and AMU settings, and between all settings for multiparae, results for nulliparae who used a birthing pool during labour in the community setting consistently differed from those for nulliparae who planned to give birth in either an OU or AMU, and significantly so for virtually all intrapartum events, interventions and maternal outcomes (Table 4-5). This trend did not alter for subgroup analyses for nulliparae and multiparae who had a spontaneous labour onset, and removing induction of labour as a potential confounder. In contrast, the Birthplace study stated that intrapartum interventions were 'substantially' fewer for *all* women who planned to give birth outside the OU setting (Birthplace in England Collaborative Group, 2011b).

It is conceivable that evidence showing that compared to an OU, healthy women who labour in an AMU setting have fewer intrapartum interventions, an increased likelihood of having an SVD, and greater satisfaction with their childbirth experience (Hodnett *et al.*, 2012), may be sending a subliminal message to midwives and obstetricians, and the general childbearing population that, apart from geographic location in relation to the OU, there is little difference between the AMU and FMU. Indeed, nulliparae may feel that the close AMU, OU proximity confers greater safety in the event of a problem developing

during labour. This factor may have influenced more nulliparae to choose to give birth in an AMU than in the community setting in both the birthing pool and Birthplace studies (Birthplace in England Collaborative Group, 2011a, Burns *et al.*, 2012).

Organisational and philosophical differences may also have influenced the contrasting AMU and community results for nulliparae. Ostensibly, midwives working in these settings have a shared philosophy and commitment to working with women offering one to one support and continuity of care, to optimise their potential to labour and give birth with minimal intervention. However, the influence of the care culture in the OU environment inevitably permeates more easily to the AMU than to the community setting. In order to be able to confidently and effectively facilitate and empower women during labour, midwives need time to develop an empathetic rapport with them and to be emotionally present (Kennedy and Shannon, 2004, Kennedy *et al.*, 2010, Nettleton, 2006, Walsh and Devane, 2012). It is less difficult to establish that level of connection with a woman during labour if you have cared for her in the antenatal period, which is atypical for the majority of midwives working in the AMU environment.

AMU based midwives may be called to help provide cover on OUs when they are very busy, so they have less control over their work; a feature that can be disabling and demotivating (Kirkham *et al.*, 2006). When midwives are shared between an AMU and OU, their threshold for intervention, especially when caring for nulliparae, may be lower than their community colleagues based in an FMU or a woman's home, as the prevailing medical model in OUs, wherein the clock assumes a primary importance, can affect their practice. Although mere conjecture on my part, this could explain the 11% difference between AMU and community nulliparae transfer (Table 4.7). A meta-synthesis of midwifery led care questioned the feasibility of midwifery led care being possible in an OU setting (Walsh and Devane, 2012).

Conversely, an RCT from Australia that compared intrapartum interventions and outcomes for healthy women (N=2,314) who received care from midwives operating a caseload model versus standard shared care model in an OU setting found that significantly fewer caseload women had epidural analgesia (p=0.004), an emergency CS (19.4% versus 24.9%, RR 0.78, 95% CI 0.67-0.91, p=<0.001), an episiotomy (23.1% versus 29.4%, RR 0.79, 95%

CI 0.67-0.92, p=0.003) and significantly fewer newborn were admitted to NICU (4.0% versus 6.4%, RR 0.63, 95% CI 0.44-0.90) (McLachlan *et al.*, 2012). Post hoc (not pre-specified in trial protocol) subgroup analysis by parity showed a stark difference between groups for emergency CS for nulliparae: caseload 21.6% versus 28.6% (p=0.001), and a 10% difference for spontaneous birth (p=<0.001) (McLachlan *et al.*, 2012). This trial, which included more than 70% nulliparae, indicates that it is possible to reduce interventions and improve outcomes for healthy women, particularly nulliparae in an OU setting. The authors did acknowledge the influence that practitioner attitudes and beliefs may have contributed to results; the caseload midwives were self-selected and may have had a shared philosophy of care (McLachlan *et al.*, 2012).

A recent survey compared nulliparae, midwifery (OU based) and medical student expectations regarding an uncomplicated labour and birth, and found that fewer midwives than medical students expected nulliparae to have a normal birth (Shub *et al.*, 2012). Care settings can affect caregiver decision making and risk perception (Freeman *et al.*, 2006, Johanson *et al.*, 2002), and it has been suggested that midwives working in a midwifery led setting such as homebirth can feel ill-prepared and lack confidence and competence in essential skills, which shall inevitably affect their judgement and threshold for referral when caring for women during labour outside the OU setting (McCourt *et al.*, 2012).

4.4.4 Strengths and limitation

This was a large prospective study comprising a comprehensive dataset with little missing data overall. Stratifying analyses by parity and planned place of birth provided the first thorough examination of the full range of care settings where birthing pools are available to women in the UK. It was the first intrapartum birthing pool study to present clear information about what typically happened to women who had a waterbirth and those who left the birthing pool before delivery. The large sample facilitated examination of less frequent event and outcomes, and each care setting involved a similar proportion of nulliparae and multiparae, which enabled more robust comparisons between them.

The key constraint of this study was the absence of a control group of women who shared the same eligibility criteria for birthing pool use but chose not to use it, which precluded comparative analyses between care settings. Although I invited study centres to collect

data for women who could have but chose not to use a birthing pool simultaneously, only one OU did so. The study took place over an eight year time period, which was long. However, sensitivity analyses of epidural, spontaneous vaginal birth (SVD) and episiotomy showed no evidence of changes over time to prevent pooling of data.

4.4.5 Conclusions

Results from this study suggest that intrapartum birthing pool use might have potential to contribute to normalising the childbirth experience for healthy women, particularly outside the OU care setting: nulliparae who used a birthing pool and planned to give birth in the community setting experienced significantly fewer intrapartum interventions and adverse outcomes, including transfer to an OU, compared with nulliparae who planned to give birth in an AMU or OU. Results for multiparae were similar between care settings overall. The study also suggests that intrapartum birthing pool use may facilitate a key quality care marker; *normal birth* for healthy women, particularly nulliparae. There was no associated OASIS increase for hands off delivery technique at waterbirth, no PPH increase in relation to physiological third stage, no association between waterbirth and TTN or NICU admission. Reports of maternal and newborn infection were minor and very few. A small proportion of umbilical cord snaps occurred during waterbirth, suggesting that it is important to prevent undue traction on the cord as baby is guided out of the water. As this study did not collect contextual data beyond the planned place of birth, it is unclear the extent to which organisational issues, care culture and practitioner beliefs, attitudes and skills across the care settings may have affected the striking differences in what typically happened to nulliparae who used a birthing pool for labour and for waterbirth. Nonetheless, this study offers an important insight into midwifery led units, which requires further research.

Only one participating obstetric unit responded to the invitation to submit data for women who had a similar obstetric profile and could have used a birthing pool, but chose not to use a birthing pool. Whilst this precluded comparative analyses of intrapartum events, interventions and outcomes for the sample as whole, data from this single study centre presented a potential comparator.

Intrapartum birthing pool use versus no intrapartum birthing pool use in one obstetric unit

CHAPTER 5 – Intrapartum birthing pool use versus no intrapartum birthing pool use in one obstetric unit

This Chapter takes forward the argument that intrapartum birthing pool use can contribute to normalising birth by reducing intrapartum interventions, and adverse maternal and newborn outcomes, and by facilitating *normal birth* for healthy women in childbirth. It does so by exploring the differences in intrapartum events, interventions and maternal and newborn outcomes between women who did and did not use a birthing pool.

5.1 INTRODUCTION

The lack of a control group in the birthing pool study described in Chapter four meant that comparisons of intrapartum events, interventions and maternal and newborn outcomes could only be made across the care settings where women planned to give birth, and not with women who chose not to use a birthing pool and had a land birth. A control group is required to determine if birthing pool use leads to fewer intrapartum events, interventions with no increase in adverse maternal or newborn outcomes for women and newborn.

As referred to in Chapter four, I invited study centres to contribute data for controls, i.e. women whose obstetric characteristics met the eligibility criteria for birthing pool use, but who declined to do so, whilst the study centres were also collecting data for women who used a birthing pool. However, due principally to the added work that collecting data for two groups of women would involve, only one of the participating OUs (OUX) in the birthing pool study responded to my invitation. OUX collected the data for controls for a short period during which this unit also collected data for women who used the birthing pool. Hence, the sample selected for comparison with the control sample comprised a sub group of OUX's overall birthing pool data.

My research question was
How did the intrapartum interventions and maternal and newborn outcomes for women who used a birthing pool during labour compare with those for women who did not do so?

Objectives

A priori

- To undertake descriptive analysis of intrapartum events, interventions and maternal and newborn outcomes for the subgroup of women who used a birthing pool in the one obstetric unit that collected the relevant data and a control group of women in the same obstetric unit who met the criteria to use a birthing pool but chose not to do so.
- To compare maternal characteristics, intrapartum interventions and maternal and newborn outcomes between women who used a birthing pool and controls who chose not to do so in the one obstetric unit that collected the relevant data.

Post hoc

- To determine how representative women who used a birthing pool in one obstetric unit were of all women who planned to give birth in the obstetric unit setting in the larger study, described in Chapter four with respect to intrapartum events, interventions and maternal and newborn outcomes

5.2 METHODS

5.2.1 Data collection

All women who were in labour and met eligibility criteria for using a birthing pool (term gestation, with a singleton fetus in cephalic presentation, no co-morbidities such as diabetes or pre-eclampsia and no known fetal concerns) were recruited consecutively from one UK obstetric unit between June 2005 and March 2006. Women could use the birthing pool if they were at low risk of childbirth complication: OUX had an average annual birth rate of 3,500 newborn and was part of a district general hospital, which cared for a varied socio-economic population living in a range of urban, rural and remote areas.

Midwives prospectively recorded data on a standardised form whilst caring for birthing pool users and controls during labour and birth. Data collection commenced at the same time point for both groups, which was when the women requested pain relief and opted either to use the pool or have pharmacological analgesia. Data for maternal and newborn

complications were collected up to and including the seventh postnatal day. A link midwife in OUX collected, collated and checked forms for completeness, and entered data onto an Excel spreadsheet.

The same data were collected as described in Chapter four and shown in box 5.1 below. Resuscitation was defined as any use of a bag and mask on a continuum from a few ventilation breaths, to inflation breaths with or without the need to perform cardiac compressions, and/or resuscitation drug administration. Respiratory support was defined as any requirement for facial or head-box oxygen. In addition to the data items in Box 1, for spontaneous vaginal birth, data were collected for maternal birth position and whether or the midwife adopted hands off technique for the birth of baby's head and shoulders. For women who used the birthing pool, data were collected for time spent in the pool, and reasons for leaving the birthing pool before delivery.

Box 5.1: data variables for maternal characteristics, intrapartum events, interventions and outcomes

Maternal characteristics: parity, age, gestation, spontaneous or induced labour onset, previous Caesarean section
Intrapartum events and interventions: analgesia (pharmacologic/non pharmacologic), augmentation by artificial rupture of the membranes (ARM) and augmentation by intravenous infusion of oxytocin (IVI)
Maternal outcomes: mode of delivery, type of third stage management, duration of labour, perineal outcome, postpartum haemorrhage (PPH) graded as minor (500-999 ml) and major (≥ 1000ml), manual removal of placenta (MROP), infection, pyrexia, readmission, and death
Neonatal outcomes: Apgar scores (at one, five and ten minutes), birth weight, resuscitation, TTN, umbilical cord snap, shoulder dystocia, infection, admission to neonatal intensive care unit (NICU), readmission and death.

5.2.2 Descriptive comparisons

Using SPSS (version 19.0), descriptive analyses of maternal characteristics, intrapartum events, interventions and outcomes were undertaken stratified by group (birthing pool

versus control), and by parity. For continuous data, frequencies and percentages with 95% confidence intervals were calculated. Appropriate measures of central tendency (mean, median) and dispersion (SD, range) were calculated for continuous measures after assessing the distribution of the data. Comparisons between groups were performed using Pearson χ^2 test for categorical data, or Fishers exact for cell counts of less than five, and the independent t-test for continuous data with a significance set at 0.05.

5.2.3 Post hoc exploratory analyses

Descriptive comparisons identified differences between the birthing pool women and controls, which raised concerns about the representativeness of OUX compared with other obstetric units in the larger study. Firstly, there was a higher proportion of birthing pool nulliparae compared with nulliparae in the control group. Maternal parity disproportion between the two groups could influence intrapartum events, interventions and outcomes and confound the effects of birthing pool use. Secondly less than a quarter of the nulliparae who used a birthing pool had a waterbirth. Additional differences between this birthing pool sample and other OUs in the larger study included labour augmentation, type of delivery, normal birth, episiotomy and PPH. Therefore, I undertook a sensitivity analysis to compare intrapartum events, interventions and outcomes for women in OUX with those for the other obstetric units in the birthing pool study. If results for the birthing pool women in OUX proved to be significantly different from birthing pool women in the other obstetric units, they could not be considered to be representative, which would negate the external validity of comparative analyses.

5.2.4 Exploratory analyses for birthing pool women who planned to give birth in all obstetric units in the birthing pool study

I performed descriptive comparative analyses for maternal parity for women who planned to give birth in obstetric units in the larger study, and compared labour augmentation, epidural analgesia, spontaneous vaginal birth, waterbirth and episiotomy by parity. I compared the mean percentage difference for these interventions and outcomes by parity for each obstetric unit, and completed sensitivity analyses by comparing the effect of removing each obstetric unit in turn on estimates for maternal parity, epidural, spontaneous vaginal birth, waterbirth and episiotomy.

5.3 RESULTS

5.3.1 Maternal characteristics

There were significant differences in the proportion of nulliparae and multiparae between the two groups: 48% more nulliparae in the birthing pool group compared with nulliparae in the control group (p<0.001). Maternal age by parity was similar between the two groups, and nulliparae were significantly younger than multiparae (p<0.001: mean difference 5 years; 95% CI 3.8, 6.2). All women were at term gestation and all went into labour spontaneously. There were no multiparae with a previous CS (Table 5.1).

Table 5.1: maternal characteristics for birthing pool women and controls by parity

Binary: n (%) *Continuous: mean (SD) [CI 95%]*	**Birthing pool** N=278(41.9)		**Controls** N=384(58.0)	
Parity	Nulliparae N=196 (70.5) [64.7, 75.7]	Multiparae N=82 (29.4) [24.2,35.2]	Nulliparae N=141 (36.7) [31.8,41.7]	Multiparae N=243 (63.2) [58.2, 68.1]
Age: year Mean (SD)	24.9 (6.05) [23.9, 25.6]	29.7 (5.67) [28.5,30.9]	24.2 (5.72) [23.3,25.2]	29.2 (5.74) [28.5, 29.9]
Gestation: completed weeks Mean (SD)	39.7 (1.07) [39.6, 39.9]	39.7 (1.04) [39.5,40.0]	39.5 (1.08) [39.4,39.8]	39.5 (1.08) [39.4, 39.6]

N=sample size, no missing data.

5.3.2 Intrapartum events, interventions and maternal outcomes

There was no significant difference between groups for the proportions of nulliparae or multiparae who had an ARM to augment their labour, although notably more nulliparae in the birthing pool group received IVI oxytocin augmentation than controls (Table 5.2). No multiparae in either group had IVI oxytocin. A significantly higher proportion of nulliparae in the birthing pool group (49%) had an epidural compared with nulliparae in the control group: p<0.001; RR 1.97 [95% CI 1.3, 2.9]. There was no significant difference between groups for multiparae and epidural: p=0.06; RR 2.4 [95% CI 0.9, 5.8]

Table 5.2: Labour augmentation and epidural for birthing pool women and controls by parity

Binary: n (%) *Continuous: mean (SD) [CI 95%]*	**Birthing pool** N=278(41.9)		**Controls** N=384(58.0)	
Parity N=662	Nulliparae N=196 (70.5) [64.7, 75.7]	Multiparae N=82 (29.4) [24.2, 35.2]	Nulliparae N=141 (36.7) [31.8, 41.7]	Multiparae N=243 (63.2) [58.2, 68.1]
Augmentation N=662 ARM	60 (30.6) [24.2, 37.5]	11 (13.4) [6.8, 22.7]	44 (31.2) [23.6, 39.5]	24 (9.8) [6.4, 14.3]
IVI oxytocin	17 (8.6) [5.1, 13.5]	0	1 (0.7) [0.01, 3.8]	0
Epidural N=662	74 (37.7) [5.1, 13.5]	8 (9.7) [4.3, 18.3]	27 (19.1) [13.0, 26.6]	10 (4.1) [1.9, 7.4]

N=sample size, no missing data.

A significantly lower proportion of nulliparae (13.5%) in the birthing pool group had a spontaneous vertex birth (SVD) than those in the control group: *p*= 0.02; RR 0.87 [95% CI 0.8, 1.0]. A similar high proportion of multiparae in both groups had an SVD: *p*=0.68; RR 0.99 [95% CI 0.96, 1.03]. Of the birthing pool nulliparae who had an SVD, 23.9% (47) were waterbirths, and 51% (42) multiparae in the birthing pool group had a waterbirth (Table 5.3).

Significantly more nulliparae in the control group had a *normal birth* compared with birthing pool nulliparae: *p*=0.02; RR 0.79 [95% CI 0.66, 0.96], and significantly more multiparae in the control group also did so, compared with birthing pool multiparae: *p*=0.04; RR 0.91 [95% CI 0.83, 1.00].

With regard to perineal outcome, a higher overall proportion of nulliparae had an episiotomy than multiparae, and there was no significant difference between the birthing pool and control groups for nulliparae: *p*=0.58, RR 0.9 [95% CI 0.63, 1.3], or for multiparae: *p*=0.19; RR 0.42 [95% CI 0.1, 1.5] (Table 5.3). Overall, more multiparae had an intact perineum with no perineal trauma at all than nulliparae with no significant difference between nulliparae: *p*=0.44; RR 0.8 [0.5, 1.4], or multiparae: *p*=0.23; RR 0.81 [95% CI 0.6, 1.1] in either group.

Fewer nulliparae in both groups had a physiological third stage compared with multiparae overall, with no significant parity differences between the birthing pool and control groups (nulliparae: p=0.77; RR 0.90 [95% CI 0.4, 2.1], multiparae: p=0.23; RR 1.6 [95% CI 0.8, 3.2].

Although there were few minor and major PPH overall, a higher proportion of nulliparae in both groups had a PPH than multiparae. There was no significant difference between groups for minor PPH for nulliparae: p=0.17; RR 1.4 [95% CI 0.9, 2.4], or for multiparae: p=0.42; RR 1.8 [95% CI 0.4, 7.3], and likewise for major PPH: nulliparae p=0.32; RR 1.9 [95% CI 0.5, 7.2]. Only two birthing pool and no control multiparae had a major PPH (Table 5.3).

Very few women in either group had a retained placenta that required manual removal (Table 5.3). There was no report of maternal pyrexia or infection in either group.

Table 5.3: Mode of delivery, perineal outcome, physiological third stage, manual removal of placenta, normal birth, pool time and duration of labour for birthing pool women and controls by parity

Binary: n (%) *Continuous: mean (SD) [CI 95%]*	**Birthing pool** N=278(41.9)		**Controls** N=384(58.0)	
Parity	Nulliparae N=196 (70.5) [64.7, 75.7]	Multiparae N=82 (29.4) [24.2, 35.2]	Nulliparae N=141 (36.7) [31.8, 41.7]	Multiparae N=243 (63.2) [58.2, 68.1]
Mode of delivery				
SVD	138 (70.4) [63.4, 76.7]	80 (97.5) [91.4, 99.7]	114 (80.8) [73.3, 86.9]	239 (98.3) [95.8, 99.5]
Operative vaginal	31 (15.8) [11.0, 21.6]	1 (1.2) [0.00, 6.6]	19 (13.4) [8.3, 20.2]	2 (0.8) [0.09, 2.9]
Emergency CS	27 (13.7) [9.2, 19.4]	1 (1.2) [0.00, 6.6]	8 (5.6) [2.4, 10.8]	2 (0.8) [0.09, 2.9]
Perineal trauma				
1˚	20 (10.2) [6.3, 15.3]	22 (26.8) [17.6, 37.7]	17 (12.0) [7.1, 18.6]	46 (18.9) [14.2, 24.4]
2˚	53 (27.0) [20.9, 33.8]	22 (26.8) [17.6, 37.7]	32 (22.6) [16.0, 30.5]	54 (22.2) [17.1, 27.9]
3˚	4 (2.0) [0.5, 5.1]	0	3 (2.1) [0.4, 6.0]	5 (2.0) [0.6, 4.7]
4˚	0	0	1 (0.7) [0.00, 3.8]	0
Episiotomy	49 (25.0) [19.1, 31.6]	4 (4.8) [1.3, 12.0]	39 (27.7) [19.8, 35.0]	4 (1.6) [0.4, 4.1]
Intact perineum	21 (10.7) [6.7, 15.9]	28 (34.1) [24.0, 45.4]	19 (13.4) [8.3, 20.2]	102 (41.9) [35.6, 48.2]
*Normal birth	97 (49.5) [42.3, 56.7]	70 (85.4) [75.8, 92.2]	88 (62.4) [53.9, 70.4]	228 (93.8) [90.0, 96.5]
†Physiological third stage	11 (5.6) [2.8, 9.8]	10 (12.1) [6.0, 21.2]	9 (6.3) [2.9, 11.7]	19 (7.8) [4.7, 11.9]
Pool time (minutes) Mean (SD)	n=194 135.9 (117.6)	58.7 (105.1)	NA	NA
PPH				
500-999ml	36 (18.4)	3 (3.7)	18 (12.8)	5 (2.1)
≥1000ml	8 (4.1)	2 (2.4)	3 (2.1)	0
‡MROP	3 (1.5) [0.3, 4.4]	2 (2.4) [0.2, 8.5]	2 (1.4) [0.1, 5.0]	0
Labour duration (minutes) Mean (SD)	n=176 731.6 (288.2)	440.0 (193.2)	605.2 (270.4)	361.0 (270.9)

N=sample size, n=number analysed. Data were only missing for duration of labour and time in birthing pool for nulliparae. Missing data excluded from analyses.
*****Normal birth was defined as spontaneous labour onset, no epidural, spontaneous vertex delivery, no episiotomy †Physiological third stage was defined as no oxytocic injection before delivery of the placenta. ‡MROP = manual removal of placenta.

5.3.3 Newborn outcomes

Few babies in either group had a low Apgar score at five or ten minutes, and few required resuscitation at delivery (Table 5.4). Of the seven babies who developed TTN, one was a waterbirth, three had a spontaneous birth on land, one baby was born by operative vaginal delivery and two by emergency CS. All but one was born to a nulliparous woman.

Babies born to nulliparae in the birthing pool group were slightly heavier than those for nulliparae in the control group (p = 0.02: mean difference 47 grammes; 95% CI 17.2, 201.9). There was one report of newborn infection, and all babies who were admitted to NICU were discharged home; two babies required paediatric follow up for a congenital anomaly.

Table 5.4: Newborn outcomes for birthing pool women and controls by parity

n (% for care setting total)	**Birthing pool** N=278(41.9)		**Controls** N=384(58.0)	
Parity	Nulliparae N=196 (70.5) [64.7, 75.7]	Multiparae N=82 (29.4) [24.2, 35.2]	Nulliparae N=141 (36.7) [31.8, 41.7]	Multiparae N=243 (63.2) [58.2, 68.1]
Apgar 7 or < at 5 minutes	3 (1.5) [0.3, 4.4]	0	0	0
Apgar 7 or < at 10 minutes	1 (0.5) [0.01, 2.8]	0	0	0
Birth weight (grammes) mean (SD)	3478 (438.6)	3664 (447.6)	3368 (405.4)	3556 (476.9)
†Resuscitation required	6 (3.0) [1.1, 6.5]	3 (3.6) [0.7, 10.3]	3 (2.1) [0.4, 6.0]	2 (0.8) [0.0, 2.9]
‡Respiratory support	6 (3.0) [1.1, 6.5]	0	1 (0.7) [0.0, 3.8]	0
NICU admission	7 (3.5) [1.4, 7.2]	3 (3.6) [0.7, 10.3]	4 (2.8) [0.7, 7.1]	2 (0.8) [0.0, 2.9]
Time in NICU (days) mean (SD)	n=194 3.0 (0.00)	n=80 3.0 (0.00)	n=139 .03 (0.26)	N=243 .01 (0.14)

N=sample size. No missing data.
†Resuscitation was defined as any use of a bag and mask on a continuum from a few ventilation breaths, to inflation breaths with or without the need to perform cardiac compressions, and/or resuscitation drug administration. ‡Respiratory support was defined as any requirement for facial or head-box oxygen

5.3.4 Reasons why birthing pool women left the pool before delivery

Maternal reasons accounted for the majority of birthing pool exits before delivery (Table 5.5). Three quarters of nulliparae and just under half the multiparae who used the birthing pool did not have a waterbirth.

Table 5.5: Reasons for leaving the birthing pool before delivery by parity

Binary: n (%) Continuous: mean (SD) [CI 95%]	**Birthing pool** N=278(41.9)	
Parity	Nulliparae N=196 (70.5) [64.7, 75.7]	Multiparae N=82 (29.4) [24.2, 35.2]
Maternal		
More analgesia	74 (37.7) [30.9, 44.9]	16 (19.5) [11.5, 29.7]
*Miscellaneous	48 (20.4) [14.9, 26.7]	15 (15.8) [8.7, 25.5]
Slow first stage of labour	13 (6.6) [3.5, 11.0]	6 (7.3) [2.7, 15.2]
Slow second stage of labour	4 (2.0) [0.5, 5.1]	2 (2.4) [0.2, 8.5]
Pyrexia	2 (1.0) [0.1, 3.6]	0
Fetal		
Bradycardia	7 (3.6) [1.4,7.2]	1 (1.2) [0.01, 2.8)
Malposition	1 (0.5) [0.03, 6.6]	0

N=sample size. No missing data.
* Miscellaneous reasons included maternal choice, for a procedure such a vaginal examination, or to mobilise

5.3.5 Maternal birth position and hands off delivery technique

A higher overall proportion of nulliparae in the birthing pool group adopted a kneeling or all fours position for birth compared with nulliparae in the control group (Table 5.6). Irrespective of parity, and notwithstanding a higher proportion of missing data for the birthing pool group for delivery technique for SVD, more women in the birthing pool group who had an SVD, had hands off delivery technique than did women who had an SVD in the control group. All the reported hands off for the birthing pool group were waterbirths.

Table 5.6: Maternal position and hands off delivery technique for birthing pool women and controls by parity

n (%) [CI 95%]	**Birthing pool** N=278(41.9)		**Controls** N=384(58.0)	
Parity	Nulliparae N=196 (70.5) [64.7, 75.7]	Multiparae N=82 (29.4) [24.2, 35.2]	Nulliparae N=141 (36.7) [31.8, 41.7]	Multiparae N=243 (63.2) [58.2, 68.1]
Maternal position for vaginal delivery	n=157/169	n=76/81	n=128/133	n=232/241
Semi recumbent	103 (65.6) [57.6, 72.9]	49 (64.4) [52.6, 75.1]	66 (51.5) [42.5, 60.4]	141 (60.7) [54.1, 67.1]
Sitting	2 (1.2) [0.1, 4.5]	1 (1.3) [0.0, 7.1]	21 (16.4) [10.4, 23.9]	31 (13.3) [9.2, 18.4]
Kneeling, on all fours	15 (9.5) [5.4, 15.2]	17 (22.3) [13.6, 33.3]	4 (3.1) [0.8, 7.8]	24 (10.3) [6.7, 15.0]
Left or right lateral	3 (1.9) [0.3, 5.4]	4 (5.2) [1.4, 12.9]	11 (8.5) [4.3, 14.8]	20 (8.6) [5.3, 12.9]
Supine	0	1 (1.3) [0.0, 7.1]	3 (2.3) [0.4, 6.6]	4 (1.7) [0.4, 4.3]
Lithotomy	31 (19.7) [13.8, 26.8]	1 (1.3) [0.0, 7.1]	21 (16.4) [10.4, 23.9]	3 (1.2) [0.2, 3.7]
Hands off technique (SVD only)	n=45/138	n=42/80	n=113/114	N=239
	44 (97.7) [97.7, 99.9]	37 (88.0) [74.3, 96.0]	2 (1.7) [0.2, 6.2]	8 (3.3) [1.4, 6.4]

N=sample size; *n*=number of women analysed for each variable – women with missing data excluded from analysis.

5.3.6 Sensitivity analyses

5.3.6.1 Exploratory comparisons between obstetric units

Descriptive analysis of the parity ratio, labour augmentation, epidural, spontaneous vaginal birth, waterbirth and episiotomy for all obstetric units in the birthing pool study by parity, revealed some idiosyncratic measures for OUX. For example, OUX had the highest proportion of nulliparae of all obstetric units [Appendix 3]. The proportions of nulliparae and multiparae in the comparative sub group birthing pool sample (70.5% and 29.4%) were the same as the parity ratio for OUX overall (70.5% and 29.5%).

The sample size for obstetric units varied from 47 to 762 women, and OUX was the largest. The mean number of women for obstetric units was 275.

Appendix 3 and the six figures below illustrate the proportions by parity, and across all obstetric units of the following interventions and outcomes

- Augmentation of labour by means of ARM and/or IVI oxytocin
- Epidural analgesia
- Spontaneous vertex birth (SVD)
- Waterbirth
- Episiotomy

OUX is coloured lilac and identified by the arrows in Figure 5.1 to Figure 5.6.

Figure 5.1 showed that the use of ARM to augment labour in OUX was the second highest for nulliparae of all obstetric units.

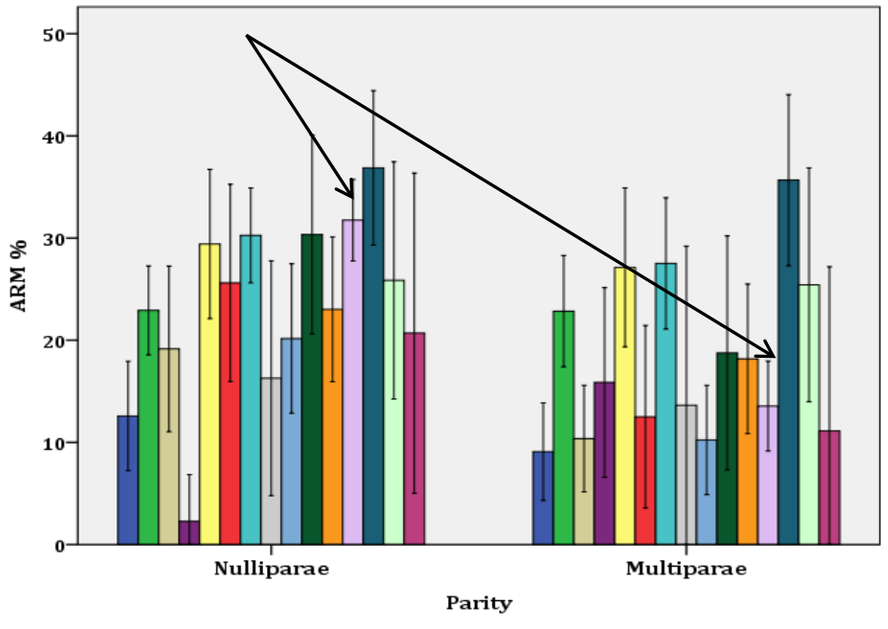


Figure 5.1: Proportions for artificial rupture of the membranes for all obstetric units by parity

Figure 5.2 showed that OUX had the second highest proportion of labour augmentation using IVI oxytocin for multiparae

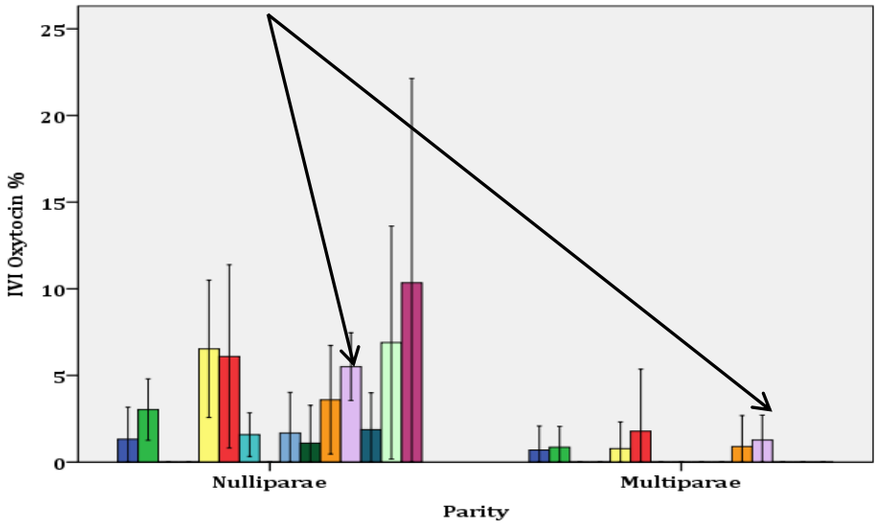


Figure 5.2: Proportions for IVI oxytocin labour augmentation for all obstetric units by parity

Figure 5.3 revealed OUX to have the highest overall proportions for epidural for nulliparae and multiparae.

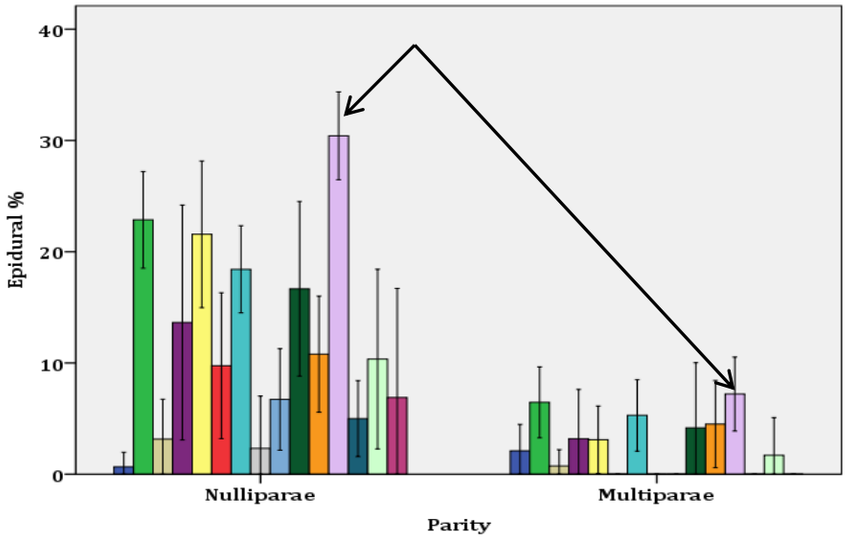


Figure 5.3: Proportions for epidural for all obstetric units by parity

The majority of multiparae had a spontaneous vaginal birth, and OUX was no exception. The proportion of nulliparae who did so in OUX however, was among the lowest for obstetric units (Figure 5.4).

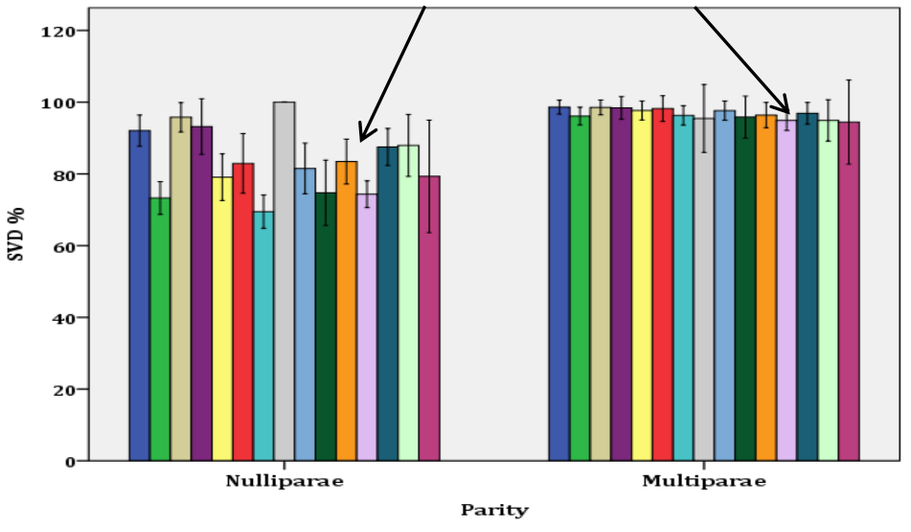


Figure 5.4: Proportions for spontaneous vertex delivery for all obstetric units by parity

Irrespective of parity, a lower proportion of women in OUX had a waterbirth compared with the other obstetric units (Figure 5.5).

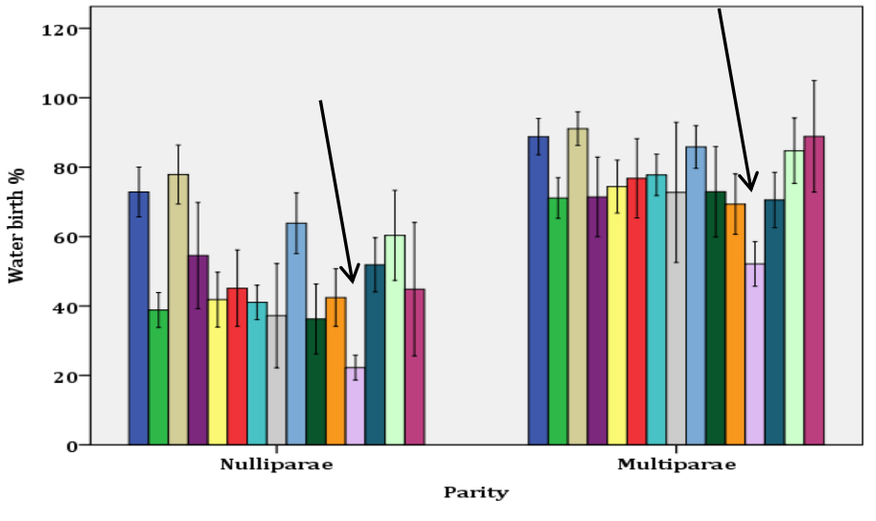


Figure 5.5: Proportions for waterbirth for all obstetric units by parity

A higher proportion of nulliparae in OUX had an episiotomy compared with nulliparae in the other obstetric units (Figure 5.6).

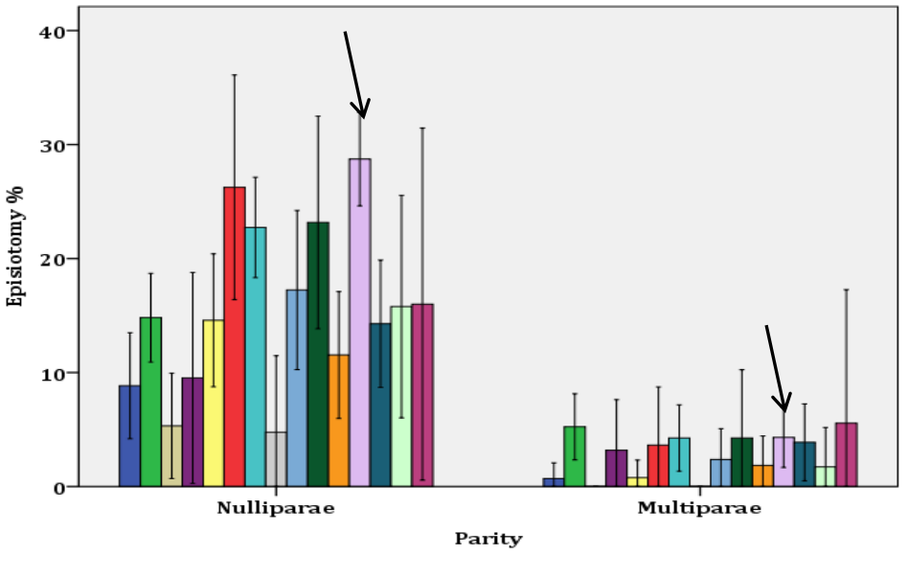


Figure 5.6: Proportions for episiotomy for all obstetric units by parity

5.3.7 Results for post hoc sensitivity analysis

Sensitivity analyses performed to identify if there was any significant difference between obstetric units for maternal parity, epidural, SVD, waterbirth and episiotomy are shown in Table 5.7, Table 5.8, Table 5.9, Table 5.10, and Table 5.11.

Compared to other OUs, OUX indicated a slight overall difference for maternal parity ratio (Table 5.7).

Table 5.7: estimates for the proportion of nulliparae and multiparae by obstetric unit

Obstetric units	Mean % difference for maternal parity	Lower 95% CI	Upper 95% CI
All	41	40	43
-1	41	39	42
-2	41	40	43
-3	40	39	42
-4	41	39	42
-5	41	39	42
-6	41	40	43
-7	42	41	44
-8	41	40	43
-9	40	39	42
-10	41	40	43
-11	41	39	42
-OUX	43	42	45
-13	41	39	42
-14	41	39	42
-15	41	40	43

There was a significant reduction in the mean proportion and 95% confidence intervals for epidural when OUX was removed (Table 5.8),

Table 5.8: Estimates for the proportion of women who had an epidural by obstetric unit

Obstetric units	Mean % difference for epidural	Lower 95% CI	Upper 95% CI
All	12	11	13
-1	12	11	13
-2	11	10	12
-3	12	11	13
-4	12	11	13
-5	11	10	12
-6	12	11	13
-7	11	10	12
-8	12	11	13
-9	12	11	13
-10	12	11	13
-11	12	11	13
-OUX	9	8	10
-13	12	11	13
-14	12	11	13
-15	12	11	13

There was no difference for SVD (Table 5.9)

Table 5.9: Estimates for the proportion of women who had SVD by obstetric unit

Obstetric units	Mean % difference for SVD	Lower 95% CI	Upper 95% CI
All	99.8	99.7	99.9
-1	99.8	99.7	99.9
-2	99.8	99.7	99.9
-3	99.8	99.7	99.9
-4	99.8	99.7	100.0
-5	99.8	99.7	99.9
-6	99.8	99.7	99.9
-7	99.8	99.7	99.9
-8	99.8	99.7	99.9
-9	99.8	99.7	99.9
-10	99.8	99.7	99.9
-11	99.8	99.7	99.9
-OUX	99.8	99.7	99.9
-13	99.8	99.7	99.9
-14	99.8	99.7	99.9
-15	99.8	99.7	99.9

There was a significant increase in the mean proportion and 95% confidence intervals for waterbirth when OUX was removed (Table 5.10).

Table 5.10: Estimates for the proportion of women who had a waterbirth by obstetric unit

Obstetric units	Mean % difference for waterbirth	Lower 95% CI	Upper 95% CI
All	55	54	57
-1	54	52	55
-2	56	54	58
-3	54	52	55
-4	55	54	57
-5	55	54	57
-6	55	54	57
-7	56	54	57
-8	56	54	57
-9	54	53	56
-10	56	54	57
-11	55	54	57
-OUX	61	59	62
-13	55	53	57
-14	55	53	56
-15	55	54	57

There was a significant reduction in the mean proportion and 95% confidence intervals for episiotomy when OUX was removed (Table 5.11).

Table 5.11: Estimates for the proportion of women who had an episiotomy by obstetric unit

Obstetric units	Mean % difference for episiotomy	Lower 95% CI	Upper 95% CI
All	6	5	7
-1	6	6	7
-2	6	5	7
-3	5	6	7
-4	6	5	7
-5	6	5	7
-6	6	5	7
-7	6	5	7
-8	6	5	7
-9	6	5	7
-10	6	5	7
-11	6	5	7
-OUX	5	4	6
-13	6	5	7
-14	6	5	7
-15	6	5	7

5.3.8 In summary

Results for comparative descriptive analyses of intrapartum events, interventions and outcomes for the sample of birthing pool women and controls in OUX differed from the overall findings for obstetric units in the larger study (Burns *et al.*, 2012). This raised concerns about the representativeness of OUX, and the external validity of these data.

Results for sensitivity analyses confirmed that OUX was not representative of the other obstetric units in the birthing pool study.

5.4 DISCUSSION

Results for descriptive comparative analyses revealed two features which challenged the reliability of using these data to undertake comparative analyses. Firstly, there was a significant difference in maternal parity between the birthing pool women and controls. Secondly, sensitivity analyses to compare intrapartum interventions and outcomes between all the obstetric units in the birthing pool study highlighted some key differences for OUX. I shall discuss each of these issues and explain the decision for not proceeding to perform multivariate comparisons

5.4.1 Maternal parity discrepancy

The significant difference in the covariate maternal parity between the birthing pool group and the control group inevitably affected the results for descriptive analyses. Studies undertaken in the OU setting, and involving nulliparous women, including those who had a straightforward pregnancy, found that nulliparae were more likely to use pharmacological analgesia, and to experience labour augmentation, operative delivery, an episiotomy and OASIS than multiparae (Landy *et al.*, 2011, Petersen *et al.*, 2011, Williams *et al.*, 1998). As mentioned in Chapter two, epidural analgesia is a risk factor for women, irrespective of their parity for an operative delivery, or emergency CS (Anim-Somuah *et al.*, 2011, Nguyen Uyen-Sa *et al.*, 2010). In this exploration, 31 of the total 35 nulliparae (88.5%) who had an emergency CS, and one of the three multiparae who did so had an epidural in situ pre their operation, as did 37 of the 50 nulliparae (74%) and two of the three multiparae who had an operative vaginal delivery.

The magnitude of difference for labour augmentation using intravenous infusion of oxytocin, and epidural between nulliparae in the birthing pool group compared with nulliparae in the control group, and significant differences for overall comparisons between women in the birthing pool group and those in the control group was unexpected, and contrasted with those for women who planned to give birth in an OU in the larger study (Burns *et al.*, 2012). Other prospective comparative birthing pool studies undertaken in the obstetric unit setting have also reported an association between birthing pool use and reduced use of analgesia, increased frequency of spontaneous vaginal birth with fewer

episiotomies and less spontaneous perineal trauma (Geissbuehler *et al.*, 2004, Thoeni *et al.*, 2005, Zanetti-Daellenbach *et al.*, 2007).

5.4.2 Birthing pool practice in OUX

Sensitivity analyses clearly identified differences between birthing pool practice in OUX and other obstetric units. Only a quarter of nulliparae and just over half the multiparae who used the birthing pool in OUX proceeded to have a waterbirth. They also spent less time in the pool than OU women in the birthing pool study (Burns *et al.*, 2012). With the exception of maternal parity, maternal baseline characteristics were similar for nulliparae and multiparae in both groups, and data collection for the birthing pool group and control group commenced at the same point, which was when the women requested pain relief, and opted for either medication or the pool.

It could be argued that the significantly higher use of IVI oxytocin to augment labour for nulliparae who used the birthing pool suggest that clinicians may have had a lower threshold for intervening in these women's labour. A total of 149 (76.0%) nulliparae left the birthing pool pre delivery; a markedly higher proportion than for all OU nulliparae in the larger study (57.2%) (Burns *et al.*, 2012). A sizeable proportion of women overall left the birthing pool to mobilise, to have a vaginal examination or to pass urine and did not return to the pool afterwards.

The context in which care is provided is influential; there is evidence that having a birthing pool in the OU setting can arouse clinician anxiety and resistance (Russell, 2011). Birthing pool use has evolved to symbolise the promotion of normality in childbirth. There can be discord among clinicians who have conflicting ideologies, and this is more likely to occur in the OU setting than in midwifery led units (Hunter, 2005). OUX had its birthing pool installed less than a year before the midwives collected the data for birthing pool group and the control group, and the link midwife who coordinated data collection and collation acknowledged that OUX had a predominantly medical model of care at the time. Whilst It is unclear why these results are different, one possible explanation was that due to the prevailing medical model of care in OUX at the time, the midwives might have lacked sufficient confidence to adopt hands off birth technique when assisting women having a

spontaneous birth outside the waterbirth scenario; a practice that can reduce the incidence of episiotomy (McCandlish *et al.*, 1998).

Whilst OUX's care context could possibly explain its findings for the birthing pool group, it does not alter the fact that the results of sensitivity analyses negated OUX's use as a unit that could represent standard birthing pool use for healthy pregnant women in the OU setting in the UK. Using OUX data would have produced skewed results that may have unfairly adversely influenced clinician responses to the use of birth pools for low risk women planning to give birth in an obstetric unit, and potentially, other care settings.

5.4.3 Strengths and limitations

There were no missing data for the key intrapartum events, interventions and outcomes examined in this comparative exploration, which enabled comprehensive descriptive and sensitivity analyses. Data were collected prospectively using a standardised form, and collated with a consistent thoroughness, which ensured their quality.

Data collection was not stratified by maternal parity, which would have removed the key imbalance between groups. Comparative analyses were based on participants from only one of the fifteen obstetric units that participated in the birthing pool study. Therefore, even had OUX not proved to be idiosyncratic, the generalisability of results would have been restricted. This examination could not address my research question, which was to compare the intrapartum events, interventions and outcomes for women who used a birthing pool during with those for women who did not use a birthing pool during labour in one obstetric unit.

5.4.4 Conclusion

Results for descriptive comparisons between birth pool women and controls showed that birthing pool women had a higher incidence of interventions and operative delivery compared with controls in OUX. Sensitivity analyses comparing key intrapartum interventions and outcomes between this unit and other obstetric units in the birthing pool study identified differences, which precluded its use as representative of UK obstetric unit birthing pool use. It was therefore not possible, to proceed and undertake multivariate

comparative analyses as originally planned, because to do so would not generate results that one could extrapolate to the overall population of healthy women in childbirth who choose to use a birthing pool during labour in the OU setting in the UK.

Exploration of routinely collected maternity data for a population of healthy women in childbirth

In the next two Chapters, I make a further attempt to investigate whether intrapartum birthing pool use may have the potential to contribute to normalising birth for healthy women in childbirth. In this Chapter, I examine the reliability of a bespoke dataset comprising routinely collected maternity data collated by Hospital Episode Statistics (HES) analysts, which would potentially allow comparative analyses. In Chapter seven, using the HES and birthing pool data, I compare intrapartum events, interventions and maternal and newborn outcomes.

6.1 INTRODUCTION

Whilst analyses of the birthing pool data provided an interesting and useful insight into the incidence and nature of intrapartum events, interventions and outcomes for a cohort of women who used a birthing pool in their planned place of birth, the absence of a control group of women who did not use a birthing pool restricted analysis to a descriptive account of intrapartum events, interventions and outcomes across care settings, and testing hypotheses in relation to bathing during labour and waterbirth. A control group was required to enable comparisons and inference testing of risk differences for events, interventions or outcomes occurring or not between groups. In Chapter five, I explored the potential of using data for controls and data for a sub-group of women who used a birthing pool that were collected during the same time period in OUX, and found that this comparison would not be possible because OUX was not representative of the obstetric units in the larger birthing pool sample. This led me to consider another strategy, which was to compare my data with a comparable dataset of healthy women in childbirth. I therefore obtained a HES dataset and examined its potential to provide a reliable comparison group for the birthing pool sample.

HES collate records for all out-patient and in-patient NHS Hospital Trust care episodes that occur in England. In addition to individual patient records by clinical speciality containing information relating to events, procedures, operations and the duration of hospital episodes, HES records also include data for NHS user demographics such as ethnicity, age, gender, marital status, and post code, which can be used to derive the indices of multiple deprivation (IMD), a marker of socioeconomic status (SES) (Information Centre, 2012). NHS hospital employed data coders assign codes to intrapartum events, interventions and

outcomes. These clinical classification codes are set by Data Standards, and are contained in two data directories: International Classification of Diseases (ICD-10) and Operation and Procedure Codes (OPCS-4).

In addition to ICD-10 and OPCS-4 codes, HES analyses data from its own commissioning dataset, the Maternity Data Directory (MDD), also referred to as the maternity data tail. The delivery and birth section of the MDD contains mandatory field (MF) data items that cover maternal obstetric characteristics as well as intrapartum interventions and outcomes (Connecting for Health, 2012a). The MDD evolved from Korner hospital records, and was developed by the Maternity Care Data Project (MCDP) in the early 2000's to standardise data collection and generate a core clinical maternity record (Steer, 2002). MDD-MF data items include maternal parity, gestational age at labour onset, type of labour onset, analgesia pre delivery, mode of delivery, planned and actual place of delivery, reason for change if applicable, live birth or stillbirth, whether or not neonatal resuscitation was required at birth, birth weight and admission to the Neonatal Intensive Care Unit (NICU).

The International Classification of Diseases and Related Health Problems, is known as the ICD set of codes. The World Health Organisation has responsibility for defining the codes in this directory, which comprises codes assigned to all causes of death, and diagnosis and symptom description of ill-health (World Health Organisation, 2010). ICD codes are utilised worldwide to monitor the health of populations, the prevalence and incidence of diseases and to identify causes of death. The current directory, ICD-10 represents its tenth overall revision, and has been used by HES since 1995 (HESonline, 2012). Individual codes are reviewed annually within the ICD-10 directory; the latest published update was in 2010 (World Health Organisation, 2010). Between 2002-2003 and 2007-2008 the number of ICD-10 codes relating to childbirth has increased from 7 to 20. Maternal childbirth related ICD-10 codes include pyrexia, infection, type of delivery, the occurrence of first, second, third, fourth degree perineal trauma, primary postpartum haemorrhage, retained placenta. Newborn ICD-10 codes cover whether the labour resulted in a live birth, or stillbirth.

The second set of codes used to record healthcare data; Operation and Procedure Codes (OPCS) comprises a classification system of procedures and operation undertaken in clinical practice. OPCS-4 reflects the fourth OPCS revision; it was implemented by NHS in 1990 and is shorthand for the Office of Population, Censuses and Surveys Classification of Surgical Operations and Procedures (4th revision)(Connecting for Health, 2012b). The introduction of Payment by Results by the Department of Health in 2000 prompted a major review of the OPCS-4 classification between 2003 and 2005, leading to the launch of OPCS-4.3 code adaptations in 2006 in order to more accurately reflect the expansion of contemporary procedures and operations (HESonline, 2012). As with the ICD-10 codes, OPCS-4 codes are reviewed annually and new codes are introduced to reflect clinical practice developments. Over the last nine years there has been a significant increase in the number of OPCS codes in relation to childbirth: before 2002-2003 (financial year April-May), there were four; 2003-2006 these increased to 12, which doubled to 24 in 2008-2009. OPCS-4 codes for childbirth include labour induction, epidural analgesia, type of delivery, repair of first, second, third, fourth degree perineal trauma, episiotomy, and manual removal of placenta.

NHS hospitals submit their maternity coded data each month to Secondary Users Services (SUS), a data warehouse based in Leeds and managed by British Telecom, from where it is transferred to HES for collation and analyses [Appendix 4: data flow chart and explanation]. Some of the data variables that hospitals send to SUS are only present in one data field, whilst for others there is a degree of overlap, for example, mode of delivery is collected in all three data fields, whilst the variations of perineal trauma only have ICD-10 codes and perineal repair for the spectrum of perineal trauma only have OPCS-4 codes. Figure 6.1 shows the overlap between the MDD-MF, OPCS-4 and ICD-10 data fields.

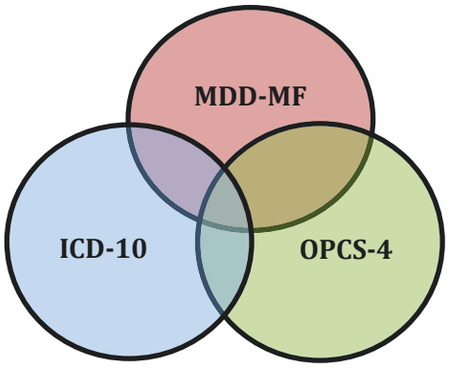


Figure 6.1: Overlap between data fields

The ICD-10, OPCS-4 and MDD-MF directories comprise the datasets that HES collate, analyse and tabulate annually for use by NHS stakeholders involved in commissioning and monitoring maternity care provision, clinical audit and to inform research projects. HES analyse data for the pregnant population as a whole. They do not stratify their descriptive analyses by obstetric risk profile; for example, healthy women who present in labour with no known maternal or fetal complication versus those who have a problem such as prematurity, and/or an antenatal hospital episode for a pregnancy related complication such as pre-eclampsia. Furthermore, HES do not summarise data by maternal parity.

The women of interest to me were those who were considered to be at low risk of childbirth complication, and as it was not possible to identify this population within data summaries produced by HES, it was necessary to draft a specification for a bespoke HES sample.

My research question was

To what extent does HES maternity data provide reliable and relevant information for intrapartum interventions, maternal and newborn outcomes for women with no identified pregnancy complication who labour at term gestation?

Objectives

- To obtain a HES dataset for a random stratified sample of women covering the same time period as the data were collected for women in the birthing pool cohort.

- To undertake descriptive analysis of HES data by each data field: MDD-MF, ICD-10 and OPCS-4.
- Test the integrity (reliability and relevance) of HES data as a benchmark against which to compare the birthing pool data.

6.2 METHODS

6.2.1 Specification for a HES sample (Objective 1)

6.2.1.1 Inclusion, exclusion criteria

It was important for the HES sample to comprise women who had a similar obstetric profile to those who were eligible for birthing pool use. Inclusion criteria were women with a singleton pregnancy who reached ≥ 37 weeks gestation, and had no co-existing problem coded on their labour and delivery episode (for example pre-eclampsia, diabetes). HES cannot link labour and birth data to antenatal records for individual women; it was not therefore, possible to screen out women with reported antenatal complications, such as an antenatal care episode for diabetes, pre-eclampsia, or antepartum haemorrhage. Women with a multiple pregnancy, or who went into labour at less than 37 weeks gestation or had a booked elective Caesarean section were excluded.

6.2.1.2 Data variables

Returning to the birthing pool data, I examined which variables were also available in HES data. Mapping the MDD-MF, ICD-10 and OPCS-4 fields to those for the birthing pool cohort identified HES equivalent data for all but five maternal variables: mode of membranes rupture (artificial, spontaneous), labour augmentation by means of intravenous infusion of oxytocin, perineal trauma of labia or vaginal wall only, and intact perineum (Table 6.1, Table 6.2). For some birthing pool variables there was more one code and more than one data field in HES data. The HES MDD-MF directory has categories for maternal parity and planned place of birth (PPB). As seen in Chapter four, analysing the birthing pool data by parity and PPB illustrated the relevance of these influential factors for intrapartum events, interventions and outcomes. I therefore needed to explore if analysis by parity and PPB

was possible using HES data. Unfortunately the MDD-MF categories for PPB were not sufficiently explicit to be confident that the data coding would be consistent with the birthing pool PPB. For example, whilst it is reasonable to assume that codes 2 and 4 in Box 6.1 represent the obstetric unit setting, and code 1 equates with a home birth, I could not reliably assume that options 0, and 3 represent an alongside midwifery unit setting. There is no MDD-MF freestanding midwifery unit equivalent. It was also unclear where to assign codes 5, 6, 7, 8, and 9.

Box 6.1: HES MDD-MF categories for planned place of birth

0. Delivery facilities associated with midwife ward
1. At a domestic address
2. Delivery facilities associated with consultant ward
3. Delivery facilities associated with general medical practitioner ward
4. Delivery facilities associated with consultant/ general medical practitioner/midwife
5. In private hospital
6. In other hospital or institution
7. In NHS hospital – ward or unit without delivery facilities
8. None of the above
9. Not known

Table 6.1: Maternal variables collected in the birthing pool sample mapped to HES data fields MDD-MF, ICD-10 and OPCS-4

Variables	Birthing pool	MDD-MF	ICD-10	OPCS-4
Planned place of birth	†1,2,3	‡0-9		
Parity	√	√		
Age	√	√		
Gestation	√	√		
Cephalic singleton	√	√		
Breech singleton	√	√		
ARM	√			
Labour augmentation	√			
Labour induction	√	√		R148,149,151,158,159
Epidural pre delivery	√	√		Y81.1, Y81.2
Pyrexia in labour	√		0752	
Infection in labour	√		0753	

√= variables in the birthing pool data and MDD-MF field. >One ICD-10, OPCS-4 code for a single variable indicates the range of options available within the variable: for example, different methods of labour induction. † Planned place of birth for the birthing pool sample: 1=obstetric unit, 2=alongside midwifery unit, 3=community (freestanding midwifery unit/planned homebirth). ‡ Planned place of birth for MDD-MF – please see Box 4.1 for options 0-9.

Table 6.2: Maternal variables collected in the birthing pool sample mapped to HES data fields MDD-MF, ICD-10 and OPCS-4

Variables	Birthing pool	MDD-MF	ICD-10	OPCS-4
Mode of delivery				
SVD	√	√	0800,0808,0809	R249
Breech	√	√	0830,0831,0801	R191,198,201,202,208,209
Ventouse	√	√	0814, 0815	R221,222,223,228,229
Forceps	√	√	0810,0811,0812,0813	R211,212,213,214,215,218,219
Emergency CS	√	√	0821,0822,0828,0829	R181,182,188,189,191
Elective CS		√	0820	R171,172,178,179
Perineal trauma				
Labial tear only	√			
Vaginal wall only	√			
1°	√		0700	
2°	√		0701	
3°	√		0702	
4°	√		0703	
Perineal repair				
1°	√			R324
2°	√			R323
3°	√			R322
4°	√			R325
Episiotomy	√			R271
Intact perineum	√			
Retained placenta	√		0730,0731	
MROP	√			R291,298
Primary PPH	√		0720,0721	
Death	√	√		

√= variables in the birthing pool data and MDD-MF field. >One ICD-10, OPCS-4 code for a single variable indicates the range of options available within the variable. For example, spontaneous vertex delivery, spontaneous single delivery, spontaneous, assisted or extraction for vaginal breech delivery.

For newborn data, codes were limited to the MDD-MF and ICD-10 fields with two variables (live birth or stillbirth) in more than one field (Table 6.3). There were no HES variables for initial Apgar score assessment, infection or neonatal death.

Table 6.3: Newborn birthing pool variables mapped to HES data by MDD-MF, ICD-10 and OPCS-4 fields

Variables	Birthing pool	MDD- MF	ICD-10	OPCS-4
Apgar score @ 1, 5,10 minutes	√			
Resuscitation	√	√		
Birth weight	√	√		
Live birth	√	√	Z370	
Stillbirth	√	√	Z371	
Neonatal death	√			
Admission to NICU	√	√		

√= variables for which data were collected in the birthing pool data and MDD-MF field

6.2.1.3 Participants and time period

Data collection for the birthing pool study took place from 2000-2008; therefore in order to reduce the potential confounding effect of practice changes over time, the data requested from HES would need to cover the same time period. The aim was to obtain an overall sample of sufficient size to enable comparison of variables of interest (maternal parity, epidural, mode of delivery, perineal trauma, newborn resuscitation) to the level of the same precision as for the birthing pool data. The sample size for each strata (year) was calculated by adding 20% to the number of birthing pool women for each year of the HES sample, in order to compensate for the expected average missing total HES data coverage reported for each year (Hospital Episode Statistics, 2002, 2004, 2005, Information Centre, 2006, 2007, 2008, 2009a, b, 2010, Moser and Hilder, 2008).

The recruitment time periods for participating centres for each year of the birthing pool cohort were calculated from January to December. For HES data however, the year runs from April to March, in line with the financial year, so the number of women who were recruited for each year to the birthing pool study was matched to fit the HES sample. This resulted in a total sample size of 10,708 women, stratified by the years 2000-2009 (Table 6.4)

Table 6.4: Number of women randomly selected from HES data stratified by year

Year 1st April-31 March	Birthing pool sample N	+20% for each year for HES extract
2000-2001	21	25
2001-2002	98	118
2002-2003	477	572
2003-2004	1208	1450
2004-2005	2307	2768
2005-2006	2020	2424
2006-2007	976	1171
2007-2008	1560	1872
2008-2009	257	308
Total	**8,924**	**10,708**

6.2.1.4 Data preparation for analysis

MDD-MF data items were checked and data logged as 0, 99 or x (missing), 8 (not applicable) or 99 (unspecified) were recoded to represent missing data. The HES Excel files for each year of the sample were transferred to SPSS (version 19).

Some MDD-MF data items had more than category; for example the number of previous birth births for multiparous women was listed (for instance para 3 was coded as 3). The ordered category for parity was collapsed to a binary category (nulliparae, multiparae) to match maternal parity for the birthing pool sample. MDD-MF procedures for induction of labour, modes of delivery, and variants of newborn resuscitation were also collapsed and assigned binary codes; for example for modes of delivery, SVD 1 (yes) or 0 (no) encompassed spontaneous cephalic delivery, occipito-anterior and 'other', operative vaginal delivery 1/0 included low and 'other' forceps delivery, and ventouse, and breech delivery 1/0 represented 'including partial breech extraction', 'breech extraction not otherwise specified'.

The different ICD-10 codes for a given variable as listed in Table 6.1 were collapsed to form one binary code (1/0), as were the OPCS-4 codes for this directory's variables. The new codes covered the OPCS-4 codes for induction of labour, and epidural, the ICD-10 codes for modes of delivery, and OPCS-4 codes for modes of delivery; ICD-10 codes for

perineal trauma and all OPCS-4 codes for perineal repair, ICD-10 codes for retained placenta, and primary PPH, and OPCS-4 codes for MROP. For mode of delivery, ICD-10 codes for ventouse and forceps were combined into operational vaginal delivery; as were OPCS-4 codes for ventouse and forceps.

6.2.2 Descriptive analysis (Objective 2)

Analyses of MDD-MF, ICD-10 and OPCS-4 fields were performed using SPSS (version 19.0). Frequencies were calculated; the number and percentage for categorical data, and the mean and standard deviation for continuous data. Missing data were excluded from the analyses.

6.2.3 Testing the integrity of the HES dataset (Objective 3)

To examine if the implementation of Payment by Results, whereby NHS maternity units receive funding for their OPCS-4 activities and the expansion of OPCS-4 codes between 2003 and 2009 resulted in an increase the number of cases over time, the annual OPCS-4 data field coverage for 2000-2009 was examined for the proportions of data completeness reported. MDD-MF and ICD-10 data completeness were likewise checked by year looking for changes over time in the recording of data in the different fields. The degree of inter and intra data field completeness for each year would provide some indication of the reliability of the HES data.

To get a precise estimate of the consistency of data recording between data fields over the time period 2000-2009, I performed a sensitivity analysis for two key outcomes; mode of delivery and newborn birth status (live, stillbirth). I selected these because the birth (whatever the mode of delivery) of a baby (live or stillborn), are the inevitable endpoints of labour for every woman, so one would expect there to be minimal missing data for them. The proportion and 95% confidence interval would show the pattern of data completeness over the time period.

To establish the level of data entry agreement/overlap for variables that shared more than one data field; for example mode of delivery (MDD-MF, ICD-10, OPCS-4), induction of labour (MDD-MF, OPCS-4) cross tabulations were performed on data for labour induction,

epidural analgesia, types of delivery, perineal trauma and repair, retained placenta and manual removal of placenta, live birth/stillbirth.

6.3 RESULTS

6.3.1 Descriptive analysis, missing data and data inconsistencies between fields: maternal data

Overall descriptive results for maternal characteristics, induction of labour and epidural analgesia showed that the HES sample included 41% nulliparae and 59% multiparae, with a mean gestational age of 39.7 weeks. The proportions of missing data for parity and gestational age were 26% and 38% respectively. Labour induction and epidural were recorded in two fields: MDD-MF and OPCS-4. There was a marked discrepancy between MDD-MF and OPCS-4 records for labour induction with 15% more inductions reported in OPCS-4 field, and a minor inconsistency of 1.5% more epidural recorded in OPCS-4 than MDD-MF (Table 6.5).

Table 6.5: Maternal characteristics, induction of labour and epidural for HES data 2000-2009

	MDD-MF N=10,708	**ICD-10 N=10,708**	**OPCS-4 N=10,708**
n(%) Nulliparae n (%) Multiparae n (%)	*Completed data n=7,929 (74.0)* 3243 (40.9) 4,686 (59.0)	NA	NA
n(%) Age: mean (SD) years	*Completed data n=8,653 (80.8)* 28.6 (5.99)	NA	NA
n(%) Gestation: mean (SD) weeks	*Completed data n=6,652 (62.1)* 39.7 (1.23)	NA	NA
Type of labour onset Induction n (%)	*Completed data n=10,074(94)* 2,266 (22.4)	NA	3,891 (36.3)
Analgesia Epidural n (%)	*Completed data n=8,895 (83.0)* 1,246 (14.0)	NA	1,666 (15.5)

N=sample size; *n*=number of women analysed for each variable – women with missing data excluded from analysis.
NA = no ICD-10 or OPCS-4 code equivalent

As expected with a population of healthy women in childbirth, SVD was the most common mode of delivery (Table 6.6). As with maternal parity, age, gestation, labour induction and epidural analgesia, there were missing data for mode of delivery; ICD-10 codes contained no information for this outcome for a large proportion (76%) of the sample, whereas there was 97% completion for OPCS-4 data. There was no type of delivery recorded for 22% women in the MDD-MF field. There were discrepancies in the overall proportions of the different modes of delivery between fields, with the most significant differences occurring in the ICD-10 field. With the exception of vaginal breech delivery, there was relative consistency between MDD-MF and OPCS-4 records for the mode of delivery proportions (Table 6.6). Unexpectedly, the sample included 683 (6.3%) women who had an elective Caesarean section, despite this being an exclusion criterion for the sample.

Table 6.6: mode of delivery for HES data 2000-2009

	MDD-MF N=10,708	**ICD-10 N=10,708**	**OPCS-4 N=10,708**
Mode of delivery	*Completed data n=9,426 (88.0)*	*Completed data n= 2,439 (22.7)*	*Completed data n=10,371 (96.8)*
SVD n (%)	6899 (73.1)	2154 (88.3)	7548 (72.8)
Operative vaginal n (%)	1197 (12.7)	55 (2.2)	1341 (12.9)
Vaginal breech n (%)	40 (0.4)	4 (0.1)	6 (0.1)
Emergency CS n (%)	1030 (10.9)	76 (3.5)	1203 (11.6)
Elective CS n (%)	260 (2.7)	150 (6.9)	273 (2.6)

N=sample size; *n*=number of women analysed for each variable – women with missing data excluded from analysis.

Few women overall were reported to have suffered OASIS, defined as per the WHO ICD-10 classification of anal sphincter rupture on a continuum from partial to total (third degree), or total sphincter rupture extending into the rectum (fourth degree), a primary postpartum haemorrhage or manual removal of placenta (Table 6.7). There were discrepancies between ICD-10 and OPCS-4 results for the occurrence of spontaneous perineal trauma and its subsequent repair. As seen in table 4.1, the ICD-10 field contains the variables for perineal trauma, whilst the OPCS-4 field reports perineal repair and episiotomy. Whilst some first and second degree tears are not sutured in clinical practice, third and fourth degree PT always requires suturing. For OASIS, there were marginally

more repairs (OPCS-4) than tears (ICD-10) recorded. Likewise, a lower proportion of women were identified in ICD-10 codes as having a retained placenta than that recorded in the OPCS-4 field as having a manual removal of placenta (Table 6.7).

Table 6.7: Perineal trauma, perineal repair, episiotomy, PPH and MROP for HES data 2000-2009

	MDD-MF N=10,708	**ICD-10 N=10,708**	**OPCS-4 N=10,708**
Perineal trauma n (%) First degree	NA	† 1,790 (16.7)	‡ 589 (5.5)
Second degree	NA	2,511 (23.4)	2,078 (19.4)
OASIS	NA	193 (1.8)	202 (1.9)
Episiotomy n (%)	NA	NA	1,490 (13.9)
PPH n (%)	NA	742 (6.9)	NA
Retained placenta n (%)	NA	96 (0.9)	NA
MROP n (%)	NA	NA	186 (1.7)

N=sample size; *n*=number of women analysed for each variable – women with missing data excluded from analysis.
NA = no MDD-MF, ICD-10 or OPCS-4 field equivalent. †ICD-10 = the number and proportion of women who sustained spontaneous perineal trauma. ‡OPCS-4 = the number of women who had perineal repair

6.3.2 Descriptive analysis, missing data and data consistency between fields: newborn data

For birth weight and neonatal resuscitation, there were missing data for just over 10% and 20% newborn respectively. The ICD-10 field had less missing data for whether the baby was born alive or stillborn than MDD-MF (Table 6.8). A higher proportion of stillbirths were recorded in the MDD-MF field comprising 36 antepartum, one intrapartum and 10 cases that were recorded as 'indeterminate'. The ICD-10 code for stillbirth (Z371) does not differentiate whether the fetus died during the antenatal period or during labour.

Overall, there were little missing HES data for newborn and high level of agreement between fields, suggesting that it is a priority to record newborn birth status.

It was not possible to establish the number of admissions to NICU because all entries for the MDD-MF neocare category were coded as 'not applicable'. I learned retrospectively that due to a lack of data linkage between mother and infant, newborn data collected beyond birth status, resuscitation at delivery and birth weight are stored separately to maternal data, and to access this information would have required requesting another dataset.

Table 6.8: Newborn outcomes for HES data 2000-2009

	MDD-MF N=10,708	**ICD-10 N=10,708**	**OPCS-4 N=10,708**
Birth weight: mean (SD)kg	*Completed data n=9,485(88.5)* 3410.9 (494.34)	NA	NA
Resuscitation n (%)	*Completed data* n=8,538 (80) 620 (7.2)	NA	NA
Birth status n (%)	*Completed data n=8692 (81.2)*	*Completed data n=10,283 (96.0)*	NA
Live n (%)	8645 (99.5)	10,268 (99.9)	NA
Stillbirth n (%)	47 (0.5)	15 (0.1)	NA

N=sample size; *n*=number of women analysed for each variable – women with missing data excluded from analysis.
NA = no ICD-10 or OPCS-4 field equivalent

6.3.3 HES data integrity: ranges for missing data

Results for data completeness for all HES fields over the time period 2000-2009 showed a consistent pattern of less than 100% data completion for each year. A series of bar charts (Figure A5.1 to A5.7) showed that irrespective of data field, there were no discernible trends towards greater completeness over time [Appendix 5].

Data completion range for MDD-MF field only variables 2000-2009

- Maternal parity: from 81% in 2002 to 57% in 2007
- Maternal age: from 91% in 2006 to 68% in 2008
- Gestation at time of delivery data: from 56% in 2003 to 79% in 2008
- Newborn resuscitation: from 83% in 2006 to 72% in 2008
- Birth weight: from 79% in 2001 to 91% in 2006 and 2008

Data completion range for variables that are recorded in more than one data field 2000-2009

Mode of delivery

- ICD-10: from 27% in 2002 to 17% in 2008
- MDD-MF: from 91% 2008 to 84% in 2000
- OPCS-4: from 92% in 2001 to 98% in 2006 and 2007

Birth status (live/still birth)

- MDD-MF: from 74% in 2003 to 91% in 2008
- ICD-10: from 88% in 2000 to 97% in 2003 and 2004

6.3.4 HES data integrity: consistency of data records within and between data fields 2000-2009

To get a precise estimate of the consistency of data recording between data fields over the time period 2000-2009, sensitivity analysis of mode of delivery and newborn birth status was performed, to examine if there was any discernible pattern to the proportion and 95% confidence interval of missing data both within and between the data fields (Table 6.9, Table 6.10).

There was no significant difference in data completion in any one year of the sample within any of the three data fields, but there were differences between fields for mode of delivery. OPCS-4 and ICD-10 proportions for completeness for mode of delivery were identical year on year at 97% and 23% respectively. MDD-MF completeness was 88% for each year bar 2003-2004 when it increased by 1% (Table 6.9).

Table 6.9: Estimates for mode of delivery for HES data by year 2000-2009

Years	Mean % difference for mode of delivery	Lower 95% CI	Upper 95% CI
Mode of delivery OPCS-4			
2000-2009	0.97	0.96	0.97
-2000-2001	0.97	0.96	0.97
-2001-2002	0.97	0.96	0.97
-2002-2003	0.97	0.97	0.97
-2003-2004	0.97	0.97	0.97
-2004-2005	0.97	0.97	0.97
-2005-2006	0.97	0.97	0.97
-2006-2007	0.97	0.96	0.97
-2007-2008	0.97	0.96	0.97
-2008-2009	0.97	0.97	0.97
Mode of delivery ICD-10			
2000-2009	0.23	0.22	0.24
-2000-2001	0.23	0.22	0.24
-2001-2002	0.23	0.22	0.24
-2002-2003	0.23	0.22	0.23
-2003-2004	0.23	0.22	0.24
-2004-2005	0.22	0.21	0.23
-2005-2006	0.23	0.22	0.24
-2006-2007	0.23	0.22	0.24
-2007-2008	0.23	0.22	0.24
-2008-2009	0.23	0.22	0.24
Mode of delivery MDD-MF			
2000-2009	0.88	0.87	0.89
-2000-2001	0.88	0.87	0.89
-2001-2002	0.88	0.87	0.89
-2002-2003	0.88	0.87	0.89
-2003-2004	0.89	0.88	0.89
-2004-2005	0.88	0.87	0.88
-2005-2006	0.88	0.87	0.89
-2006-2007	0.88	0.87	0.88
-2007-2008	0.88	0.88	0.89
-2008-2009	0.88	0.87	0.89

Data completeness was consistently high for newborn birth status within and between the HES MDD-MF and ICD-10 fields (Table 6.10).

Table 6.10: Estimates for newborn birth status for HES data by year 2000-2009

HES extracts	Mean % difference for newborn status	Lower 95% CI	Upper 95% CI
Newborn birth status MDD-MF			
2000-2009	0.99	0.99	1.0
-2000-2001	0.99	0.99	1.0
-2001-2002	0.99	0.99	1.0
-2002-2003	1.0	0.99	1.0
-2003-2004	0.99	0.99	1.0
-2004-2005	0.99	0.99	1.0
-2005-2006	0.99	0.99	0.99
-2006-2007	0.99	0.99	1.0
-2007-2008	1.0	1.0	1.0
-2008-2009	0.99	0.99	1.0
Newborn birth status ICD-10			
2000-2009	0.96	0.96	0.97
-2000-2001	0.96	0.96	0.97
-2001-2002	0.96	0.96	0.97
-2002-2003	0.96	0.96	0.97
-2003-2004	0.96	0.96	0.97
-2004-2005	0.96	0.96	0.97
-2005-2006	0.96	0.96	0.97
-2006-2007	0.96	0.96	0.97
-2007-2008	0.96	0.96	0.97
-2008-2009	0.96	0.96	0.97

6.3.5 HES data integrity: data agreement between fields

In order to investigate the reliability of data that shared more than one data field shown in Table 6.5 to Table 6.8, cross tabulations were performed to examine the differences for the proportion of data recorded within each data field and the overall level of agreement between the data fields. For example, the number and percentage of records that were identified for SVD having occurred (yes) versus SVD not having occurred (no) within MDD-MF and ICD-10 fields and the resulting overall agreement that this represented between those two fields.

Table 6.11 shows the proportions of overall agreement between two data fields and the proportion of records that matched for something having occurred (yes) or not occurred (no) within two data fields. The only cross tabulations with complete agreement occurred

between MDD-MF and OPCS-4 and MDD-MF and ICD-10 for vaginal breech delivery wherein no cases were identified. OPCS-4 and ICD-10 had the highest agreement between fields, and this was for extensive perineal trauma and perineal repair. Reassuringly, results for PT (ICD-10) and PT repair (OPCS-4) did not identify any women who had a repair without sustaining a tear. Likewise between ICD-10 and OPCS-4, no women who had a manual removal of placenta were identified as not having a retained placenta

Table 6.11: Proportions for data agreement within data fields and overall proportions for data agreement between fields

Data items	**†Overall agreement % between two data fields**	**‡% recorded within two data fields**	
		MDD-MF %	**ICD-10 %**
SVD	41.2	23.6	75.7
Operative vaginal	87.4	2.4	52.7
Emergency CS	89.2	3.9	52.6
Elective CS	97.0	21.9	38.0
Vaginal Breech	99.5	0	0
Neonatal			
Live birth	95.7	96.2	81.0
Stillbirth	99.5	21.3	66.6
		MDD-MF %	**OPCS-4 %**
Labour induction	66.0	55.2	38.6
Epidural	83.2	48.3	36.1
SVD	75.6	78.7	74.6
Operative vaginal	86.7	47.3	42.2
Emergency CS	87.9	45.8	39.2
Elective CS	96.8	40.1	38.1
Vaginal Breech	99.5	0	0
		ICD-10 %	**OPCS-4 %**
SVD	49.1	98.7	28.1
Operative vaginal	87.9	72.7	4.0
Emergency CS	89.3	90.7	5.7
Elective CS	98.8	99.3	54.6
Vaginal Breech	99.9	25.0	16.6
Perineal trauma and repair			
First degree	87.6	29.3	89.1
Second degree	94.7	80.1	97.6
Extensive (3°, 4°)	99.5	90.6	86.6
Retained placenta and MROP	98.6	72.1	37.1

†Overall agreement represents the proportional congruence between what was recorded in one field with what was recorded in another field.

‡Proportion recorded within two fields shows the intra data field proportion of records that matched for an event occurring.

6.4 DISCUSSION

6.4.1 Overall results

The HES sample comprised 10,708 women whose records indicated that they were at low risk of childbirth complication: all laboured at term gestation with a singleton fetus, spontaneous vaginal birth was the most common mode of delivery, few women sustained OASIS, a primary postpartum haemorrhage, or had a manual removal of placenta, the mean newborn birth weight was average for term gestation and fewer than 1% of babies were stillborn. The overall low proportion of women who had epidural analgesia, sustained extensive perineal trauma, postpartum haemorrhage, or required a manual removal of placenta were similar to results for other national studies involving healthy women in childbirth (Birthplace in England Collaborative Group, 2011a, Burns *et al.*, 2012, Overgaard *et al.*, 2011).

The HES dataset incorporated data from three data directories, and whilst some variables were field specific, others shared more than one data field, for example, mode of delivery for example. Descriptive analysis showed that notwithstanding the issue of missing data, MDD-MF provided data for crucial obstetric characteristics such as maternal parity, age and gestation, which can influence what happens to women during labour (Bai *et al.*, 2002, Balasch and Gratacos, 2011). The HES MDD-MF data would enable stratified analyses by maternal parity, as undertaken for the birthing pool data. This data field also yielded some essential newborn data; birth status, resuscitation at delivery and birth weight.

The higher proportions of ICD-10 records for first and second degree perineal trauma, which had no corresponding OPCS-4 perineal repair recorded had clinical credibility because over the time period of the sample, a practice trend evolved wherein midwives did not routinely suture first and second degree perineal tears (Elharmeel *et al.*, 2011).

Cross tabulations showed good overall agreement between MDD-MF and OPCS-4 fields for mode of delivery and birth status. Sensitivity analyses for the HES sample for mode of delivery and birth status identified no statistically significant difference in their proportion of missing data by field for each year, although it did show differences in the annual coverage between fields. HES tabulations for all women in childbirth in England for the

same time period also showed differences in data completeness between fields for mode of delivery and differences for MDD-MF birth status coverage. Moreover, data linkage investigations comparing HES delivery and baby records data with birth registration and National Number for Baby (NN4B) (Connecting for Health, 2007) records have highlighted continued disparities and missing data (Dattani *et al.*, 2011, Moser and Hilder, 2008). Missing data, data discrepancies between fields, and fragmented data linkage challenge the overall reliability of HES data. These issues require discussion for two reasons: firstly, because they present a potential threat for HES data to provide a reliable control group for the birthing pool data, and secondly, the integrity (reliability and clinical relevance) of HES maternity data in general.

6.4.2 Maternity data coder perspective

To set the routine coding of childbirth data into context and explore reasons for disparities, I had informal discussions with three data coders employed by three NHS maternity units situated in three different strategic health authorities. All coders had received training for their role and each had between 10 and 11 years' experience in coding childbirth data submitted to SUS.

6.4.2.1 Data field prioritisation

Common practice between all coders regarding data field prioritisation included: OPCS-4 codes for induction of labour and for mode of delivery; no use of MDD-MF codes for mode of delivery, or newborn birth status, ICD-10 codes for newborn status; ICD-10 codes for PT, and OPCS-4 codes for PT repair, and episiotomy; ICD-10 codes for retained placenta, and OPCS-4 for MROP.

All coders recorded ICD-10 for PPH; in one hospital, the estimated blood loss parameters were >500ml for vaginal deliveries, or >800ml for CS. These are not consistent with RCOG definitions for minor or major PPH (Royal College of Obstetricians and Gynaecologists, 2009).

One coder routinely prioritised OPCS-4 for epidural analgesia during labour, one did on occasion (I could not elicit any conditions for recording or not recording this item), and one hospital never coded epidural.

In addition to prioritising the OPCS-4 codes for mode of delivery, two coders also recorded the ICD-10 codes. Interestingly all coders stated that in the absence of case note or maternity electronic delivery system information for perineal trauma or perineal repair, they used spontaneous (cephalic) vaginal delivery ICD-10 code 0800 (Table 6.2). Code 0800 therefore represented a spontaneous birth with an intact perineum. However, when I cross tabulated my data to test this belief, I found it to be incorrect.

6.4.2.2 Variation in MDD-MF recording

Coders were not consistent in their use of the MDD-MF field, and differences included

- Parity data recording varied from none to nulliparous women > 35years, and one also recorded parity for women who had >5 previous births
- Maternal age recording ranged from none to only women who were under 16 years of age
- Gestational age data entry ranged from any to only <37 weeks
- Birth weight recording ranged from any to <999gr, or if <2,500gr or >4,500gr

The planned and actual place of birth codes were an area of uncertainty among coders. One used the HES intended and actual place of delivery codes listed in Box 6.1, but recognised they did not cover the three freestanding midwifery units in her NHS Trust, which she coded as 'delivery facilities associated with midwife ward' (Box 6.1). One coder used 'domestic address' as place of birth for babies who were born en route to hospital, and did not record homebirths unless they involved a hospital episode; for example, admission for a retained placenta.

All coders appeared to be responsible, diligent and committed to being as accurate as they could be about the labour and delivery data; all had been trained for their role, and two attended a refresher course every two to three years. Each received code updates regularly and had access to more senior coders and clinicians when unsure about her source information which comprised a mix of case notes, birth notifications and in-house patient administration systems (PAS). Finally, all coders thought the purpose of their work related to income for their respective hospitals.

Coder information corroborated my HES sample results of highest data completeness for OPCS-4 field for mode of delivery, and ICD-10 for newborn birth status. Does data completeness equate with accuracy however? An Australian study that compared the accuracy and reliability of ICD-10 and OPCS-4 coded intrapartum data with a 'gold standard' population based validation study, reported a higher level of completeness and accuracy for OPCS-4 than for the ICD-10 field (Roberts *et al.*, 2008); a finding echoed by other reports on maternity data (Lain *et al.*, 2008b, Lydon-Rochelle *et al.*, 2005, Yasmeen *et al.*, 2006). These studies support the use of the OPCS-4 codes for mode of delivery but not the use those for ICD-10 codes for newborn birth status. However, it may be possible to use this field for exclusive ICD-10 directory data items.

Coder discussions revealed differing levels of engagement between hospitals with MDD-MF data items, and idiosyncratic, local parameter applications. Coder uncertainty about coding data for planned and actual place of delivery confirmed my interpretation that the definitions lack clarity and do not reflect contemporary care settings for birth in the UK.

6.4.3 Organisational factors in relation to the collation and analysis of maternity data for England

6.4.3.1 HES analyst remit

HES data are processed by analysts in the NHS Information Centre (IC). On receipt of the data from SUS, they clean and analyse ICD-10, OPCS-4 and MDD-MF coded records in accordance with rules set by Data Standards (DS) in NHS Connecting for Health (NHS CH)(NHS Connecting for Health, 2012). NHS CH is part of the DoH's informatics department and governs the NHS data dictionaries. Data rules are decided following consultation with the National Information Standards Board (NISB) within CH. Analysts prioritise ICD-10 and OPCS-4 coded data over information from the MDD-MF. This corroborates coder priorities who receive their training from CH, suggesting that Payment by Result requirements drive the analyses agenda, and could explain why despite setting the mandatory fields (MF) for delivery and birth data collection in the MDD directory(Connecting for Health, 2012a), the NHS CH do not appear to engage with it.

HES analysts have statistical expertise but no specialist knowledge of obstetrics or midwifery, yet part of their remit involves addressing enquires from researchers, clinicians, NHS managers and the public. Whilst their work arena extends beyond maternity data, it is nonetheless problematic that they do not have at least a working knowledge of the obstetric and midwifery terminology and processes. Analysts draft specifications for bespoke datasets, which they may be commissioned to analyse on behalf of a hospital trust or primary care trust for example, and bespoke datasets for analyses by others, such as my HES sample.

Analysts also liaise with the Maternity Statistics Information Exchange Group (MSIEG), and some attend the meetings of this committee, which comprises a mix of health and management professionals who are involved in pregnancy, childbirth and child health. The MSIEG is part of the Health Statistics Users' Group (HSUG), and sits within the Royal Statistical Society, an independent entity which engages in activities aimed at improving data access, data quality and the use of healthcare statistics (The Royal Statistical Society). Improving the quality of data linkage between HES and Office for National Statistics (ONS) data for gestation, newborn birth status and birth weight is one example of MSIEG activities (Moser and Hilder, 2008).

6.4.3.2 Organisational fragmentation

The work of healthcare data analysts is split between the IC and CH departments. They draft bespoke dataset specifications, for which they do not extract the data; that job is done by analysts based in Northgate Information Solutions (NIS), the NHS information technology provider responsible for the HES website in the IC department (Northgate Information Solutions). Organisational fragmentation within HES and between HES and ONS limit essential data linkage, for example between maternal antenatal, intrapartum and postpartum records and newborn records. This inevitably reduces the overall reliability and clinical relevance of routinely collected maternity data.

6.4.3.3 MDD-MF: current status and relevance

The MDD-MF is the only field with key maternal and newborn variables that can influence intrapartum events, interventions and outcomes. The variables in the directory that are identified as mandatory field items for labour and delivery (Table 6.2) were decided upon

following recommendations of a maternity care data project, and aimed to provide a standardised 'core clinical record'. It was also an attempt to assert the importance and relevance of clinical data, which had assumed a lower value than administrative data (ICD-10, OPCS-4 and the Payment by Results agenda) (Steer, 2002).

The NISB in CH rejected the MDD-MF in 2002 on the grounds that it was substandard, but without explaining why it considered it to be so (Steer, 2002). This rejection of the MDD-MF has resulted in it assuming a Cinderella status, and explains why NHS CH data coder training and instructions to HES analysts prioritise use of the ICD-10 and OPCS-4 directories. It also clarifies why NHS trusts have been left to apply in-house parameters for, and decide their level of engagement with MDD-MF data items, and could explain the escalating proportion of missing MDD-MF data being submitted to SUS. Despite no review of the MDD-MF, in 2011 the NISB approved a 'new' maternity services dataset, which is currently awaiting implementation government funding (Information Standards Board, 2011).

The implication of proposed continued use of unclear definitions for such important data items is of concern in the context of a proposed reconfiguration of the maternity service set out in an RCOG expert advisory group report (Royal College of Obstetricians and Gynaecologists, 2011). The backdrop for the report's recommendations included a shortfall of medical personnel for the current number of UK obstetric units, coupled with Working Time Regulations, the financial downturn and impending healthcare commissioning changes. Supporting a wellness model aimed at optimising health and in line with the choice agenda for women in childbirth, the central thread of proposals is to increase the use of midwifery units and home birth for healthy pregnant women. This number of obstetric units would be reduced to ensure they all have safe staffing levels, the required expertise and resources for pregnancy complications: 'care must be the right care, at the right time, in the right place and provided by the right person', (Royal College of Obstetricians and Gynaecologists, 2011). The report emphasises the importance of having quality information to inform healthcare commissioners and to guide practice. Currently, it is not possible to gather accurate data for where women plan to and actually give birth or why they are transferred from their planned to actual place of delivery.

6.4.4 Clinical relevance of routinely collected maternity data in general

The clinical relevance of routinely collected healthcare data is really important, yet it is acknowledged that the analyses and presentation of these data can be poor (Barratt and Kirwan, 2009). Notwithstanding the aforementioned limitations in data linkage, the on-going and in the case of the MDD-MF directory, increasing proportion of missing data, along with variations in data coding as illustrated, it is not possible to extrapolate the relevance of maternity data from current HES annual tabulations for labour and birth. This is because the analyses of intrapartum events, interventions and outcomes are not separated by obstetric profile or by maternal parity. Obstetric profile stratification is important; for example, tabulations for routinely collected maternity data do not specifically identify healthy pregnant women who reach term gestation; have a singleton fetus and no identified problem at their labour onset. As mentioned in chapter one, this group represents the largest childbearing population in the UK (National Collaborating Centre for Women's and Children's Health, 2007). One would expect the overall events, interventions and outcomes for these women and their newborn to be different from those with co-morbidities such as diabetes, or autoimmune pathologies for example. Maternal parity is an influential factor for intrapartum events, interventions and outcomes.

Antenatal, intrapartum and postpartum data fragmentation for women and their newborn further limits the potential to produce robust, relevant results for stakeholders. With greater data linkage and more discerning analyses involving obstetric risk and parity stratification, NHS Trusts, PCTs and SHAs would not need to commission bespoke analyses from HES or Dr Foster Intelligence (who like HES, have a contract to receive maternity data from SUS)(Dr Foster Intelligence, 2012). Despite investment in the number of people involved in collating and analysing maternity data following the introduction of the internal market into healthcare contracting in the 1990's, quality information has yet to become available (Brennan *et al.*, 2012, Steer, 2002).

There is a thrust to engage clinician interest in what data are collected and how they are collated in their NHS trusts; currently they have little involvement in the data submitted to SUS. It is heartening to note that the clinical context in which data are collected is being considered. As the lead caregiver for the majority of women in childbirth and the clinicians attending 100% of births in the UK, it is essential that midwives with clinical expertise and

an understanding of data are invited to participate in any initiatives to improve maternity data quality, and appropriately remunerated. A discussion document published as part of a joint initiative between the IC and the Academy of Medical Royal Colleges, underlines the necessity of having quality data to improve the quality of care for service users (Spencer, 2011), as identified by the government's Operating Framework for 2010 and the Next Stage Review (Darzi, 2008, Department of Health, 2011).

6.5 CONCLUSION

The purpose in obtaining a random sample of intrapartum data collated by HES data for women and their newborn was to determine if the HES data could be used as a comparison group for the birthing pool data. Exploration indicated that despite its limitations, the dataset was sufficiently reliable for it to be used as a control group for the birthing pool dataset. Furthermore, results for descriptive analysis were similar to those found for the Birthplace study, which suggested that the HES sample of women were representative of healthy women in childbirth, and could therefore be compared with the birthing pool women. Using MDD-MF data, I could stratify analysis by maternal parity, but not by planned place of birth because the MDD-MF definitions for these codes lack clarity, and whilst there is a code for homebirth (domestic address), there is none for freestanding midwifery unit, which precluded having a community setting that was the equivalent of the community setting for the birthing pool dataset.

Through examining the HES dataset, I acquired a deeper understanding of the strengths and limitations of routinely collected data, and the challenges involved in collating and summarising them. The current political circumstance of a government poised to implement radical changes in NHS care commissioning and service delivery, and its stated commitment to high quality healthcare information presented a unique opportunity to make recommendations for improvement [Appendix 7].

Comparing maternal characteristics, intrapartum interventions and outcomes for women who used a birthing pool during labour and a HES sample of healthy women in childbirth

Chapter six established that my bespoke HES dataset comprising routinely collected maternity data provided a core set of reliable and internally consistent data. This Chapter examines whether the maternal characteristics for women in the HES dataset were of a similar low risk obstetric profile to those for women in the birthing pool sample described in Chapter four, in order to enable comparative analyses of the intrapartum interventions and outcomes between the two groups.

7.1 INTRODUCTION

The impetus to access the HES[31] sample was to assess its potential to provide a comprehensive and reliable comparison for the birthing pool women. The specification for the HES sample, detailed in Chapter four, was therefore shaped to match the eligibility criteria for the birthing pool cohort. Women were identified to be at low risk of childbirth complication, had a singleton fetus and laboured at term gestation. The same variables of interest that were collected for the birthing pool sample were requested for inclusion in the HES sample. To account for possible clinical practice changes over time, the HES sample was stratified proportionately by each year of the birthing pool study (2000 – 2009). Finally, to ensure that the sample size was large enough to permit comparative estimates of variables of interest to be as precise as the birthing pool data, the HES analysts recommended that the sample size for HES was the same as for the birthing pool sample plus 20%, to account for a likely proportion of missing data. Therefore, 20% was added to the number of women who were randomly selected for each year.

Examination of the HES sample indicated that despite gaps in data coverage, MDD-MF[32] data could be used to compare maternal characteristics (parity, age, gestation) and some key intrapartum interventions and outcomes with those for the birthing pool women. These comprised induction of labour, epidural analgesia, mode of delivery, newborn birth weight, resuscitation, and perinatal mortality.

[31] HES – routinely collected maternity data which are collated and analysed by Hospital Episode Statistics analysts.
[32] Maternity data directory – mandatory field

My research question for this comparative analysis was

1. Are the maternal characteristics[33] of the sample of women who used a birthing pool and the sample of women from HES sufficiently similar to make a meaningful comparison of key intrapartum interventions and outcomes by parity?

If the HES sample was sufficiently similar to make a comparison with the birthing pool sample feasible, my research questions were:

1. Do intrapartum events, interventions and maternal and newborn outcomes very between the sample of women in the birthing pool sample and women in the HES sample?
2. Does the type of labour onset influence intrapartum events, interventions and maternal and neonatal outcomes for women in the birthing pool sample and women in the HES sample?
3. Do intrapartum events, interventions and maternal and neonatal outcomes vary between the subset of women who used a birthing pool and the subset of women from HES who had a spontaneous labour onset?

7.2 METHODS

7.2.1 Data preparation for birthing pool and HES MDD-MF comparisons

A new SPSS file was created containing the following binary and continuous data variables: HES/birthing pool identification, maternal parity, age, gestation, spontaneous labour, induction of labour, epidural, type of delivery (SVD, operative vaginal, vaginal breech, emergency/elective CS) and neonatal resuscitation. Birthing pool and HES MDD-MF data for these variables were transferred into two master files. Frequencies for the variables were checked against the original master files for accuracy before the data were merged into one new file. All descriptive analyses were performed using SPSS (version 19.0). Data were checked for normal distribution and frequencies were calculated; the number and percentage for categorical data, and the mean and standard deviation for continuous data. Univariate analysis was performed using Pearson χ^2 test for categorical

[33] Healthy and therefore at low risk of childbirth complication

data and the independent t-test for continuous data with a significance set at 0.05. Missing data were excluded from analyses.

7.2.2 Comparison of the maternal characteristics between birthing pool and HES women

Using MDD-MF data only because this is the only HES field that contains variables for maternal parity, age and gestation, I compared maternal characteristics for the birthing pool women with those for women in the HES sample.

7.2.3 Comparisons of intrapartum interventions and outcomes between birthing pool and HES women by parity

Maternal characteristics, intrapartum interventions and outcomes for the HES sample were compared with those for the birthing pool sample by parity. For HES data, this involved exclusive use of MDD-MF because it is the only field that contains maternal characteristic information.

7.2.4 Subgroup comparisons by type of labour onset[34] and by parity

The presence of more women who had induction of labour in the HES sample presented a potential confounder for leading to more interventions and complex intrapartum outcomes for this group. This could introduce a bias in favour of the birthing pool sample by steer the interpretation of results towards showing a 'greater benefit' for this group, because induction of labour is associated with co-interventions; for example, epidural analgesia, operative delivery and neonatal resuscitation (Beebe *et al.*, 2007, Bodner-Adler *et al.*, 2005, Caughey *et al.*, 2009, Glantz, 2005).

I therefore explored induction of labour as a potential confounder for the incidence of intrapartum interventions and outcomes by performing subgroup analyses by type of labour and by parity for women in the birthing pool sample and women in the HES sample. I tested for statistical significance using Pearson χ^2 test for categorical data with a significance set at 0.05.

[34] Type of labour onset refers to spontaneous versus induction of labour.

If significant differences were detected between spontaneous labour and induction of labour, a decision would be made to restrict HES and birthing pool comparisons to the sub-groups of birthing pool and HES women who laboured spontaneously.

7.2.5 Comparative analyses for the subgroup of birthing pool women who had a spontaneous labour onset, and the subgroup of HES women who had a spontaneous labour onset

I performed descriptive analysis for maternal characteristics, epidural, mode of delivery, newborn birth weight and resuscitation for the subgroup of birthing pool women who laboured spontaneously and the subgroup of HES women who laboured spontaneously. Data were then checked for normal distribution, and univariate analysis was performed using Pearson χ^2 test for binary data and the independent t-test for continuous data with a significance set at 0.05. Missing data were excluded from all analyses.

7.3 RESULTS

7.3.1 Comparison of the maternal characteristics between birthing pool and HES women

There were significantly more nulliparae in the birthing pool sample (4,953/8,923, 55%, [95% CI 54.5, 56.5]) compared with the HES sample (3,244/7,928, 41.0%, [95% CI 38.6, 40.7]), $p<0.001$. Although women in the birthing pool sample were significantly older (mean age 29.4 years, SD 5.6) than women in the HES sample (mean age 28.7 years, SD 5.9), $p<0.001$, the difference was less than one year. There was also a significant difference in gestational age between the two samples, but the difference was less than one week (birthing pool mean 39.8 weeks, SD 1.1 versus HES mean 39.7 weeks, SD 1.2) $p<0.001$.

Both samples had missing data for maternal characteristics, although the overall proportion of missing data was markedly greater for the HES sample: maternal parity was missing for only one woman in the birthing pool sample (1/8,924, 0.01%), versus 2,780 (25.9%) for the HES sample; maternal age was missing for 107 (1.2%) for birthing pool women, and 2,055 (19.2%) for HES women, and gestational age was missing for 1,623 (18.2%) birthing pool women versus 4,056 (37.9%) for HES women.

7.3.2 Comparisons of intrapartum interventions and outcomes between birthing pool and HES women by parity

7.3.2.1 Nulliparae

Compared with the HES sample, tenfold fewer birthing pool nulliparae had an induction of labour, fewer used epidural analgesia, a 13% higher proportion had an SVD, fewer than half had an emergency CS, and slightly fewer had a vaginal breech delivery (Table 7.1).

7.3.2.2 Multiparae

Compared with the HES sample, tenfold fewer birthing pool multiparae had an induction of labour, fewer had an epidural, 20% more had an SVD, 8% fewer had an operative vaginal delivery, 9% fewer had an emergency CS and slightly fewer had a vaginal breech delivery (Table 7.1).

Overall proportions of missing data for type of labour onset (spontaneous or induction), epidural and mode of delivery for the birthing pool sample ranged from 0.04% (four) for epidural to 0.29% (26) for type of delivery. Missing data for the HES sample for the same variables ranged from 5.5% (439) for type of labour onset to 16.8% (1337) for epidural (Table 7.1)

Table 7.1: Comparisons of intrapartum interventions and outcomes between birthing pool and HES women by parity

Binary: n (%) Continuous: mean (SD) [CI 95%]	***Birthing pool*** N=8,924		***HES*** N=10,708	
	n=8,923		n=7,928	
Parity n (%)	Nulliparae 4953 (55.5) [54.5,56.5]	Multiparae 3970 (44.5) [43.5,45.5]	Nulliparae n=3244 (41.0) [39.8,42.0]	Multiparae n=4684 (59.0) [58.0,60.2]
Age:year Mean (SD)	n=4883 27.8(5.5)	n=3933 31.3(5.1)	n=2644 27.8 (6.1)	n=3863 29.2 (5.8)
Gestation: completed weeks Mean (SD)	n=3948 39.7(1.1)	n=3352 39.8(1.1)	n=1961 39.7(1.2)	n=2921 39.7(1.2)
Induction of labour n (%)	n=4953 117(2.4) [19.6,28.2]	n=3970 109(2.7) [22.6,33.0]	n=3065 705 (23.0) [21.5,24.5]	n=4425 968 (21.9) [20.7,23.1]
Epidural n (%)	n=4949 724 (14.6) [13.7,15.6]	n=3970 101(2.5) [20.8,30.8]	n=2785 474 (17.0) [15.6,18.5]	n=3807 395 (10.4) [9.4,11.4]
Mode of delivery	n=4936	n=3961	†n=2899	†n=4210
SVD n (%)	4030(81.6) [80.5,82.7]	3871(97.7) [97.2,98.2]	1981 (68.3) [66.6,70.0]	3271 (77.6) [76.4,78.9]
Operative vaginal n (%)	608(12.3) [11.4,13.3]	48(1.2) [0.9,1.6]	467 (16.1) [14.8,17.5]	388 (9.2) [8.4,10.1]
Vaginal Breech n (%)	10(0.2) [0.9,3.7]	9(0.2) [0.1,0.4]	12 (0.4) [0.2,0.7]	23 (0.5) [0.3,0.8]
Emergency C.S n (%)	288(5.8) [5.2,6.5]	33(0.8) [0.6,11.7]	356 (12.3) [11.1,13.5]	403 (9.6) [8.7,10.5]

N=sample size; *n*=number of women analysed for each variable – women with missing data excluded from analysis.
† 208 women (2.9%, 83 nulliparae, and 3%, 125 multiparae) in the HES sample had an elective CS.

7.3.2.3 Newborn outcomes

Irrespective of parity, the mean birth weight was greater, and there were more large babies (≥4,000 grammes) in the birthing pool than in the HES sample. Fewer birthing pool newborn required neonatal resuscitation than HES newborn (Table 7.2). Missing newborn data ranged from 33 (0.36%) for birthweight in the birthing pool sample to 1,593 (20.1%) for resuscitation in the HES sample.

Table 7.2: Comparisons of newborn outcomes between birthing pool and HES women by parity

	Birthing pool N=8,924		***HES*** N=10,708	
	n=8,923		n=7,928	
Parity n (%)	Nulliparae 4953 (55.5) [54.5,56.5]	Multiparae 3970 (44.5) [43.5,45.5]	Nulliparae n=3244 (40.9) [39.8,42.0]	Multiparae n=4684 (59.0) [58.0,60.2]
Birthweight (gr) mean (SD)	n=4934 3462.5 (419.6)	n=3956 3632.8 (444.6)	n=2929 3360.7 (478.7)	n=4369 3435.3 (484.7)
Birth weight ≥ 4,000 gr.	n=4934 508 (10.3) [9.5,11.2]	n=3956 825 (20.9) [19.6,22.2]	n=2929 227 (9.4) [8.4,10.6]	n=4369 555 (12.7) [11.7,13.7]
≠Resuscitation n (%)	n=4953 71 (1.4) [1.1,1.8]	n=3970 39 (0.9) [0.7,1.3]	n=2513 202 (8.0) [7.0,9.2]	n=3822 257 (6.7) [6.0,7.6]
Live birth n (%)	n=4953 4951 (99.9) [99.8,99.9]	n=3970 3968 (99.9) [99.8,99.9]	n=2680 2670 (99.6) [99.3,99.8]	n=3887 3874 (99.7) [99.4,99.8]
Stillbirth n (%)	n=4953 1 (0.02) [0.0,0.1]	n=3970 1 (0.03) [0.0,0.1]	n=2680 10 (0.4) [0.2,0.7]	n=3887 13 (0.3) [0.2,0.6]

N=sample size; *n*=number of women analysed for each variable – women with missing data excluded from analysis.
≠resuscitation=use of bag and mask with or without endotracheal intubation, with or without drug administration

7.3.3 Subgroup comparisons for birthing pool women by type of labour onset and by parity

7.3.3.1 Nulliparae

Overall, few nulliparae in the birthing pool sample had an induction of labour (Table 7.3). Irrespective of their type of labour onset, birthing pool nulliparae were a similar age, and the gestation was one week longer for those who had an induction of labour. Of the nulliparae who had an induction of labour, 9% more had an epidural, 20% fewer had an SVD, 50% more had an operative vaginal delivery and 9% more had an emergency CS than those who laboured spontaneously. Less than 1% of nulliparae who laboured spontaneously had a vaginal breech birth, and no induced nulliparae did so.

7.3.3.2 Multiparae

As with nulliparae, few multiparae had an induction of labour, and of those who did so had a non-significant longer gestation (Table 7.3). Also similar to the nulliparae, although to a less marked degree, a higher proportion of multiparae who had an induction of labour had an epidural and emergency CS, and only 2% fewer had an SVD than those who laboured spontaneously. As for nulliparae, less than 1% of multiparae who laboured spontaneously had a vaginal breech birth and no induced multiparae who had an induction of labour did so (Table 7.3).

Table 7.3: Maternal characteristics, intrapartum interventions and outcomes by type of labour onset for birthing pool women by parity

Binary: n (%) *Continuous: mean (SD) [CI 95%]*	***Birthing pool*** ***Spontaneous labour*** N=8,698		***Birthing pool*** ***Induction of labour*** N=226	
Parity n (%) n=8,923	Nulliparae 4836 (55.6) [54.6,56.7]	Multiparae 3861 (44.4) [43.3,45.4]	Nulliparae 117 (51.8) [45.0,58.4]	Multiparae 109 (48.2) [41.6,54.9]
Age (year) mean (SD)	n=4766 28.8 (5.5) [27.3, 27.7]	n=3826 31.3 (5.1) [31.0, 31.4]	28.4 (5.3) [27.1, 30.4]	n=107 31.2 (5.2) [29.8, 32.6]
Gestation (completed weeks) mean (SD)	n=3905 39.7 (1.1) [39.7, 39.8]	n=3289 39.8 (1.0) [39.7, 39.8]	n=43 40.7 (1.1) [40.4, 41.1]	n=63 40.7 (1.1) [40.4, 40.9]
Epidural n (%)	n=4832 697 (14.4) [13.4,15.4]	n=3861 97 (2.5) [2.0,3.1]	27 (23.1) [15.8,31.8]	4 (3.7) [1.0,9.1]
Mode of delivery	n=4816	n=3848	N=117	N=109
SVD n (%)	3957 (82.2) [81.1,83.2]	3767 (97.8) [97.4,98.3]	73 (62.9) [52.9,71.2]	104 (95.4) [89.6,98.5]
Operative vaginal n (%)	578 (12.0) [11.1,12.9]	42 (1.2) [0.8,1.4]	27 (23.1) [15.8,31.8]	2 (1.8) [0.2,6.5]
Vaginal Breech n (%)	10 (0.2) [0.1,0.4]	9 (0.2) [0.1,0.4]	0	0
Emergency C.S n (%)	271 (5.6) [49.9,63.2]	30 (0.8) [0.5,1.1]	17 (14.5) [8.7,22.2]	3 (2.8) [0.6,7.8]

N=sample size; *n*=number of women analysed for each variable – women with missing data excluded from analysis.

7.3.3.3 Newborn outcomes

The mean birthweight for newborn was greater, and irrespective of parity, there were significantly more large babies[35] for birthing pool women who had their labour induced compared with women who laboured spontaneously (p=0.001) (Table 7.4).

Table 7.4: Newborn outcomes by type of labour onset for birthing pool women by parity

Binary: n (%) Continuous: mean (SD) [CI 95%]	***Birthing pool Spontaneous labour*** N=8,698		***Birthing pool Induction of labour*** N=226	
Parity n (%) n=8,923	Nulliparae 4836 (55.6) [54.6,56.7]	Multiparae 3861 (44.4) [43.3,45.4]	Nulliparae 117 (51.8) [45.0,58.4]	Multiparae 109 (48.2) [41.6,54.9]
Birthweight (grammes) mean (SD)	n=4817 3457.8 (417.8) [3446.1, 3469.7]	n=3847 3627.2 (442.5) [3613.2, 3641.2]	3656.6 (448.9) [3574.4, 3738.8]	3829.9 (472.1) [3740.3, 3919.6]
Birthweight ≥ 4,000 gr.	478 (9.9) [9.1,10.8]	786 (20.4) [19.2,21.7]	30 (25.6) [18.0,34.5]	39 (35.8) [26.8,45.5]
≠Resuscitation n (%)	70 (1.4) [1.1,1.8]	38 (1.0) [0.7,1.3]	1 (0.9) [0.0,4.7]	1 (0.9) [0.0,5.0]
Stillbirth n (%)	1 (0.0) [0.0,0.1]	1 (0.0) [0.0,1.4]	0	0

N=sample size; n=number of women analysed for each variable – women with missing data excluded from analysis.
≠resuscitation=use of bag and mask with or without endotracheal intubation and/or drug administration

In summary

For birthing pool women overall, induction of labour increased the risk of having an epidural by 50% greater compared with spontaneous labour: p=0.02; RR 1.50 [95% CI 1.1, 2.1], and it reduced the risk of having an SVD by 10% compared with spontaneous labour: p<0.001; RR 0.9 [95% CI 0.8, 0.9].

[35] Large baby – birthweight of 4,000 grammes or more.

7.3.4 Subgroup comparisons for HES women by type of labour onset and by parity

7.3.4.1 Nulliparae

A similar proportion of HES nulliparae laboured spontaneously compared with HES nulliparae who had an induction of labour, and their age was similar. Although gestation for multiparae who had an induced labour was significantly longer compared with multiparae who laboured spontaneously (p=<0.001), the difference was only 0.3 weeks (Table 7.5). In contrast with birthing pool nulliparae, irrespective of the type of labour onset, similar proportions had an epidural and operative delivery. Significantly fewer HES nulliparae who laboured spontaneously had an emergency CS (p=<0.001), and significantly more had an SVD (p=<0.001) compared with nulliparae who had their labour induced. A small proportion of nulliparae who did so had a vaginal breech delivery, and no induced nulliparae did so (Table 7.5).

7.3.4.2 Multiparae

A similar proportion of HES multiparae laboured spontaneously compared with those who had an induction of labour, and their age was similar. As for the nulliparous women in the HES sample, gestation for multiparae who had an induced labour was significantly longer compared with multiparae who laboured spontaneously (p=<0.001), the difference was only 0.3 weeks (Table 7.5). Significantly fewer multiparae (23%) who had an induction of labour had an SVD (p=<0.001), and 11.6% more had an emergency CS (p=<0.001) compared with multiparae who laboured spontaneously.

The anomalous finding that a proportion of HES nulliparae (n=70, 10.7%) and multiparae (109, 12.1%) who had an their labour induced had an elective CS (see Table 7.5 footnote) suggests a possible data reporting error because it is clinically unlikely that women who were booked for elective CS had an induction of labour. In the event of unsuccessful labour induction however, a decision is sometimes made to proceed to emergency CS (Table 7.5).

Table 7.5: Maternal characteristics, intrapartum interventions and outcomes for the HES sample by type of labour onset by parity

Binary: n (%) Continuous: mean (SD) [CI 95%]	***HES Spontaneous labour*** Completed data n=5,817		***HES Induction of labour*** Completed data n=1,673	
Parity n (%)	Nulliparae 2361 (40.6) [39.3,41.9]	Multiparae 3456 (59.4) [58.1,60.7]	Nulliparae 705 (42.1) [39.8,44.5]	Multiparae 968 (57.9) [55.4,60.2]
Age (year) mean (SD)	n=1990 27.7 (6.0) [27.6, 28.2]	n=2925 29.1 (5.8) 28.9, 29.4]	n=606 28.2 (6.3) [27.2, 28.5]	n=841 29.7 (5.8) [28.8, 29.8]
Gestation (completed weeks)mean (SD)	n=1476 39.6 (1.1) [39.6, 39.7]	n=2206 39.6 (1.1) [36.6, 39.6]	n=449 39.9 (1.5) [39.7, 40.1]	n=621 39.9 (1.4) [39.9, 40.1]
Epidural n (%)	n=2057 338 (16.4) [14.9,18.1]	n=2853 280 (9.8) [8.7,10.9]	n=604 113 (18.7) [15.7,22.1]	n=820 98 (12.0) [9.8,14.4]
Mode of delivery	†n=2196	†n=3198	†n=652	†n=904
SVD n (%)	1627 (74.1) [72.2,75.9]	2677 (83.7) [82.4,84.9]	333 (51.1) [47.2,54.9]	524 (58.0) [54.7,61.2]
Operative vaginal n (%)	342 (15.6) [14.1,17.2]	276 (8.6) [7.7,9.7]	110 (16.9) [14.1,19.9]	100 (11.1) [9.1,13.3]
Vaginal Breech n (%	11 (0.5) [0.3,0.9]	18 (0.6) [0.3,0.9]	0	5 (0.6) [0.2,1.3]
Emergency C.S n (%)	206 (9.4) [8.2,10.7]	218 (6.8) [5.9,7.7]	139 (21.3) [18.2,24.7]	166 (18.4) [15.9,21.0]

N=sample size; *n*=number of women analysed for each variable – women with missing data excluded from analysis.
†The following HES women had an elective CS: spontaneous labour nulliparae 10 (0.5%), multparae 9 (0.3%); induction of labour nulliparae 70 (10.7%), multiparae 109 (12.1%)

7.3.4.3 Newborn outcomes

Whilst birthweight was similar for nulliparae and multiparae who laboured spontaneously, Significantly more multiparae who had an induction of labour had a large baby compared with those who laboured spontaneous (p=0.001) (Table 7.6). Irrespective of the type of labour onset and maternal parity, a low overall proportion of newborn re**c**eived resuscitation, and there were few stillbirths.

Table 7.6: Outcomes for the HES sample newborn by parity and by spontaneous labour versus induction of labour

Binary: n (%) Continuous: mean (SD) [CI 95%]	***HES Spontaneous labour*** Completed data n=5,817		***HES Induction of labour*** Completed data n=1,673	
Parity n (%)	Nulliparae 2361 (40.6) [39.3,41.9]	Multiparae 3456 (59.4) [58.1,60.7]	Nulliparae 705 (42.1) [39.8,44.5]	Multiparae 968 (57.9) [55.4,60.2]
Birthweight (grammes) mean (SD)	n=2175 3350 (471.6) [3330.2, 3369.8]	n=3271 3427 (480.0) [3411.1, 3443.9]	n=647 3396.1 (498.1) [3357.7, 3434.6]	n=922 3465.7 (505.7) [3432.9, 3498.4]
Birthweight ≥ 4,000 gr.	187 (8.6) [7.4,9.8]	392 (12.0) [10.9,13.1]	78 (12.1) [9.6,14.8]	143 (15.5) [13.2,18.1]
≠Resuscitation n (%)	n=1866 153 (8.2) [6.9,9.5]	n=2873 181 (6.3) [5.4,7.2]	n=561 42 (7.5) [5.4,9.9]	n=808 68 (8.4) [6.6,10.5]
Stillbirth n (%)	n=2017 7 (0.3) [0.1,0.7]	n=2965 9 (0.3) [0.1,0.6]	n=631 3 (0.5) [0.1,1.4]	n=818 4 (0.5) [0.1,1.2]

N=sample size; *n*=number of women analysed for each variable – women with missing data excluded from analysis.
≠resuscitation=use of bag and mask with or without endotracheal intubation and/or drug administration

In summary

For women in the HES sample, induction of labour increased the risk of having an epidural by 20% compared with spontaneous labour: p=0.003; RR 1.20 [95% CI 1.1, 1.4], and reduced the risk of having an SVD by 30% compared with spontaneous labour: p<0.001; RR 0.71 [95% CI 0.68, 0.7]

7.3.4.4 Missing data for the birthing pool and HES samples by spontaneous labour and induction of labour

For birthing pool women, the highest proportion of missing data was for gestation, which included 1503 (17.3%) women who had a spontaneous labour onset, and 102 (53%) women who had an induction of labour. There was less than 1% of missing data for type of delivery and newborn birthweight for the birthing pool sample (Table 7.3, Table 7.4).

For HES women, similar to the birthing pool sample, the highest proportion of missing data was for gestation: this included 2139 (36.8%) of women with a spontaneous labour,

and 603 (36.0%) who had an induced labour. For mode of delivery, there were 7.2% (423) and 6.9% (117) missing data for spontaneous labour and induction of labour respectively. For newborn birth weight 6.3% (371) and 6.2% (104) data were missing respectively for type of labour onset. A similar proportion of HES data were also missing for spontaneous labour resuscitation (18.5%, 1078), and induction (18.2%, 304), and likewise for stillbirth: spontaneous (14.4%, 835), and induction (13.4%, 224).

There were significant differences between interventions and outcomes for spontaneous labour and induction of labour

7.3.5 Comparative analyses for the subgroup of birthing pool women who had a spontaneous labour onset, and the subgroup of HES women who had a spontaneous labour onset

7.3.5.1 Birthing pool and HES nulliparae

Although there was a statistically significant difference in maternal age and gestation for nulliparae between the birthing pool and HES samples, the difference for age was only 0.1 yrs, and 0.1 week for gestation (Table 7.7). Nulliparae in the birthing pool sample had a 10% decreased risk of having an epidural compared with nulliparae in the HES sample. Birthing pool nulliparae had a 10% [95% CI 0.8, 1.0] increased risk of having an SVD compared with HES nulliparae. There was no significant difference between groups for nulliparae giving birth to a baby that weighed 4,000 gr or more. Newborn in the birthing pool sample had an 80% [95% CI 0.1, 0.2] decreased risk of requiring resuscitation compared with nulliparae newborn in the HES sample.

Table 7.7: Maternal characteristics, epidural, mode of delivery and newborn outcomes for birthing pool and HES nulliparae who laboured spontaneously

	Birth pool Nulliparae N=4,836	**HES Nulliparae N=2,361**	RR/MD	P value
Age (year) mean (SD)	n=4766 27.8 (5.5)	n=1990 27.7 (6.0)	NA	<0.001
Gestation (completed weeks) mean (SD)	n=3905 39.7 (1.1)	n=1476 39.6 (1.1)	NA	<0.001
Epidural n (%)	n=4832 697 (14.4)	n=2057 338 (16.4)	0.90 [0.8, 1.0]	0.032
SVD n (%)	n=4815 3957 (82.2)	n=2196 1627 (74.1)	1.1 [0.08, 1.14]	<0.0001
Birth weight ≥ 4,000 grammes. N (%)	n=4817 478 (9.9)	n=2175 187 (8.6)	1.2 [1.0, 1.4]	0.082
≠Neonatal resuscitation n (%)	N=4836 70 (1.4)	n=1866 153 (8.2)	0.2 [0.1, 0.2]	<0.0001

N=sample size; *n*=number of women analysed for each variable – women with missing data excluded from analysis.
SVD=spontaneous vaginal birth
≠resuscitation=use of bag and mask with or without endotracheal intubation, with or without drug administration
RR=relative risk for categorical data. MD=mean difference and SD=standard deviation for continuous data. [ ]=95% confidence interval.

7.3.5.2 Birthing pool and HES multiparae

Multiparae in the birthing pool sample were two years older than multiparae in the HES sample, and their gestation was only 0.2 week longer (Table 7.8). Birthing pool multiparae had a 70% [95% CI 0.2, 0.3] decreased risk of having an epidural compared with HES multiparae. Multiparae in the birthing pool sample had a 20% [95% CI 1.1, 1.2] increased risk of having an SVD compared to multiparae in the HES sample. Birthing pool multiparae had a 70% [95% CI 1.5, 1.9] increased risk of giving birth to a baby weighing 4,000 grammes or more, compared with newborn for HES multiparae. Newborn for birthing pool multiparae had an 80% decreased risk of requiring resuscitation at birth compared with newborn for multiparae in the birth HES sample.

Table 7.8: Maternal characteristics, epidural, mode of delivery and newborn outcomes for birthing pool and HES multiparae who laboured spontaneously

	BP multiparae N=3,861	**HES multiparae N=3,456**	RR/ MD	P value
Age (year) mean (SD)	n=3826 31.3 (5.1)	n=2925 29.1 (5.8)		<0.001
Gestation (completed weeks) mean (SD)	n=3289 39.8 (1.0)	n=2206 39.6 (1.1)		<0.001
Epidural (%)	N=3861 97 (2.5)	n=2853 280 (9.8)	0.3 [0.20, 0.32]	<0.0001
SVD (%)	n=3852 3767 (97.8)	n=3198 2677 (83.7)	1.2 [1.15, 1.19]	<0.0001
Birthweight ≥ 4,000 gr.	n=3847 786 (20.4)	n=3271 392 (12.0)	1.7 [1.5, 1.9]	<0.0001
≠Neonatal resuscitation n (%)	N=3861 38 (1.0)	n=2873 181 (6.3)	0.2 [0.1, 0.2]	<0.0001

N=sample size; *n*=number of women analysed for each variable – women with missing data excluded from analysis.
SVD=spontaneous vaginal birth
≠resuscitation=use of bag and mask with or without endotracheal intubation, with or without drug administration
RR=relative risk for categorical data. MD=mean difference and SD=standard deviation for continuous data. [ ]=95% confidence interval.

7.4 DISCUSSION

My primary goal for this Chapter was to compare intrapartum events, interventions and outcomes between the birthing pool and HES samples. In order to do this, I had to ascertain if these two samples were sufficiently similar to make meaningful comparisons of key intrapartum interventions and outcomes. Investigations showed that the overall maternal characteristics and low incidence of adverse maternal and newborn outcomes were similar in each sample, and matched those for healthy women in childbirth: all were at term gestation, and their mean age was average for childbearing women in the UK. (Office for National Statistics, 2010). The mean newborn birth weight was average for term newborn in both samples, few required resuscitation at birth and the stillbirth incidence was less than one percent in each sample.

Analysis by maternal parity showed some key differences between the two samples. Firstly there was a higher proportion of birthing pool nulliparae than HES nulliparae. However, despite the presence of more nulliparae, the birthing pool sample had markedly fewer epidurals, and operative deliveries, and fewer of their newborn required resuscitation at delivery than nulliparae in the HES sample.

Secondly, the HES sample had significantly more inductions of labour. It could be argued that this factor predisposed the HES sample to having more epidural, operative delivery and newborn adverse effects than those found in the birthing pool sample, because even in a low risk population, there is an association between induction of labour and these factors, (Grivell *et al.*, 2012, Patterson *et al.*, 2011, Roberts *et al.*, 2000). However, analysis by spontaneous versus induced labour onset also showed that the birthing pool sample had less use of epidural analgesia, fewer operative deliveries and less newborn resuscitation for women who had an induction of labour in the compared with women who had an induction of labour in the HES sample.

A third variation between the two samples was that the birthing pool sample had a higher proportion of babies that weighed ≥4,000kg than the HES sample. Given that a high birth weight is a risk factor for emergency CS and newborn complications (Aye *et al.*, 2010, Mocanu *et al.*, 2000, Rosenberg *et al.*, 2003, Stotland *et al.*, 2004), it is interesting to note the contrary results for the birthing pool sample. Perhaps the buoyancy offered by water

immersion and resulting ease in adopting a range of different upright positions, may have a protective maternal and newborn effect for women who have a large fetus.

Although the overall stillbirth incidence was very low, the proportion was lower for birthing pool women who laboured spontaneously than those who laboured spontaneously in the HES sample, and there was no stillbirth in the birthing pool sample for women who had an induction of labour.

Analysis by maternal parity for the subgroup of women in each sample who laboured spontaneously removed induction of labour as a potential confounder for more epidural, operative delivery and adverse newborn outcomes. Results however, showed that irrespective of parity, the subgroup of women in the birthing pool sample who did not have an induction of labour had significantly fewer epidural, significantly more SVD, significantly less newborn resuscitation at delivery, and more large babies than the sub-group of women in the HES sample that did not have an induction of labour.

These findings corroborate those for previous observational studies on the use of birthing pools during labour (Geissbuehler *et al.*, 2004, Otigbah *et al.*, 2000, Theoni and Moroder, 2004). They also offer a unique and essential insight into the intrapartum experiences of healthy women in childbirth who are estimated to comprise at least 50% of the population giving birth in the UK (Gibson and Dodwell, 2012, National Collaborating Centre for Women's and Children's Health, 2007). Acknowledging the quintessential difference between nulliparae and multiparae and analysing the data by parity provides crucial new information, as the annual maternity related summaries that HES produce are not tabulated by parity.

The results are important and reassuring for women who may consider using a birthing pool during labour, and provide essential information for midwives when discussing care options with healthy pregnant women. They are particularly important for healthy pregnant nulliparae because these women are at greater risk than multiparae, of having an epidural and operative delivery, which present a risk factor for the requirement of newborn resuscitation at delivery (Anim-Somuah *et al.*, 2011, Bai *et al.*, 2002, Tracy *et al.*, 2007b)

7.4.1 Strengths

HES provided a national benchmark against which the birthing pool sample could be compared. The sample size was large enough to enable precise estimates for less frequent intrapartum events for women with straightforward pregnancy. As a bespoke dataset, I ensured that the HES sample comprised a randomly selected (proportionate for each year of the birthing pool study) population of women who HES identified as being at low risk of childbirth complication. Chapter six details the comprehensive verification exercise that I undertook to classify variables and avoid miss-classification. For the comparisons in this chapter, I opted to only use MDD-MF data in order to secure that analysis could be reported by maternal parity.

7.4.2 Limitations

Whilst I am quite certain that the birthing pool sample included only healthy women in childbirth, I cannot exclude the possibility that this was not the case for the HES sample. For example, there was the anomalous elective CS finding, even though this was an exclusion criterion for the HES sample specification (Table 7.1). These women may have had a straightforward pregnancy and been booked to have an elective CS because of fetal presentation, for example breech or transverse lie, or because of a previous CS, and gone into spontaneous labour before the date scheduled for their delivery. The lack of data linkage between antenatal and intrapartum records that HES collate and analyse, which I referred to in Chapter six, inevitably pre-empts certainty that every woman in the HES sample was low risk at the point she went into labour. For example, as the HES analyst was unable to link an antenatal care episode to the intrapartum episode, when compiling my HES sample he may have included some inappropriate women, for example, an antenatal admission for a pregnancy complication such as pre-eclampsia, or antepartum haemorrhage.

In addition to the lack of antenatal and intrapartum data linkage, there is no linkage between these time periods, and postpartum or newborn beyond the delivery for women, and resuscitation at delivery and birth status (live or stillborn) for babies. As a result, it was not possible to report on newborn admissions to NICU, or hospital readmissions in the neonatal period for the HES sample.

Compared with the birthing pool data, the HES sample had a markedly higher proportion of missing data for all the key maternal and newborn variables, and I cannot be sure to what extent, if any that more complete data may have altered results. However, if the data were missing at random, the results would only be more precise and not different. If the missing data were events, the results would have magnified the differences found between the Birthing pool and HES samples. Ultimately therefore, it is unlikely than less missing data would have altered the message of the HES results.

Analyses by maternal parity restricted the HES sample analysis to MDD-MF field, which precluded examination of perineal trauma, episiotomy or PPH. Inclusion of these events, interventions and outcomes would have enriched the comparisons, and enabled a comparison of *normal birth* between the birthing pool and HES samples. Their exclusion represents serious omissions in the MDD-MF directory.

These comparisons lack contextual information which may have influenced findings; for example, it was not possible to use the MDD-MF data for planned or actual place of birth because the HES definitions for these variables are unclear. As described in Chapter 6, it is not possible to accurately identify an alongside midwifery unit from an obstetric unit, and there is no definition for a freestanding midwifery unit. There is clear evidence that the care setting in which women with a straightforward pregnancy plan to give birth affects their intrapartum events, interventions and outcomes (Birthplace in England Collaborative Group, 2011b, Burns *et al.*, 2012, Overgaard *et al.*, 2011).

7.5 CONCLUSION

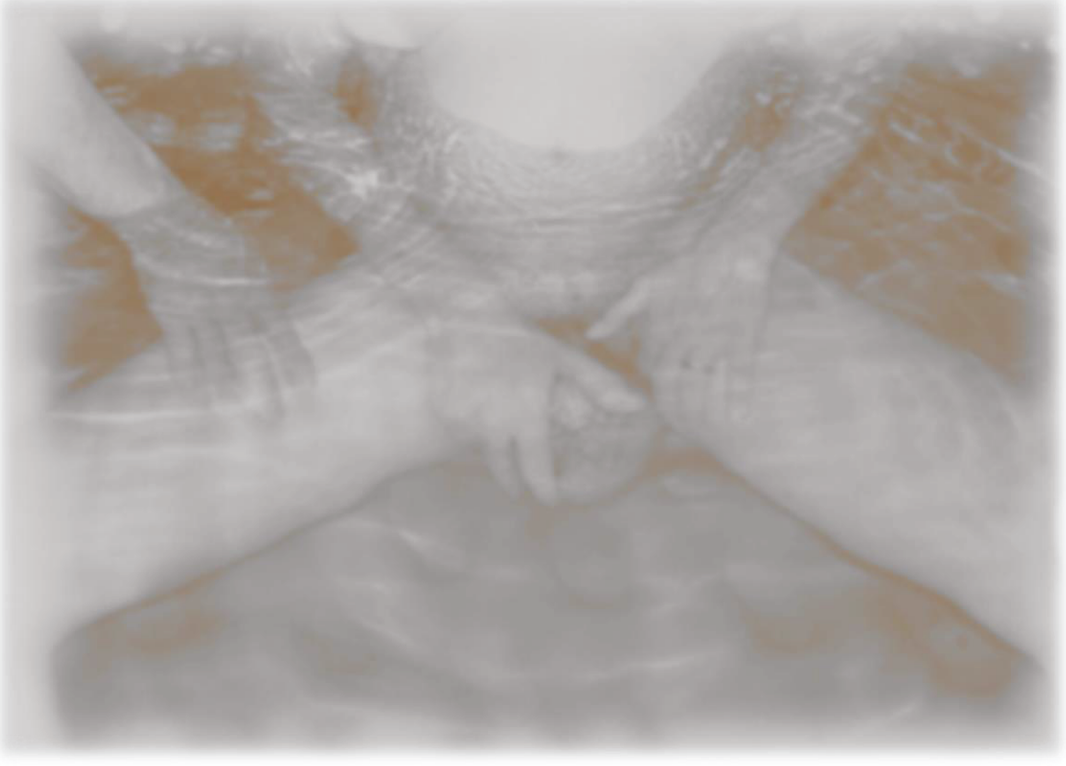
Overall maternal characteristics and obstetric profile showed that the bespoke HES sample was comparable with the birthing pool sample for healthy women in childbirth. Analysis by maternal parity showed that despite the presence of more nulliparae, and a higher proportion of large babies, there were fewer epidurals, operative deliveries and newborn resuscitations in the birthing pool sample compared with the HES sample. In both samples, women who had an induction of labour had more epidural, operative delivery and newborn resuscitation, and the incidence for all was significantly lower for the birthing

pool sample. To counterbalance a higher proportion of labour inductions in the HES sample, subgroup comparisons for women who did not have an induction found that irrespective of parity, the birthing pool sample had significantly fewer epidurals, operative deliveries, and newborn resuscitations, and significantly more large babies than the HES sample. There were a very low proportion of stillbirths in each sample.

Analyses by maternal parity restricted HES data use to one data field (MDD-MF), which omitted data for the occurrence and repair of perineal trauma, episiotomy, postpartum haemorrhage, or manual removal. A lack of data linkage between antenatal, intrapartum and postnatal data collated and analysed by HES prevented analysis of data for newborn beyond resuscitation at delivery and birth weight.

Results for these comparisons between two large samples are reassuring for women, particularly nulliparae who choose to use a birthing pool during labour, and suggest that a birthing pool may reduce the added potential for intrapartum interventions and adverse outcomes for healthy women who have a large baby and those who have an induction of labour. They also provide a unique profile of key intrapartum events and outcomes for the majority population of healthy women giving birth in the UK and add further information to the debate regarding the inadequate data linkage for routinely collected maternity data during pregnancy, childbirth and the puerperium.

Discussion



My overarching research question for this thesis was to explore whether using a birthing pool during labour and/or having a waterbirth can contribute to normalising birth for healthy women in childbirth by reducing intrapartum interventions.

As discussed in Chapter one, the international normalising birth initiative aims to reduce the inappropriate use of interventions such as induction of labour, epidural analgesia and operative delivery (American College of Nurse Midwives, 2012, Australian College of Midwives, 2012, Canadian Association of Midwives, 2012, Gibbons *et al.*, 2010, Glantz, 2012, Johanson *et al.*, 2002, Royal College of Midwives, 2009). This is a strategy that should increase the incidence of *normal birth*[36] (Maternity Care Working Party *et al.*, 2007), which has been identified as a marker of quality intrapartum care, particularly for healthy women in childbirth (Dodwell, 2010).

Compared with national averages, women who used a birthing pool during labour had fewer than expected intrapartum interventions and more spontaneous vaginal birth (SVD). Comparisons between the birthing pool sample and the HES sample found that significantly fewer birthing pool women, particularly nulliparae, used epidural analgesia, had an operative vaginal delivery, or an emergency CS. The results for women who used a birthing pool during labour showed a higher incidence of *normal birth* for nulliparous and multiparous women, particularly those who had a waterbirth than previously reported data for healthy women in childbirth in the UK (Birthplace in England Collaborative Group, 2011a, Dodwell, 2010). Taken together, these findings suggest that intrapartum birthing pool use may make a meaningful contribution to normalising birth for healthy nulliparous and multiparous women.

Another research question asked about the characteristics of women who use a birthing pool during labour. Maternal characteristics for the birthing pool study participants signified that they represented healthy women in childbirth, which matched the recommended eligibility criteria for intrapartum birthing pool use in the UK (Royal College of Midwives, 1994, Royal College of Obstetricians and Gynaecologists and Royal College of Midwives, 2006). The unchanging national eligibility criteria for birthing pool use, which

[36] Normal birth is a composite outcome comprising spontaneous labour onset, no epidural, spontaneous vertex birth (SVD) with no episiotomy

were in operation over the time period of the study, ensured that maternal obstetric characteristics remained stable for the study population.

I explored whether nulliparous women who use a birthing pool have a different intrapartum experience to multiparae. My study showed that compared with multiparae, nulliparae who used a birthing pool were less likely to have a waterbirth, experienced markedly more intrapartum interventions, and more had an operative delivery, OASIS and minor PPH. These results are consistent with other studies that report by parity (Bai *et al.*, 2002, Nguyen *et al.*, 2010, Shields *et al.*, 2007), and reaffirm some of the fundamental physiological differences between nulliparous and multiparous women discussed in Chapter two. Interestingly, differences found for maternal outcomes in relation by maternal parity, were not reflected in newborn outcomes which were remarkably similar for nulliparous and multiparous women.

Another question asked whether the intrapartum experience differs between the care settings where nulliparous and multiparous women use a birthing pool and plan to give birth. The birthing pool study found differences for the intrapartum interventions and outcomes that women overall, and particularly nulliparae experienced between the care settings where they planned to give birth, with fewer interventions and more SVD in the community compared with the OU and AMU settings. Differences included fewer transfers to hospital from the community compared with AMU transfers, again principally for nulliparae. Results for Chapter four highlighted striking differences in the occurrence of *normal birth* for nulliparae between care settings: 19% more women who planned to give birth in the community had a normal birth compared with AMU nulliparae; a difference that increased to 22% compared with OU nulliparae. There was however, minimal variation for newborn between settings.

The recent Birthplace study also found differences for the intrapartum interventions and outcomes that women experienced between the care settings where they planned to give birth, with fewer interventions and more SVD in the community setting (freestanding midwifery unit, homebirth) compared with the OU and AMU results (Birthplace in England Collaborative Group, 2011a). The same study presented results for transfers to hospital from an AMU and the birthing pool community equivalent (FMU and home) by parity: both

community and AMU hospital transfers were higher overall and by parity for Birthplace compared with the birthing pool study (Birthplace in England Collaborative Group, 2011a). Notwithstanding that differences in case mix, data collection and data completeness may have contributed to the different results, these findings suggest that intrapartum birthing pool use may have potential to normalise birth for low risk women. They also have important cost implications because even accounting for intrapartum transfer costs, the community setting (freestanding midwifery unit or homebirth) is less expensive than an AMU or OU setting, as is a *normal birth* (Schroeder *et al.*, 2011).

It is possible that contextual workplace issues might have influenced findings across different care settings. Factors such as workload organisational priorities, prevailing model of care, the level of autonomy that midwives feel, and their degree of confidence in the innate skills of being 'with woman,' can affect attitudes and behaviour. A study of mixed methods design found an association between intrapartum intervention levels in obstetric units and midwives level of risk perception: the more interventions, the higher their risk perception (Mead and Kornbrot, 2004). The physical proximity between an AMU and OU renders AMU based midwives more vulnerable than their community based colleagues to being asked to bail out a busy OU labour ward. If this happens on a regular basis, it may affect their sense of control over their work and their job satisfaction. It may also thwart them in developing and retaining the core skills required for optimal midwifery led care, which are different to the obstetric care model that predominates on a typical hospital labour ward. The way in which midwives behave towards and interact with women during labour and birth are critical factors for women's satisfaction with their childbirth experience (Hodnett *et al.*, 2002, Roberts, 2002, Roberts and Hanson, 2007). The differences observed in the birthing pool study between care settings; particularly between the AMU and community have implications for healthy women in childbirth, especially nulliparae.

Next I explored whether the intrapartum experience differs between women who use a birthing pool during labour and women who meet birthing pool eligibility criteria but chose not to. First I explored the feasibility of using data collected by one obstetric unit for women who used a birthing pool and women who met criteria but chose not to in order to

compare interventions and outcomes. However, exploratory analyses indicated that birthing pool practice was not representative of other obstetric units in the overall sample. For example, a markedly higher proportion of nulliparae left the birthing pool pre delivery, than for all OU nulliparae in the study overall. In addition, the proportion of nulliparae and multiparae who had an epidural was almost two-fold higher. On this basis a comparison would not provide reliable information.

I then looked at HES as an alternative source of control data. I found that the maternal characteristics of the birthing pool study were similar to those in the HES sample. This high level of participant comparability strengthens the reliability of the birthing pool, HES comparisons. As would be expected for a study sample comprising healthy women in childbirth, analyses of the birthing pool sample, and comparisons with the HES sample showed a low overall incidence of epidural and operative delivery.

However, highly significant and interesting differences for epidural, mode of delivery and newborn resuscitation between the birthing pool and HES samples for both nulliparae and multiparae, but particularly for nulliparae are important for two key reasons. Firstly, these comparisons offered a unique insight into the strengths and limitations of routinely collected maternity data for a population of nulliparae and multiparae who were identified as healthy as far as was possible, given the gaps in data linkage between antenatal, intrapartum and postnatal records for women, and intrapartum and postnatal records for newborn. Secondly, presenting the HES sample and the birthing pool sample by maternal parity provided an important and reassuring addition to existing comparative studies for intrapartum birthing pool use, which lack detailed information regarding interventions and outcomes that nulliparae and multiparae who used a pool for labour and had a land birth, or had a waterbirth, and their respective newborn.

Lastly, I investigated whether induction of labour affects intrapartum interventions and maternal and newborn outcomes for healthy women in childbirth. Irrespective of parity, comparisons between the birthing pool sample and the HES sample showed a higher incidence of epidural, operative delivery, and newborn resuscitation for women who had an induction of labour, compared with results for women who had a spontaneous labour. This finding corroborated evidence for associated adverse effects in relation to induction

of labour, even for healthy women in childbirth, discussed in my review of the literature in Chapter two.

8.1.1 Strengths of the work presented in this thesis

The birthing pool study comprised prospectively collected data for a large sample of women, which enabled precise estimates for less common events. There were negligible missing data, which optimised analysis potential, and avoided a problem encountered by most observational studies. National recommendations for birthing pool eligibility criteria did not alter over the time period during which data were collected, which secured a stable obstetric profile for the study population.

Separate analyses for nulliparae and multiparae and by planned place of birth provided the first comprehensive insight into what events, interventions and outcomes for a cohort of women who used a birthing pool during labour. It also provided key information in relation to its effectiveness and safety.

Analysis by planned place of birth enabled the first detailed, prospective investigation into birthing pool use during labour in midwifery led units, the care settings where it is used most. Additionally, differentiating AMUs from the community setting (FMUs and homebirth) adds new knowledge to the scant evidence base comparing intrapartum events, interventions and outcomes between these care settings. It also tested the prevalent assumption that they are interchangeable, because they share philosophy and staffing profile, and care for healthy women.

Accessing a bespoke dataset, derived from routinely collected maternity data collated by HES, facilitated comparisons stratified by maternal parity for key interventions and maternal and newborn outcomes between the birthing pool and HES samples. The comparisons also comprised a unique overview of childbirth events and outcomes for a cohort of low risk women using routinely collected maternity data.

8.1.2 Limitations of the work presented in this thesis

Despite its large sample size and a quality dataset, the birthing pool study's lack of a control group comprising women with similar characteristics and low risk obstetric profile who did not use a birthing pool during labour, limited the extent to which it could examine intrapartum events, interventions and maternal and newborn outcomes in relation to birthing pool use during labour.

Unfortunately, only one OU responded to the request that study centres prospectively collect data for women who fitted the birthing pool eligibility criteria during the same time period when they were also collecting data for women who used the birthing pool. Sensitivity analysis showed that birthing pool practice was different in OUX when compared with the other participating centres.

The bespoke HES dataset that I then obtained to use as a comparison group of women at low obstetric risk also proved of limited value in examining intrapartum events, interventions and maternal and newborn outcomes in relation to birthing pool use. Because comparative analysis required that both the birthing pool sample and the HES sample were stratified by parity, for the HES sample only data recorded in the MDD-MF field could be used, and this field did not include data on perineal outcome and PPH. This precluded comparison of the incidence of *normal birth* between the two groups. Lack of data completeness raised another limitation of the HES dataset.

Although it was outside the scope of my research programme, it would have been enriched by gaining a perspective from midwives who cared for women using a birthing pool and women who did so.

8.2 Implications for practice

Results for the birthing pool study and the comparisons with the HES sample have several uses for practitioners to consider for both their own birthing pool practice, and when discussing the birthing pool care option with healthy pregnant women. Findings also offer practitioners an insight into differences between care settings, which can inform discussions about birthing pool use in relation to planned place of birth.

Findings indicated that birthing pool use for labour and waterbirth can contribute to the normalising birth agenda, and can facilitate *normal birth* for healthy women, particularly for nulliparae who plan to give birth at home or in an FMU. Using a birthing pool during labour presented no added perinatal risk for healthy nulliparous and multiparous women in childbirth, particularly for nulliparae who planned to give birth in the community setting. This is an important finding, which contrasts with advice from the RCOG that healthy pregnant nulliparae consider the AMU setting due to its closeness to the OU should transfer be required (Royal College of Obstetricians and Gynaecologists, 2012).

8.2.1.1 Implications and recommendations for birthing pool guidelines

- There is no evidence to deny a healthy multiparous woman in labour access to a birthing pool if her cervix is less than four centimetres dilated because of fear that this may present an added risk of her requiring labour augmentation. As when caring for any woman during labour, irrespective of parity, it is important to understand that cervical dilatation is only one indicator of labour progress.
- Practitioners should consider facilitating women to push as and when they have the urge to when adopting hands off delivery technique at waterbirth, and not to direct women to push.
- Women who use a birthing pool should be offered physiological third stage care as this has not been shown to increase the risk of PPH for healthy women in childbirth
- Birthing pool use has not been shown to increase the risk of requirement for newborn resuscitation, TTN requiring treatment or NICU admission.
- A small proportion of newborn born in water however, had an umbilical cord snap, highlighting that it is important to prevent undue traction on the cord as the baby's head is gently guided out of the water.
- Women who have a suspected large baby, and who have no other discernible problem, and would like to use a birthing pool during labour should be facilitated to do so.
- Irrespective of whether or not healthy women use a birthing pool, induction of labour confers a significant cascade risk of intrapartum interventions and maternal and newborn complications.

8.2.1.2 Implications and recommendations for care settings

- The difference in results between AMUs and the community settings, and the converse similarity of results between the OU and AMU settings raise concerns that require proactive discussion with maternity stakeholders, especially in the context of current threats of closure for some FMUs.

8.2.1.3 Implications for practitioner skills in normalising birth

- Differences in results found between care settings also require exploration about how to optimise the development of midwifery skills and confidence to care for healthy women in childbirth. For example, introduce an annual workshop on skills sharing and strategies to normalise birth for ALL NHS employed midwives. This session could form part of the annual mandatory skills update that all maternity units in the UK provide as part of their requirements for the Clinical negligence scheme for trusts (CNST) (NHS Litigation Authority, 2010/11).

8.2.1.4 Implications and recommendations for routinely collected maternity data

My exploration of routinely collected data that are collated and analysed by HES, and the birthing pool, HES sample comparisons highlighted major issues that require discussion and strategies to address. These include

- Overall minimal engagement with, variable and idiosyncratic MDD-MF field usage between hospitals. This is reflected in the increasing overall national proportion of missing MDD-MF data for key variables such as maternal parity, year on year.
- Organisational fragmentation and HES analysts' lack of knowledge about obstetric, or midwifery terms and practice, together with a lack of clinician engagement with HES data, contributes to a reduced clinical relevance of the annual tabulated summaries produced by HES. For example, it is not possible to differentiate women by their risk profile, or parity. Also, the continued use of unclear definitions for planned (and actual) place of delivery preclude being able to gain a meaningful insight into the experiences of low risk women by this important factor.

- Limited data linkage between antenatal, intrapartum and postpartum records for women, and between mother and newborn records, which presents a significant constraint when analysing routinely collected data.

I recommend that waterbirth be assigned a mode of delivery code because this would enable data collection to gauge its prevalence and examine its potential cost effectiveness.

8.3 Suggestions for further research

8.3.1 Care settings

The differences in results between the midwifery led care settings for the birthing pool study illuminated an area that requires further research to explore possible influential factors. For example, does the proximity of location between OUs and AMUs influence midwives attitudes and behaviour? Does the biomedical model of the OU setting permeate through to the AMU setting? Given that it is common practice for OUs to move midwives from AMUs to cover their workload, how might the organisation of midwifery cover between these two settings influence the care model practiced in AMUs, and affect midwifery skills and confidence?

8.3.2 Intrapartum birthing pool use

The birthing pool study lacked data on potential predictors for intrapartum interventions and outcomes. Further research for birthing pool use is needed, which includes factors relating to

- Maternal characteristics, for example socio economic status, relationship status, ethnicity and BMI; midwifery practice
- Work organisational details for midwives based in the OU, AMU and community settings
- One to one care for women during labour (continuous support), maternal mobility during the first and second stage of labour, directed versus supportive pushing style adopted, maternal and fetal position for birth.

My study focused on examining the effectiveness and safety of birthing pool use, and as such, I did not collect qualitative data to gain an insight into maternal and caregiver attitudes and experiences in relation to birthing pool use. These are also potential predictors for events, interventions and outcomes in childbirth.

The acceptability of care options to the women who use them and their caregivers is equally important to their effectiveness, and safety. Further research is required to examine what women, midwives, obstetricians and paediatricians like and do not like

about using a birthing pool during labour and why, to explore their concerns, and ideas for resolving them.

8.3.2.1 Study design

The key limitation of the birthing pool study was the absence of a control group, coupled with the selection bias inherent in observational study design. The obvious design required to examine the effectiveness of the use birthing pools during labour in greater depth is a randomised controlled trial (RCT). This however, raises an immediate anxiety that it may obviate maternal choice. An alternative to consider, which women and their caregivers may find more acceptable, would be an RCT with preference arms. This design would accommodate maternal choice, and enrich the study sample because the self-selection effect could be tested. A pilot study using this design has been conducted, suggesting that this approach may be feasible (Woodward and Kelly, 2004).

A well conducted RCT is an expensive undertaking, and any funding application to perform one faces unprecedented competition, so the case to present for a trial on intrapartum birthing pool use has to be exceptionally compelling, not least because it is a politically sensitive care option, and still considered to be a marginal practice. However, the birthing pool study found a high proportion of *normal birth* for women who used a birthing pool at any point during labour, particularly for women who had a waterbirth. Intrapartum birthing pool use has cost saving potential for healthy women, especially nulliparae, and the latter represent the highest risk group for emergency CS. It can be therefore argued that it merits a trial, which is powered to test its clinical and cost effectiveness, with a qualitative dimension that explores the experiences of women and midwives, and examination of the barriers and facilitators to birthing pool use during labour.

Birthing pool use during the first and second stage of labour is likely to grow in the UK and possibly other countries because women and caregivers are increasingly voicing their unwillingness to accept the medical model of care, particularly in the absence of pregnancy complications, as evidenced by the drive to normalise birth. There is an international thrust to reduce the accelerating Caesarean section rate in many middle income countries, for financial reasons and clear evidence of its associated short and long term adverse

physical and psychological effects on women and adverse newborn effects. Birthing pool use has the potential to facilitate *normal birth*; a marker of the quality of intrapartum care. In the UK, there is a drive to focus the workload of obstetric units on women with pregnancy complications, and promote the use the AMUs, FMUs and homebirth for those who have a straightforward pregnancy (Royal College of Obstetricians and Gynaecologists, 2011).

Conclusions

This programme of research revealed several reassuring findings for a population of healthy pregnant women who used a birthing pool for labour and for the subgroup who had a waterbirth. The large sample size of the prospective observational study enabled comprehensive analyses of intrapartum events, interventions and outcomes. Additionally, it was the first to report analyses by maternal parity and planned place of birth.

Adverse maternal and newborn events were rare for women who used a birthing pool during labour, and also for women who had a waterbirth.

A high proportion of nulliparous and multiparous women who had a waterbirth had a *normal birth*.

Nulliparous women who used a birthing pool and planned to give birth in a community setting experienced notably fewer intrapartum interventions, and more *normal birth* compared with those who used a birthing pool and planned to give birth in either an obstetric unit or alongside midwifery unit.

Results for intrapartum interventions and outcomes were remarkably similar between the obstetric unit and alongside midwifery unit for nulliparous women who used a birthing pool during labour, and for nulliparous women who had a waterbirth

For multiparous women who used a birthing pool during labour, and for multiparous women who had waterbirth, results did not indicate that planned place of birth influenced the incidence of interventions and outcomes.

Exploratory analyses found no basis for concern regarding birthing pool use at a cervical dilatation of less than four centimetres during the first stage of labour and augmentation for multiparae, and although there was a significant association for nulliparae, it was marginal. No association was found between waterbirth and OASIS, physiological third stage and PPH, waterbirth and TTN, waterbirth and NICU admission.

Comparisons between the birthing pool study sample and routinely collected intrapartum data suggested that birthing pool use may have the potential to make a substantial contribution to the international drive to normalise birth for healthy pregnant women.

Differences in results between midwifery led settings warrant further research as this would help to inform women when choosing where they would like to give birth. It would also provide important organisational, skill requirements and financial information for maternity care providers tasked with optimising the maternity service, and normalising birth safely and effectively within limited financial resources.

Whilst it was possible to collate a sample of 'healthy women' to serve as a control group for the birthing pool sample of women, it was only feasible to compare a limited number of outcomes by maternal parity. Overall exploration of the HES dataset exposed seminal limitations regarding routine maternity data collection, which require urgent attention in order to provide comprehensive and clinically meaningful information for maternity stakeholders.

Further research on the role that birthing pool use can play to normalise birth is warranted. This would include women's and midwives views, and robust comparison between birthing pool and no birthing pool use within the context of an RCT.

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