UNIVERSITY OF SOUTHAMPTON

FACULTY OF SOCIAL AND HUMAN SCIENCES

School of Social Statistics

Home birth in the UK: A safe choice?

by

Andrea Nove

Thesis for the degree of Doctor of Philosophy

June 2011

UNIVERSITY OF SOUTHAMPTON

ABSTRACT

FACULTY OF SOCIAL AND HUMAN SCIENCES
SCHOOL OF SOCIAL STATISTICS

Doctor of Philosophy

HOME BIRTH IN THE UK: A SAFE CHOICE?

by Andrea Nove

The safety of home as a place of birth in developed countries, and the extent to which pregnant women should have the right to choose a home birth, are highly contentious and emotive subjects which have been hotly debated for many years. Since 1993, Government policy in England and Wales has been that pregnant women should have a free and informed choice about whether to give birth at home or in a hospital or birthing centre. However, fewer than 3% of maternities take place at home, indicating either that this option is not routinely available or that most women do not want to have a home birth. Previous research indicates that there is an element of both, and that most women believe that hospital birth is safer than home birth. Although research has demonstrated that, for low-risk pregnancies in most developed countries, perinatal death is no more common for planned home birth than for hospital birth, and that maternal outcomes tend to be better if there is a planned home birth, this research has been done at the population level. At the level of the individual women, there remain lingering doubts over whether home birth can be as safe as hospital birth if there are serious complications in labour.

Using data from four UK datasets, this thesis contains detailed analysis of the characteristics of women who plan a home birth in the UK, and how these have varied over time and according to where the woman lives. Recognising that decisions about place of birth are subject to change over the course of a pregnancy, the analysis presented here identifies key factors which robustly predict whether women will express an intention to give birth at home, whether their intentions will change during the pregnancy, and whether those who intend a home birth will actually have a planned home birth. Understanding these predictors helps to understand the factors that may influence women's choices at different stages of pregnancy. There is evidence from this analysis to suggest that women do not all have equal access to choice about where to give birth.

Understanding of the factors that predict women's choices also enables a fair comparison of the relative safety of planned home birth and planned hospital birth, while controlling for the fact that women who plan a home birth are not a random sub-set of the population of childbearing women. From the perspective of the mother, planning a home birth (whether or not she goes on to give birth at home) is associated with a much lower risk of the potentially life-threatening postpartum haemorrhage (defined as the loss of more than 1,000ml of blood) and several other distressing labour complications such as retained placenta. From the perspective of the baby, the risk of perinatal death is slightly, but not significantly higher, if a home birth is planned than if a hospital birth is planned, even if high-risk pregnancies are included in the analysis. However, there is weak evidence to suggest that, if pregnancy/labour is complicated by malpresentation, umbilical cord prolapse or the need for infant resuscitation via positive pressure/cardiac massage, the risk of perinatal death is higher if a home birth is planned than if a hospital birth is planned. Other pregnancy and labour complications are associated with a higher risk of negative outcomes, but this is true whether a home birth or a hospital birth is planned – hospital birth has not been shown to be safer in these situations.

Malpresentation occurs in roughly 1 in 20 pregnancies and is detectable before labour commences, so this research provides some support for the current advice that women with a malpresented foetus should be advised to plan a hospital birth unless and until midwives attending home births can be fully confident in their ability to deliver a malpresented foetus vaginally. Cord prolapse and the need for positive pressure/cardiac massage, on the other hand, are both extremely rare and not predictable before labour. Given their rarity and the lack of strong evidence that home birth is less safe when they occur, rather than being encouraged to plan a hospital birth 'just in case', women should be provided with the available information and allowed to come to an informed decision without being put under pressure to choose any particular birth setting. Additionally, midwives attending home births should have a thorough grounding in dealing effectively with these situations when they occur in the home setting.

Contents

Index of tables

Index of figures

Declaration of authorship

I, Andrea Nove, declare that the thesis entitled 'Home birth in the UK: A safe choice?' and the work presented in the thesis are both my own, and have been generated by me as the result of my own original research. I confirm that:

- this work was done wholly or mainly while in candidature for a research degree at this University;
- where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated;
- where I have consulted the published work of others, this is always clearly attributed;
- where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work;
- I have acknowledged all main sources of help;
- where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself;
- part of this work has been published as Nove et al (2008) and another part has been published as Nove et al (2011).

Signed: _____

Date: _____

Acknowledgements

This PhD would never have been possible without the contribution of a number of people and organisations.

The Economic and Social Research Council (ESRC) provided funding for me to carry out this work and learn more about quantitative methods along the way, for which I am extremely grateful.

Family and friends have provided emotional and practical support over the last few years. My husband, Martin Boyce, has faithfully been paying most of the bills while I have been carrying out this work. My parents (Evelyn and David Nove) and parents-in-law (Penny and David Boyce) have provided many, many hours of childcare which has allowed me to make the journey from Ryde to Southampton twice a week for the last four years and to work during school holidays. Martin and Evelyn have also provided sterling proof-reading services and always had faith in my ability to do high-quality research while juggling the demands of a young family and assorted other commitments. My children, Emily and Adam, inspired the subject matter of my research through their births, and have helped me to remember that a PhD need not take over one's entire life. My friend and fellow student, Olga Maslovskaya, has been a constant source of support and encouragement (and a spare bed when I have needed to stay overnight in Southampton!).

My supervisors, Dr Ann Berrington and Prof Zoë Matthews, have been fantastic to work with. They are highly intelligent, supportive, thorough and have not been afraid to play devil's advocate when I needed to take a more dispassionate and objective view of an issue.

In addition to my supervisors, a number of people have provided specialist advice on specific questions over the course of my research. Prof Peter Smith from the University of Southampton Department of Social Statistics has been on hand to answer the more tricky statistical questions. Prof Phil Steer from Imperial College London has been highly approachable, helpful and patient in addressing my questions about the SMMIS database and various obstetric matters. Dr Ying Cheong from the University of Southampton School of Medicine and Jane Cullen from Southampton's Princess Anne Hospital provided useful advice about the selection of relevant outcome measures. Mary Foss from the University of Southampton School of Nursing and Midwifery has been very helpful in advising on matters relating to midwifery training in the UK. Dr Will Stones gave helpful advice on pregnancy risk classification, and Dr Imelda Balchin provided advice on the use of ICD codes.

My deepest gratitude and greatest respect goes out to you all.

1 Introduction

1.1 Why study home birth in the UK?

Accounts of positive birth experiences (e.g. Edwards, 2004) emphasise how childbirth can be empowering and self-affirming for the mother, and how a 'good' labour and delivery can be the start of a positive relationship between mother and baby, with positive knock-on effects on their mental and physical health (Oakley, 1980). On the other hand, a negative birth experience can bring about both short- and long-term physical and mental health problems for both mother and child. Clement (2001) described how women can be severely traumatised by their birth experiences, to the extent that some display symptoms of post-traumatic stress disorder (PTSD). The Birth Trauma Association website contains numerous descriptions of traumatic birth experiences and their after-effects (Birth Trauma Association, 2008).

Estimates of the incidence of trauma among women who have recently given birth are rare, and the only UK study (Menage, 1993) used a volunteer sample of women who had undergone any obstetrical or gynaecological procedure, so cannot be used to estimate incidence in the general UK population of women giving birth. Olde et al (2006) reviewed a number of studies from various developed countries including Sweden and Australia, and found that reported incidence of PTSD at 6 weeks postpartum was between 2.8% and 5.6%. They also found that between 24% and 33% of women reported at least some traumatic stress symptoms.

The vast majority of women in England and Wales give birth at least once (Office for National Statistics, 2010a). In 2009, over 700,000 women gave birth in England and Wales (Office for National Statistics, 2010). If Olde et al's figures apply in England and Wales, every year between 20,000 and 40,000 women will develop PTSD after childbirth, and 170,000-230,000 women will be affected by traumatic stress after childbirth. Research which looks into ways to minimise the chances of trauma - while not adversely affecting physical safety - therefore has the potential to have a positive effect on thousands of women and their families every year.

According to the Healthcare Commission (2008), a realistic objective is for 60% of births to be 'normal'[1] ("spontaneous vaginal delivery without the aid of an epidural, spinal or general anaesthesia, forceps or ventouse"), but they found that the median NHS trust-level 'normal' birth rate in 2007 to be just 40%, and that a quarter of trusts had a 'normal' birth rate of below 33%.

[1] The use of the term 'normal' could be criticised, since it implies that other births are 'abnormal', but this is the generally-used term, and it was the one used by the Healthcare Commission. Its use here is not intended as a value judgement.

Proponents of home birth argue that a planned home birth attended by a competent midwife is one way to maximise the chances of a normal birth and minimise the chances of birth trauma, because the factors associated with normal birth and a positive birth experience are much more likely to be in place at home than in hospital. Furthermore, they argue that the factors associated with non-normal birth and birth trauma are much more likely to occur in hospital than at home.

Shaw & Kitzinger (2005) used a variety of sources to produce a list of reasons why a woman might want to have a home birth. In their quantitative survey of women giving birth in England and Wales in 2006, Redshaw et al (2007) found that women having a planned home birth gave a number of reasons for making this choice. In both studies, the reasons broadly divided into two themes: (1) feeling relaxed/safe/secure and (2) feeling in control of what happens during labour and delivery. The research evidence on these two themes is summarised below.

Feeling relaxed/safe/secure

Some women seem to find the pain of childbirth more manageable than others (Green et al, 1998). This may simply be due to differences in physiological and/or psychological make-up, but studies suggest that the circumstances of the birth, including the environment in which it takes place, and the level of fear felt by the labour woman can also affect her ability to cope with labour pain (Borquez and Wiegers, 2006; Alehagen et al, 2005). Wickham (1999) theorised that this may be due to women's hormonal responses to labour pain and to stress. During labour, the body secretes oxytocin and endorphins, which help to cope with pain; at times of stress or insecurity, the body secretes stress hormones such as cortisol. Wickham suggested that the production of stress hormones may suppress the secretion of oxytocin and endorphins, thereby making the woman feel the pain more sharply and decreasing her ability to cope with it. If true, this indicates that a woman will cope better with labour pain if she feels relaxed. A woman seeking to maximise her chances of feeling relaxed may opt for the familiar surroundings of her home.

Young (1994) suggested that the reasons for the relatively good outcomes of home birth (see Section 2.4.2) are psycho-social, citing evidence from a number of studies suggesting that a mother's feelings of safety and security during labour are extremely important. Similarly, Tew (1998) noted that past research has tended to focus on the physical and biochemical aspects of childbirth rather than the emotional or psychological ones. She felt that this was a misguided focus, due to obstetricians being interested only in aspects of childbirth that they could directly influence, and a lack of understanding of the interconnectedness of a labouring woman's psychological state and the physiology of the birth.

Feeling in control of labour/delivery

Green & Baston (2003), Neuhaus et al (2002) and Page (1994) all acknowledged the importance of a feeling of control in terms of how positive a woman feels about her birth experience. They found that a feeling of control during labour and delivery tends to lead to feelings of accomplishment and self-confidence. Kitzinger (2000) suggested that such feelings are likely to lead to a better early relationship with the baby.

Green et al (1998) found that women who had experienced obstetric interventions during labour/delivery (except artificial rupture of membranes and foetal monitoring) tended to feel less fulfilled and less satisfied with their birth experience, and that women who felt unfulfilled by the experience had a greater tendency to use negative terms to describe their baby. They reported that the woman's perceptions of "the necessity or 'rightness' of the intervention" (as opposed to its administration *per se*) were key to whether it affected the woman's subsequent emotional well-being. This suggests that a positive birth experience is not necessarily one in which everything goes according to plan, and that women who have experienced complications requiring medical interventions can still feel their experience has been a positive one, as long as they have taken an active part in the decision-making process. Because childbirth in most developed countries tends to be a medicalised event rather than a physiological process, there is much potential for a woman to feel as though she is not in control of her labour and delivery, which may lead women to choose home birth as a way to maximise control.

In addition to the type of reasons described above, a qualitative study in the US (Boucher et al, 2009) found that one of the most common reasons given for choosing a home birth was a previous negative experience of hospital birth.

Proponents of hospital birth argue that because there is always the potential for unforeseen complications, women should deliver in hospital so that they are close to emergency facilities should the need arise. They consider birth to be a potentially pathological event as opposed to a physiological process, and therefore perceive hospital to be the safest place to give birth. Previous research suggests that there is a widespread belief among women that, because of easy access to technology in case of emergency, hospital is a safer place to give birth than home (Pitchforth et al, 2007; Fordham, 1997). This is especially true for first-time mothers (Rogers et al, 2005), who make up about 40% of those giving birth in the UK (National Collaborating Centre for Women's and Children's Health, 2007).

Pregnant women and their families are caught in the middle of this debate. Research has shown that, despite recent increases in the proportion of women offered a choice regarding place of birth, not all UK women are proactively given information about their options regarding place of birth:

- A 2010 survey of women in England who had recently had a live birth (Care Quality Commission, 2010) found that 83% felt they had been given a choice of place of birth (up from 81% in 2007), and that 74% felt that home was one of the choices offered to them (a large increase on 58%[2] who said the same in 2007). Only 47% felt that they were given all the information they needed in order to make a choice.
- A 2006 survey of women in England and Wales who had recently had a live birth found that just 38% felt that home birth was an option for them (Redshaw et al, 2007)
- A 2003/4 study in Hampshire found that, while the majority of women felt they were offered a choice of place of birth, only about half felt that the options included home birth (Rogers et al, 2005).
- A 1998 survey of women in Scotland found that just 41% felt home birth was an option (Hundley et al, 2000).
- A 2009 study concluded that, nationally, fewer than 5% of women had easy access to all three options recommended by the Government: home, an obstetrician-led maternity unit or a midwife-led maternity unit (Dodwell & Gibson, 2009).

Furthermore, there is qualitative evidence of women being given outdated, biased and/or incorrect information when making enquiries about their options, e.g. being told that it is dangerous to have one's first baby at home, or that the NHS can refuse a woman a home birth due to its workload (Edwards, 2005; Shaw & Kitzinger, 2005). If women are asked if they want a choice about place of birth, they are likely to say 'yes' (Rogers et al, 2005). Green et al (1998) found that a feeling of not having a choice about where to give birth was associated with dissatisfaction with the birth experience.

The UK is an interesting case study in relation to home birth. As will be seen in Section 4.2.1, home birth had all but disappeared in the UK by the mid-1980s, following the trend evident in most other Western countries (Declercq et al, 2001). Since the late 1980s, however, there has been an increase in the UK home birth rate (Office for National Statistics, 2010b), in contrast to other western countries such as the US and Finland, where the home birth rate has been consistently low over recent years (Declercq et al, 2001) and the Netherlands, where the home birth rate has traditionally been relatively high but has fallen steadily over recent years (de Jonge et al, 2009). The UK is also unusual in that the government of England and Wales has an explicit policy to give women a choice about where they give birth (Department of Health, 2007).

[2] 58% was the national figure, but there was wide variation between NHS trusts (between 22% and 93%) (Healthcare Commission, 2008).

However, in publishing its clinical guidelines for the care of "healthy women and their babies during childbirth" in 2007, the National Collaborating Centre for Women's and Children's Health (NCCWCH) acknowledged that more research was needed in order for women and clinicians to be fully informed about the different options in relation to place of birth.

Despite support from the State, there does appear to be a discrepancy between the level of interest in home birth and the home birth rate. In 2009, just 2.7% of women giving birth in England and Wales did so at home (Office for National Statistics, 2010b), and the figures for Scotland and Northern Ireland tend to be even lower than those for England and Wales (see Figure 4.5). These figures included women who had not planned to have a home birth, so the figures for planned home birth will have been even lower. It is possible that the low percentage of home births in the UK is simply due to nearly all women preferring to give birth in hospital, but the evidence suggests otherwise. A national survey carried out in the early 1990s found that about 16% of women who had recently given birth in hospital would have liked the option of a home birth, whereas health professionals tended to assume that women wanted to give birth in hospital (Department of Health, 1993). A more recent survey found that 20% of women in the third trimester of pregnancy were interested in knowing more about home birth (Singh & Newburn, 2000).

It is not advisable to take these figures of 16% and 20% at face value; the 'real' figure could be lower because: (a) expressing an interest in home birth is not the same as wanting one, and (b) some women who are interested in home birth may have medical or obstetric reasons why a home birth is inadvisable. On the other hand, it could be *higher* than 20%. Salkeld et al (2000) found that, when people are asked to state a preference for different models of healthcare, they will tend to choose the model that they know best. It is not clear why people tend to favour the *status quo*, but Salkeld et al suggested that it might be due to an assumption that the model of care on offer had been scientifically proven to be the best, and/or to lack of information about the alternatives. Whatever the reason, the consequence would be that any UK study asking women where they would prefer to give birth will underestimate the level of interest in home birth. This hypothesis was supported by Sandall et al (2001a) and Leap (1996), who reported home birth rates of over 40% in midwifery practices in South-east London where home birth was actively encouraged and supported. NHS trusts offering caseload midwifery tend to find that the home birth rate among women cared for by the caseload team is high in relation to the overall home birth rate for that trust (e.g. Ward, 2009).

1.2 Research questions and objectives

This thesis aims to answer three research questions:

1. **Who plans a home birth in the UK, who changes intention during pregnancy, and who achieves a planned home birth?**
   What social, demographic and clinical factors predict whether a woman will express an intention to give birth at home, whether she will change her intention during pregnancy, and whether women who intend a home birth go on to have one?

2. **Is planned home birth in the UK safe for mothers?**
   Does intended place of birth predict labour complications once other related factors are held constant?
   Does the same pattern apply to all, e.g. women with high-risk pregnancies?

3. **Is planned home birth in the UK safe for babies?**
   Does intended place of birth predict negative pregnancy outcomes for the baby, once other related factors are held constant?
   Does the same pattern apply to all, e.g. high-risk pregnancies?

All three questions are addressed using secondary quantitative analysis of existing datasets. The first question is answered using four data sources: (1) vital registration statistics, (2) a national survey from Scotland, (3) a national survey from England, and (4) NHS maternity records from one region of England. The second and third questions are answered using the same set of NHS maternity records.

1.3 Personal motivations in framing the research questions

The second and third research questions were the main motivation for this thesis, and they were born out of my own experience. After an intervention-filled labour and unsatisfactory postnatal care in hospital after the birth of my first child in 2001, I decided to plan a home birth for my second in 2004[3]. Before making this decision, I did my own research on the safety of home birth, and was surprised and dissatisfied at the lack of high-quality research on the subject. Certainly, there is plenty of strong opinion on the matter, but I was left without an answer to the question: 'is it safe for me?' A number of research studies have considered the question of the relative safety of home and hospital birth (Wax et al, 2010a; Olsen, 1997). However, many of them took place overseas, and

[3] I lived in England throughout both pregnancies, and both babies were delivered under the care of the same NHS Trust.

conclusions reached by research in other countries will not necessarily apply in the UK because the subject must be considered within the context of the maternity care system in place. Even the UK-based research suffered from a number of problems, as described in Section 2.4.2.

In the event, my second labour took place in hospital and was a more positive experience than my first, but I remained with the conviction that more high-quality evidence is required to help women make this important decision. While the 'hospital versus home' debate continues unresolved, pregnant women will not have access to clear, unbiased information, making informed choice about place of birth impossible. At the outset of this research, I tended to believe that planned home birth was safe for most women, but the research questions have been investigated in a genuine spirit of enquiry, because I was conscious that I had formed this opinion based on my own beliefs and very limited experience, rather than on reliable evidence.

The first research question was an obvious question to ask in order to aid investigation and interpretation of the other two, especially in relation to controlling for bias resulting from selection effects. I had assumed that the existing literature would answer it, and was surprised to find only very sketchy and largely out-of-date information in the literature on the profile of home birthing women in the UK. A wide-ranging search for possible sources of data ensued (see Appendix B), and four were used to provide evidence to help answer this question.

1.4 How this thesis contributes to what was already known

As can be seen in Chapter 2, very little research on home birth has been carried out in the UK in recent years, not least because very few women give birth at home, which makes it very difficult to capture them in sufficient numbers for detailed analysis. In producing its recent guidance on place of birth, the National Institute for Health and Clinical Excellence therefore felt it had no alternative but to publish its official guidance on place of birth on "consensus" rather than evidence (National Collaborating Centre for Women's and Children's Health, 2007). The team responsible for reaching this consensus contained many more medical doctors than midwives (see Section 2.2) which may have led the guideline to be biased towards the preferences of the medical profession rather than those of the midwifery profession.

This thesis is intended to go some way towards filling the gap in high-quality evidence about the relative safety of different birth settings in the UK. It has been produced by someone with no particular 'axe to grind', other than a desire to understand whether home birth in the UK is a safe option for all, some, or no women. No prior assumptions have been made about which women are or are not 'suitable' for home birth. For example, the analysis has not been restricted just to women with uncomplicated pregnancies, because the case for high-risk pregnancies all giving birth in hospital has been made *a priori* rather than from reliable evidence. Attempts are made to overcome

the problems that were inherent in most previous studies which attempted to compare the experiences of women giving birth at home against those of women opting for hospital birth (see Section 2.4.2).

1.5 Structure of thesis

This thesis contains 8 chapters:

1. *Introduction*: explains the rationale for the study and its specific objectives.

2. *Literature review*: a discussion of the history of home birth in the UK and other countries (by way of context and an aid to understanding of the current situation in the UK), and a review of what previous research and commentary has been published on the three research questions set out in Section 1.2.

3. *Data and methods*: A description of the data sources used to answer the research questions, and a discussion of their strengths and weaknesses, followed by a description of the statistical methods used in the later chapters.

4. *Who plans a home birth in the UK, who changes intention during pregnancy, and who achieves a planned home birth?*: analysis of four separate UK datasets, which between them provide a detailed analysis of the factors that predict whether a woman will express an intention to give birth at home, whether women who intend a home birth go on to have one, and whether a woman's intention changes over the course of pregnancy.

5. *Methodological approach taken to answering the research questions on the safety of home birth*: discussion of the theory behind the approach taken, the outcome measures used, and justification of the exclusion of certain cases from the analysis.

6. *Is planned home birth in the UK safe for mothers?*: assessment of the extent to which intended place of birth predicts negative maternal outcomes, once other observed characteristics are held constant.

7. *Is planned home birth in the UK safe for babies?:* assessment of the extent to which intended place of birth predicts negative infant outcomes, once other observed characteristics are held constant.

8. *Discussion/conclusions*: including study limitations and policy implications.

2 Literature Review

This chapter is divided into four sections. Section 2.1 considers the social, medical and political history of maternity care in the UK and identifies important landmarks in the history of maternity care in the UK and how these have influenced women's birthplace choices. It demonstrates how the fight for professional control of maternity services over the last century has contributed to the current low rate of home birth, and then discusses the situation in other developed countries, focusing particularly on the Netherlands. Section 2.2 describes how, in the UK, medical, governmental and pressure group policy towards home birth for uncomplicated pregnancies is unanimously positive, yet notes that this policy can be at odds with the views held by individual health professionals. Section 2.3 addresses the first research question describes what was previously known about the types of women who plan/have a home birth in the UK, noting that there is very little up-to-date information, and that such women tend to be higher-parity, middle-class and obstetrically low-risk. Section 2.4 addresses the second and third research questions about the relative safety of home and hospital birth. Most of the existing quantitative research evidence on home birth has focused on attempts to find out whether home birth or hospital birth is safer. The extent to which is has succeeded in doing so depends on what is understood by the word 'safe', so this section begins with a discussion of the different meanings attached to the concepts of safety and risk and the reasons why making a comparison between the safety of home and hospital is fraught with problems. Section 2.4 then goes on to summarise the findings of research from the UK and other developed countries, most of which concluded that the outcomes of planned home birth tend to be as good, if not better, than the outcomes of planned hospital birth, but little of which was able adequately to control for the fact that women who plan a home birth are not a random sub-set of the population of childbearing women.

2.1 History of home birth

2.1.1 The UK

The first 'lying-in' hospitals in the UK opened their doors in the middle of the 18th century. They were designed to give women who were homeless or living in very poor housing a suitable birthing environment (Chamberlain et al, 1997), although they were also used as centres for teaching and research (Tew, 1998). Initially, they were not widely used. Campbell and Macfarlane (1994) noted that, in the late 19th century, about 99% of births took place at home, indicating that this was the norm throughout the 18th and 19th centuries.

Place of birth has always been strongly associated with the type of birth attendant. Generally, modern home births are attended by community midwives, and hospital births by hospital midwives and/or obstetricians. Loudon (1992) estimated that midwives (who were nearly all women) attended about half of all births in the 19th century, with most of the rest attended by GPs. This overall figure masked geographical variations, with midwives attending births in "rural areas and in working-class areas of large manufacturing towns", and GPs attending most deliveries in other areas. Midwives - especially those employed by the working classes - tended not to have had formal training. It wasn't until the 1902 Midwives Act that midwives were required to register and prove their credentials. Even after this date, the requirements of the Act were patchily implemented (Van Lerberghe and De Brouwere, 2001), with the result that lay midwives continued to practise, especially among working-class women.

During the 19th century, obstetrics was viewed as the 'poor relation' of other branches of medicine. Loudon (1992) attributed this to the snobbery of senior physicians, who saw childbirth as the province of 'lesser' practitioners (i.e. midwives and GPs – whose methods were compatible with home birth). There were hardly any specialist obstetricians until the development of surgical techniques relevant to childbirth and the emergence of gynaecology as a new speciality in the late 1800s, which gave obstetricians the chance to expand their practice to include surgical procedures. Thus, the obstetrician-gynaecologist could attain similar status to other physicians, which made the profession more attractive to ambitious medical men.

Loudon (1992) described how this new breed of obstetrician-gynaecologist began to present serious competition to midwives and GPs, and that their preference for surgical intervention was incompatible with home birth. Midwives tended to practice independently, so did not have the organisational back-up to stand up to this well-organised and highly-educated competition. Loudon also noted that GPs tended to find childbirth a stressful and not particularly well-paid part of their practice, but they did gain satisfaction and 'repeat business' from it, so were reluctant to cede power to the obstetricians.

Campbell and Macfarlane (1994) and Loudon (1992) described how in the early 1900s there was growing public concern about infant mortality rates and about the housing conditions of very poor women. In response to these concerns, 1920s government policy was to provide hospital beds for pregnant women with complications and places in maternity homes for women whose homes were not suitable for home birth. Maternity homes were meant to be peaceful and hygienic places to give birth, rather than medicalised environments.

When women first started giving birth in hospital, it was widely acknowledged that hospitals were unsafe places to give birth, because of high infection rates (Loudon, 1992). Once action was taken to reduce infection rates, hospital became more attractive to women, who appreciated the break from their domestic responsibilities after giving birth (Lumey, 1993).

In 1927 the first national statistics on place of birth were published. At that time, 85% of live births in England and Wales took place at home (Macfarlane & Mugford, 2000). Campbell and Macfarlane (1994) noted that during the 1930s, the debate between GPs and obstetricians over which discipline should control maternity services[4] was still current, but the two professions were in agreement that for most women, childbirth was not dangerous and could safely take place at home (British Medical Association, 1936; British College of Obstetricians and Gynaecologists, 1936). Just a few years later, however, the Royal College of Obstetricians and Gynaecologists (RCOG) recommended that 70% of women should give birth in hospital (RCOG, 1944), without justifying this figure. Chamberlain et al (1997) suggested that this was an example of "asking for more than you need in order to get enough" rather than being based on any research evidence. Nevertheless, the figure of 70% was, apparently unquestioningly, accepted by the Government (Cranbrook, 1959). Lumey (1993) suggested that the RCOG wanted 100% hospitalisation as part of their drive to gain control over maternity services, but realised that this was unrealistic due to insufficient midwives and hospital beds.

The National Health Service (NHS) was launched in 1948, bringing hospital birth within the financial reach of all women in the UK. In its review of reasons for escalating NHS costs, in 1953 the Guillebaud committee suggested that the fragmented structure of NHS maternity services encouraged competition rather than co-operation and was therefore inefficient (Lumey, 1993). According to Lumey, obstetricians in particular felt that a unified organisational structure – with themselves at the head - would be more efficient.

Chamberlain et al (1997) attributed the move away from home birth during the early to mid 20th century to a number of causes, the main ones being: increased urbanisation (leading to less space/privacy in the home), the introduction of the NHS making hospitals financially accessible to the general population, and lower fertility (leading to people attaching more importance to each pregnancy and expecting medical treatment in emergency cases rather than accepting mortality as an inherent risk of pregnancy). Chamberlain et al felt that, initially, the change was driven by women's choices rather than being led by the medical profession.

Declercq et al (2001) suggested that the development of obstetric technology and anaesthesia contributed to the move towards hospital birth, because much of this technology is not available in the home setting. They also felt that the potential for economies of scale helped to drive the process, although they noted that in practice the potential for saving money has not been realised. They noted that the move to hospital coincided with a more general move away from the community towards hospital for medical care.

[4] Apparently the midwifery profession was not involved in this debate.

By the mid-1950s, the RCOG's expressed position was that all women should give birth in hospital (Campbell and Macfarlane, 1994). At this time, it co-sponsored a major research study carried out by the National Birthday Trust Fund, in the expectation that it would demonstrate that hospital birth was safer than home birth. The study sample comprised 98% of all births during a single week in March 1958, plus 94% of all stillbirths and neonatal deaths in March, April and May of the same year. Detailed social, demographic and obstetric information was collected from the mother and her midwife (Butler & Bonham, 1963). The study actually found a *lower* mortality ratio among the 41% of women who booked a home birth (whether or not they went on to have one) than among the women who booked a hospital birth. The authors noted that this could be due to selection effects, and recommended more detailed analysis to establish the extent to which these explained the difference.

A later report using the same study data (Baird & Thomson, 1969) found that the overall pattern of the PMR being lower among those who booked a home birth masked variations by region and rurality. The two obstetricians who conducted this analysis were convinced that the relatively good outcomes among rural women (who were more likely to have home births) was due to their "superior health and physique", apparently without considering that place of birth may have been a contributory factor. Given that no serious attempt was made to control for confounding and selection effects, it is not possible to draw firm conclusions about the relative safety of different birth settings in 1958. It appears that different parties chose to interpret the results in such a way as to further their own cause, ignoring other possible explanations for the observed patterns. RCOG – evidently the most powerful group - continued to recommend hospital birth for all women.

From the 1950s onwards, criteria for 'allowing' women to have a home birth were published periodically. According to Allison (1996), the criteria in 1967 – when 21% of maternities took place at home - were that the woman should: be in good physical health, be on her second, third or fourth pregnancy, be aged under 35, have no rhesus antibodies, live in suitable accommodation and be of 36-42 weeks' gestation. Allison's study of birth records in Nottingham from 1948-1972 found that around half of home births did not fulfil all of these criteria. This may have been due to health professionals applying the criteria loosely, but Allison found evidence to suggest that hospital beds were not always available for 'high-risk' women because so many 'low-risk' (mainly middle-class) women were opting for hospital birth.

Campbell and Macfarlane (1994) also noted that at this time there was increasing demand for hospital birth from women themselves. Indeed, the Association for the Improvement of Maternity Services (AIMS) - which today campaigns for, *inter alia*, "safe and adequate provision for home birth by all NHS Trusts" (AIMS, 2007) - was set up in 1960 when one of its main objectives was to campaign for more maternity beds in hospitals (Chamberlain et al, 1997). Campbell and Macfarlane (1990) noted that obstetricians began to take note of women's demands for better quality maternity

care in the late 1970s, but chose to "translate these demands into a call for more consultant obstetric posts", apparently without considering other aspects of quality in maternity care.

A sharp fall in fertility began in the mid-1960s, which reduced the pressure on hospital beds (Declercq et al, 2001) and made 100% hospitalisation a realistic aim. In 1970, the Peel Report recommended that provision be made for all women to give birth in hospital (Peel, 1970). Macfarlane and Mugford (2000) noted that this recommendation was made in the belief that hospital birth was safer than home birth for all women, but without any high-quality research evidence to support this belief. The Peel Report observed that the increase in hospital birth rates over the first half of the 20th century had been accompanied by a decrease in maternal and infant mortality rates. It was assumed that the one had caused the other (Tew, 1998) and therefore that hospital was a safer place to give birth than home. Van Lerberghe and De Brouwere (2001) suggested that falls in maternal mortality from 1937 onwards were due to the greater accessibility of antibiotics, Caesarean sections and blood transfusions, and to improvements in the use of such techniques (some of which were only available in the hospital setting). In other words, increased hospitalisation could well have contributed to a reduction in the risk of death in childbirth from this date onwards. However, the underlying trend in mortality rates had been downward since the 1870s (Tew, 1998; Loudon, 1992), i.e. a time when virtually all births took place at home. Tew (1998) suggested that factors such as improvements in women's general health were responsible for the fall in mortality between 1870 and 1940, and Van Lerberghe and De Brouwere (2001) suggested that it was mainly due to improvements in the standard of midwifery care and the introduction of antisepsis.

At the same time, GPs were becoming less and less experienced at attending births, and they apparently yielded to the obstetricians in the struggle for control over maternity services. Furthermore, Lumey (1993) noted that the speed of the shift from home to hospital birth made it increasingly difficult for the NHS to provide a viable domiciliary service.

The 1974 restructuring of the NHS resulted in community midwives becoming part of the same teams as hospital midwives, and thereby losing their (relative) autonomy. Kirkham (1999) argued that hospital management was built on a masculine model involving control, hierarchy and competitiveness, and that these values did not suit the fundamentally non-medical and predominantly female tradition of midwifery. According to Tew (1998) and Kirkham (1999), midwives were torn between the demand for them to 'professionalise' in a way that would be accepted by the medical establishment, and their own desire to provide 'woman-centred' care. Because their position in the hospital hierarchy was relatively lowly, the demand to professionalise dominated, and the desire to provide woman-centred care was suppressed. Kirkham suggested that this internal conflict resulted in low self-esteem, which brought with it a fear of change and a tendency to oppress midwives who are outspoken about their discomfort with the way they are

expected to work. Thus, as she saw it, the situation is self-perpetuating, and the organisational structure of the NHS prevents the achievement of the aim of woman-centred care.

If Kirkham's theory is correct, it may explain why many parts of the NHS have problems with midwife recruitment and/or retention. Certainly, Healthcare Commission research (2008) indicated that midwives in England were more likely than other clinicians to express frustration, distress and unhappiness in their work. Curtis et al (2006) noted that dissatisfaction with the profession was the main reason for midwives ceasing to practise; well ahead of family commitments, planned career changes, retirement and ill-health.

Sandall et al (2001b) described the 1970s and 80s as "a low point for professional midwives", during which the skills of midwives were undervalued and underused to the extent that most midwives became the equivalent of obstetric nurses rather than experts in normal childbirth. Because home birth is midwife-led, the provision of home birth as a realistic choice is dependent on the midwifery profession being sufficiently confident and skilled to argue for and safely deliver it, so a country with a weakened midwifery profession is unlikely to have a high home birth rate. Section 2.1.2 describes how the Dutch midwifery profession is relatively strong and influential, which is almost certainly a major reason for the relatively high home birth rate in the Netherlands.

In the mid-1980s, there was a high-profile case of an obstetrician who supported the principle of 'woman-centred' maternity care even if the pregnancy was 'high-risk', being summarily suspended from her post at a London NHS hospital, allegedly for incompetence (Savage, 2007a). After a lengthy investigation, she was exonerated, but her case highlighted the difficulties faced by health professionals who challenge the dominant medical model of childbirth. Wagner (2007) went as far as to say that there was – and still is - a "witch-hunt" against those who do so, which results in doctors and midwives being afraid to support the wishes of pregnant women if those wishes go against orthodox practices and protocols. As recently as 2009, an independent midwifery practice in Peckham, south London, which had a very high home birth rate, had its contract with the NHS terminated suddenly, ostensibly due to concerns about safety (King's College Hospital, 2009). Many commentators highlighted concerns over the methodology used to investigate the practice's safety record, and suggested that the closure of the practice was an inappropriate response (Royal College of Midwives, 2010a; National Childbirth Trust, 2009b). This too led to accusations of a 'witch-hunt' (e.g. Jowitt, 2009).

The home birth rate in England and Wales reached its lowest ever level in 1985-88, after which time it grew slowly until 2008 before falling slightly in 2009 (Office for National Statistics, 2010b). Hence, the increase began before the publication of *Changing Childbirth* (Department of Health, 1993), which was the first policy document to advocate choice in relation to place of birth, with women being given unbiased information about the different options. Kirkham and Stapleton (2000) put forward the view that, although *Changing Childbirth* provided an increased impetus for

change, NHS structures and funding mechanisms prevented NHS trusts from acting upon its recommendations. Savage (2007b) noted that no additional funding was made available for implementation of the recommendations. In her view this, coupled with divisions within the Royal College of Midwives, meant that this landmark report had little impact in practice.

It was this lack of impact that led the government to publish *Maternity Matters* (Department of Health, 2007), which renewed calls for more 'woman-centred' maternity services in England, and required NHS Trusts to provide all women with informed choice about place of birth. Edwards (2008) identified a number of barriers to the implementation of the recommendations of *Maternity Matters*, including: (1) women's belief that hospital is safer than home – a belief that is fuelled by the depiction of childbirth in the media as a high-risk event, (2) a power imbalance between pregnant women and health professionals, (3) conflicts between obstetricians and midwives and (4) a midwife shortage.

There has been a widely-publicised NHS midwife shortage over the past few years (BBC, 2010; BBC News, 2004), and this is often cited as a reason why more women are not able to access a home birth service through the NHS. Independent midwives specialise in home birth (Independent Midwives' Association (IMA) 2005), but Sandall (2007) calculated that 95.5% of births in England in 2004-5 received maternity care from the NHS, so an NHS midwife shortage has the potential to affect the vast majority of pregnant women in this country. Whilst not detracting from the need for adequate midwifery cover, some commentators question whether there is scope for midwives to operate more efficiently. For example, Savage (2007b) calculated that, in England, there were fewer than 40 births per full-time-equivalent midwife per year, "which would not be an excessive workload if midwives were able to organise their time properly", and Sandall et al (2011) concluded that the effective deployment of maternity staff was at least as important as the number of midwives. Sandall et al also questioned whether the tool that is most commonly used to calculate the optimum number of midwives is based on appropriate assumptions about which health professionals are necessary to do which tasks.

2.1.2 The UK compared and contrasted with the Netherlands and other developed countries

The almost complete shift away from home birth towards hospital birth in the 20th century was evident in most developed countries, with the Netherlands being an exception (Chamberlain et al, 1997). Tew (1998) pointed out that the change happened most quickly in countries with large European immigrant populations (USA, Canada, Australia, New Zealand, South Africa) "where a vigorous medical profession was seeking to establish itself". She also noted that the shift was most complete in Eastern European countries, where political ideology decreed that trained 'experts' should control all social, economic and healthcare systems.

Declercq et al (2001) noted that, although the move from home to hospital was achieved in different ways in different countries, they all had some elements in common, notably:

- The increase in hospitalisation of birth accompanied a rise in hospitalisation of health care generally.
- The way in which health care systems are financed has had an indirect but strong influence over the home birth rate.
- The number / role of midwives are inextricably linked with the home birth rate.
- Women's own attitudes were instrumental in driving the increase in hospitalisation.

The recent small increase in the UK home birth rate sets it apart from most other developed countries. The practice of allowing women to choose their place of birth (from a range of options including the home) is now encouraged both by the government and by the professional organisations representing midwives and obstetricians (see Section 2.2). This situation is in stark contrast to the US in particular, where the midwifery profession has all but disappeared and the official position of the American College of Obstetricians and Gynaecologists (2011) is: "hospitals and birthing centres are the safest setting for birth".

The Netherlands is unique among developed countries, in that about 30% of births take place at home (de Jonge et al, 2009). For many years, the Netherlands achieved excellent pregnancy outcomes in comparison to other European countries, which suggested that, if the infrastructure is in place, home birth is safe. However, in recent years the Dutch perinatal mortality rate has declined relatively slowly, with the result that it has become one of the highest in Europe (Evers et al, 2010; Sheldon, 2008). This has led to questions being asked about the safety of home birth (Evers et al, 2010; Steer, 2008c). However, a study based on data from 2000-2006 (de Jonge et al, 2009) found that, for low-risk pregnancies, rates of perinatal mortality and morbidity were no higher among planned home births than among planned hospital births. The authors suggested that the relatively high Dutch PMR may be due to demographic factors (e.g. a high proportion of older mothers) and/or "substandard" maternity care (e.g. a recent study cited by Sheldon (2008) found that the Dutch PMR is relatively high among babies born at night, leading the authors to suggest that obstetrician cover is poor outside of normal office hours).

The main differences between the British and Dutch systems are summarised in Table 2.1.

Table 2.1: British and Dutch maternity services contrasted

Dutch	British
Women are carefully selected for either midwife/GP- or obstetrician-led care based on nationally agreed risk factors (Obstetric Working Group of the National Health Insurance Board of the Netherlands, 2000). All high-risk women are booked to labour and deliver in hospital	Until recently, there was no national guideline on the definition of high- and low-risk (Campbell, 1999). Guidelines were published in 2007 by the National Collaborating Centre for Women's and Children's Health, but with the caveat that more research was needed
The State, health insurance funds and influential members of the obstetric profession have always tended to think of birth as a physiological event that is best managed in a non-medical environment (Abraham-Van der Mark, 1993)	Since the early 1900s, birth has tended to be considered as a medical event, and until the early 1990s the State was convinced that hospital was the safest place for all women to give birth (e.g. Maternity Services Advisory Committee, 1984)
Midwifery is a powerful and respected profession, with midwives practising independently (Jabaaij & Meijer, 1996)	Most midwives are directly employed by hospital trusts, far lower in the 'pecking order' than obstetricians (Kirkham, 1999)

Some (e.g. Savage, 2007a; Lumey, 1993) commented on another fundamental difference between the UK and the Netherlands, in terms of the people invited to join the various committees formed to look at the structure of maternity services over the years. UK committees have tended to be heavily biased towards professions and groups with an interest in promoting hospital birth[5], whereas Dutch committees have had good representation from the midwifery profession and women's groups. There is a suggestion that this strongly influenced the conclusions drawn by these influential committees and is one of the main reasons why the home birth rate is radically different between the two countries.

2.2 Current policy in the UK

Royal College of Obstetricians and Gynaecologists (RCOG)/Royal College of Midwives (RCM)
The RCOG and the RCM issued a joint statement in 2007 saying they "support home birth for women with uncomplicated pregnancies … it may confer considerable benefits for them and their families. There is ample evidence that labouring at home increases a woman's likelihood of a birth that is both satisfying and safe, with implications for her health and that of her baby." Savage (2007a) noted that, for many years, the RCOG was fundamentally opposed to home birth, and expressed the view that, despite this 'official position', many older obstetricians still consider home birth to be inherently dangerous.

RCOG's position on the issue of home birth contrasts with those of the equivalent bodies in the USA, Australia and New Zealand, which oppose home birth in principle (McLachlan & Forster, 2009).

[5] For example, according to Lumey (1993), the Peel committee in 1970, which recommended 100% hospitalisation, contained both the incoming and outgoing presidents of the RCOG, and the representative of the Central Midwives Board was a male doctor. Only two committee members were female.

The equivalent midwifery bodies in these three countries support planned home birth for uncomplicated pregnancies.

Government

Beake and Bick (2007) pointed out that "the maternity services in England probably have one of the most comprehensive policy agendas of any maternity service in the world." Since 1993, the policy of the government in England has been that home is a safe birth environment for low-risk women, and that women should have informed a choice about where they give birth (Department of Health, 1993). This policy was re-affirmed in 2007 with the publication of *Maternity Matters*, which stated that all women should be guaranteed a choice by the end of 2009 (Department of Health, 2007). A 2009 study suggested that this choice guarantee was not universally in place; it indicated that only a very small minority of women had access to the full range of options in relation to place of birth (National Childbirth Trust, 2009a).

The Welsh Assembly is similarly supportive of home birth for low-risk women (Welsh Assembly, 2005), and in 2002 set a target that 10% of maternities should take place at home (Welsh Assembly, 2002). In 2008, however, just 3.7% did. The Scottish Executive states that, in principle, it is supportive of informed choice in relation to place of birth (Scottish Executive, 2001), but as yet has no stated policy on assuring that women have this choice. According to the National Childbirth Trust (2008), "no policies are in place [in Northern Ireland] to routinely offer home births to women".

Campbell and Macfarlane (1990) noted that RCOG has traditionally been adept at influencing UK politicians, in a way that groups representing midwives and pregnant women were not. Savage (2007a) – herself an obstetrician – expressed the view that "many obstetricians sincerely believe that the reduction in the PMR … over the last 50 years is due to their efforts to persuade all women to give birth in hospital". This firmly entrenched view perhaps explains why, despite the evidence, those responsible for government policy continued to publish statements about hospital birth being safer than home birth until the late 1980s.

The National Health Service (NHS)

Government policy in England and Wales is supported by clinical guidelines (National Collaborating Centre for Women's and Children's Health, 2007). The counterpart guideline in Scotland (NHS Quality Improvement Scotland, 2005) also promotes the principle of informed choice. There is currently no equivalent clinical guideline applicable to Northern Ireland, but the National Childbirth Trust (2008) noted that the adoption of the England and Wales guideline was being considered.

The England and Wales clinical guidelines contain a list of medical and obstetric conditions/situations that indicate there should be a "planned birth at an obstetric unit" (see

Section 4.3.1). As an official NICE guideline, maternity care providers in the NHS are expected to adhere to this list in terms of the advice they give to pregnant women. NCCWCH posed the question 'what are the risk factors which should be included in assessment to determine the most appropriate place of birth for women during pregnancy and in labour?', and found "no high-quality studies … that directly addressed this question", so they felt unable to make an evidence statement about it. The list of contraindications was "produced by consensus with the aim of providing consistency of advice for women when considering the relative risk associated with where they wish to give birth." Some commentators were unhappy about the methods used (National Childbirth Trust, 2007; Gyte et al, 2009). Others have criticised the guideline for having been overly-influenced by the belief that all pregnancies are potential emergencies (e.g. Carne, 2008), given that the guideline was specifically concerned with uncomplicated pregnancies.

The committee responsible for drawing up the UK guideline consisted of 20 people:

- Members of the NCCWCH research team: 7
- Consultant Obstetrician: 3
- Women's representative: 3 (1 resigned due to concerns over methods used)
- Consultant or senior Midwife: 2
- Health Economist: 2
- Consultant Neonatologist: 1
- Labour ward Matron: 1
- Obstetric Anaesthetist: 1

Midwives are (or should be) considered the experts in straightforward pregnancy/delivery, so it is not ideal that midwives were so heavily outnumbered on a committee appointed to look at "the care of *healthy* [my emphasis] women and their babies during labour". By contrast, the Dutch guideline (Obstetric Working Group of the National Health Insurance Board of the Netherlands, 2000), was drawn up by a committee consisting of equal numbers of representatives from the three professional associations representing midwives, GPs and Obstetricians/Gynaecologists, plus a national government representative. The committee was chaired by a representative of the Health Care Insurance Board.

Campaigning/lobbying groups

The National Childbirth Trust (2008) supports and campaigns for women's right to choose a home birth and have access to high-quality care, regardless of her risk status. The Association for Improvements in the Maternity Service (AIMS) also supports the right to choose, and campaigns for "safe and adequate provision for home birth by all NHS Trusts" (AIMS, 2007).

2.3 Who plans/has a home birth in the UK?

In the UK, most pregnant women receive maternity care from the NHS, and in most parts of the UK, NHS maternity care providers are employed by individual NHS hospitals. The organisation of planned home births varies depending on the systems in place locally. Over the last two years, NHS trusts have begun to implement systems to make it possible for a pregnant woman to refer herself directly to a midwife. Before then, the first 'port of call' was the woman's GP, and until awareness of the ability to self-refer to a midwife grows, this situation is likely to remain the *status quo*. The GP refers the woman to receive maternity care from a particular hospital, and NICE recommends that the woman has a 'booking' appointment before 10 weeks' gestation (National Collaborating Centre for Women's and Children's Health, 2007) with a midwife who is employed by that hospital. In most areas, it seems to be routine for the intended place of birth to be decided at the booking appointment.

Thus, even a woman planning a home birth receives antenatal, intrapartum and postnatal care from health professionals employed by a specific hospital (unless she employs an independent midwife, which is rare (Symon et al, 2009; Sandall, 2007)). According to Government policy, all pregnant women should be offered the choice of giving birth with a skilled birth attendant at home, in a midwife-led maternity unit or in an obstetrician-led maternity unit in hospital (Department of Health, 2007) , but there is evidence to suggest that this is not always the case (see Section 1.1). The NHS is legally required to provide a midwife to attend a woman choosing a home birth, even if her choice goes against medical advice or if midwifery resources are stretched (Nursing and Midwifery Council, 2006).

There is very little recent published analysis of the socio-demographic profile of home birthing mothers in the UK. Chamberlain et al (1997) used birth registration data[6] for 1994 to show that women giving birth at home in the UK tended to be older than average (54% were aged 30+, compared with 38% of those giving birth in hospital) and/or to have given birth before. However, Redshaw et al (2007) noted that in England and Wales in 2006, the pattern of home birthing women being older than average applied only to women having *planned* home births. Women having *unplanned* home births tended to be younger than average.

The largest UK study designed to look specifically at home births was the 1994 study by Chamberlain et al (1997), which aimed to capture all home births taking place in the UK in 1994 and in the event have captured about 60%, including both planned and unplanned home births. Women who, at 37 weeks' gestation, were planning a home birth were recruited to the study by their midwives, and women planning a hospital birth were matched with the home birth group with respect to age, parity and midwife's practice. Information was collected by questionnaire,

[6] Birth registration data did not – and still do not – distinguish between planned and unplanned home births.

completed by the women themselves for planned home births and by Supervisors of Midwives for unplanned home births[7].

Chamberlain et al concluded that women having planned home births were:

- More likely to be from a higher social class (whether measured by own occupation, partner's occupation or years of full-time education)
- More likely to have had a home birth previously
- Higher parity (more recently, this conclusion was supported by the Healthcare Commission (2008) who found that 82% of home births in England were to women who had given birth before, and by Redshaw et al (2007), who found that, in England and Wales in 2006, multiparous women were five times more likely than primiparous women to give birth at home)
- Less likely to have had a previous Caesarean section
- Less likely to have experienced complications during the current pregnancy (e.g. hypertension, pre-eclampsia, diabetes, vaginal bleeding)[8].

The information on unplanned home births in the 1994 study was sketchier, but it appeared that:

- 80% of unplanned home births were due to labour progressing extremely quickly and the woman not having enough time to get to hospital, 4% to preterm labour and the woman not realising she was in labour, 4% to the woman not knowing she was pregnant, and 4% to the woman refusing to go to hospital. Reasons were not recorded for the other 8%.
- The proportion of home births that were unplanned varied widely by region; unplanned home births made up around half of the total number of home births in Scotland and the Northern region of England, compared with just 14% in the South West Thames region and 16% in the South West region. It seems likely that unplanned home births make up a fairly constant proportion of all births[9], so this result is probably a reflection of the overall home birth rate in Scotland and Northern England being lower than that in Southern England (see Sections 4.2.1 and 4.2.2).
- Most women having an unplanned home birth (66%) were attended by a health professional (midwife, GP or "ambulance officer"), but 19% were attended by a partner, friend or family member and 14% were alone at the time of the birth.

It was noted in Hansard (2007a) that between 1997 and 2002 home birth was more common in some parts of the country than others: women living in the South West, Eastern and South East Government Office Regions of England were most likely to give birth at home, and those living in

[7] The survey used a postal questionnaire with no reminder mailings, which probably explains the relatively low response rate.
[8] Chamberlain et al noted that it was impossible to judge whether there was a causal link between such problems and intended place of birth, and if so, in which direction it may have operated.
[9] This is my own conclusion rather than that of Chamberlain et al, backed up by the analysis in Section 4.2.1.

the North East, North West and West Midlands were least likely to do so. BirthChoice UK (2009) and the National Childbirth Trust (2001) both reported high levels of regional variation in home birth rates.

Smith and Smith (2005) found a positive correlation at the local level between the availability of midwife-led maternity care and the home birth rate. They interpreted this as the availability of midwife-led care causing the heightened home birth rate, but did not present any evidence to back up this assumption of the direction of causality.

Although there is evidence of a skew towards older, middle class women having home births, it is important to note that not all home birthing women fit this stereotype. Leap (1996) and Sandall et al (2001a) recorded very high home birth rates in areas with high levels of deprivation and ethnic diversity. Davies et al (1996) found that women planning a home birth in the Northern region of England "came from a wide variety of social and economic backgrounds".

There appears to be no published quantitative evidence about the attitudinal (as opposed to obstetric, demographic or socio-economic) profile of women having home births. In her qualitative study of 30 women planning a home birth in Scotland, Edwards (2005) noted that the women did not all conform to the stereotype of 'earth mothers'. For example, many were comfortable with the use of pharmacological pain relief and some were supportive of elective abortion.

Studies from other developed countries have found that women planning a home birth tend to:

- Be older than average (e.g. Bastian, 1993; Declercq et al, 1995; Neuhaus et al, 2002)
- Be higher parity (e.g. Cunningham, 1993; Declercq et al, 1995; Neuhaus et al, 2002)
- Have uncomplicated pregnancies (e.g. Ackermann-Liebrich et al, 1996; Kleiverda et al, 1990)
- Have relatively high socioeconomic status (e.g. Bastian, 1993; O'Connor, 1993)
- Have had negative experiences of hospital for previous births (Bastian, 1993; Kleiverda et al, 1990)
- Wish to have a peaceful, relaxed birth experience and avoid technological intervention in labour (Neuhaus et al, 2002)
- Wish to have their individual needs and wishes respected (Neuhaus et al, 2002)

2.4 Safety/risk of home versus hospital

2.4.1 The meaning of 'risk' and 'safety' in the context of childbirth

Cartwright and Thomas (2001) argued that the way in which we understand the term 'risk' is socially constructed, i.e. society chooses which possible events to consider as risks. They suggested that the events chosen are not necessarily those most likely to occur and neither are they necessarily the ones with the most serious consequences. In the world of obstetrics, Cartwright and Thomas were of the view that the events labelled as risks were those which medical professionals felt able to or wanted to control via technological developments. In a similar vein, Campbell and Macfarlane (1990) pointed out that "Unlike home, hospitals for most women are alien environments over which they have almost no control. This is not so for obstetricians and hospital midwives. Thus, it might be suggested that when obstetricians recommend that the wishes of women should be met, but only 'within the confines of safety', this means – at least in part – within the confines of an environment in which the obstetrician feels 'safe'."

Murphy-Lawless (1998) felt that obstetric science judges death to be the ultimate risk, and therefore pursues the elimination of death in childbirth as its 'holy grail'. She argued that prevention of all death in childbirth is impossible, and that if it was more generally accepted that death sometimes occurs, the experience of childbirth would be greatly improved for the majority of women because obstetrics would take a more 'woman-centred' approach, i.e. it would based on the specific needs and preferences of the individual woman (Pope et al, 2001). This is not to say that obstetric intervention has no place in preventing death, but Murphy-Lawless questioned whether obstetricians always have the skill to judge when it is necessary and when it is potentially harmful.

Studies of the risks associated with different places of birth have tended to focus on comparing maternal and/or infant mortality rates (see Section 2.4.2). Historically, this was probably because mortality rates used to be relatively high. More recently, perhaps the focus on mortality has been due to what Murphy-Lawless (1998) saw as obstetric science's belief that it is possible to bring death under control, but it is likely to be due also to the fact that, unlike most other pregnancy outcomes, it can be objectively and reliably measured.

In the UK, maternal mortality fell to a very low level before infant mortality did likewise (Campbell and Macfarlane, 1994), so there have been no recent home birth studies looking at maternal mortality. Given that, nowadays, even infant mortality rates in the UK are very low, some commentators have suggested other outcomes should be taken into consideration, such as: quality of care, obstetric intervention rates and how women feel about the experience (e.g. Borquez & Wiegers, 2006; Walsh, 2000). Sandall (2007) pointed out that *Changing Childbirth* (Department of Health, 1993) recommended that there should be less emphasis on mortality as a measure of

safety and quality of maternity care, and a move towards measuring the 'woman-centredness' of care.

Campbell (1986) argued that, because reductions in perinatal mortality tend to lead to increases in perinatal morbidity, it is appropriate to consider both when assessing the relative risks associated with different places of birth. She acknowledged, however, the difficulty of measuring morbidity.

Edwards (2005) found that women planning home birth tended to consider a wide range of concepts within their evaluation of safety, many of which tend not to be considered by obstetric science, e.g. their and their babies' long-term emotional well-being. Some women reported that clinicians were dismissive of their definitions of safety, and saw the delivery of a live baby from a live mother as being the only important consideration. This point was acknowledged by Lewis (1990), who noted that women and clinicians tended to differ in their definition of a 'successful' outcome to a pregnancy and that, to women, success was measured in terms of "personal fulfilment and satisfaction". Lavender et al (1999) put forward the view that medical professionals do not always understand that a negative birth experience can have powerful after-effects, even if mother and baby are physically well. In the US, Boucher et al (2009) found that women choosing home births often equated unnecessary medical intervention with lack of safety.

In her foreword to Tew (1998), Sheila Kitzinger stated: "Safety is not only a matter of life or death. Indeed, though the death of a baby is an intense personal tragedy for parents, perinatal mortality rates are now so low that they are crude measure of safety. For a woman who, as a consequence of labour and delivery, has pelvic infection …, one who cannot have sexual intercourse without pain, who is incontinent, or who becomes depressed, or is in the panic-stricken state produced by post traumatic stress disorder, or who longs to breastfeed but is unable to do so, birth has not been safe. Equally, for a baby who, as a result of the way in which labour and delivery were managed, is in pain, or is too stressed or sluggish because of chemical substances in its bloodstream, to relate to the mother in a satisfying way or to suckle vigorously, birth has not been safe."

Despite these arguments about the suitability of mortality as a measure of safety, it remains the main measure used in research studies to compare the safety of different birth settings. For this reason, perinatal death is the outcome measure used in this thesis to assess the safety of planned home birth from the perspective of the baby (see Section 5.3.2 and Chapter 7). To acknowledge the fact that women's definitions of safety are wider than this, however, a number of other outcomes are considered in an attempt to compare the relative safety of home and hospital from the perspective of the mother (see Section 5.3.1 and Chapter 6).

2.4.2 Comparing the risks/safety of home birth and hospital birth

Buitendijk (1993) and Stephens (2005) felt it was unfair that, in the 'home vs hospital' debate, the burden of proof is on the home birth lobby. Hoff and Schneiderman (1985) neatly summed up this position by stating: "Homebirths entail a definite small risk, of unknown magnitude. Hospital births entail a wider range of risks, whose magnitude is also unknown". Several commentators (e.g. Fullerton & Navarro, 2007) have raised the issue of whether hospital birth entails iatrogenic risks. Nevertheless, because in most developed countries the dominant system is the medical model of childbirth, the reality is that the onus is on the home birth lobby to convince those making decisions about childbirth that home birth is not inherently risky.

2.4.2.1 Problems of definition, measurement and interpretation

Campbell and Macfarlane (1994) noted that problems of definition, measurement and interpretation have always dogged study of home birth, and they continue to do so. As noted earlier, studies have tended to focus on comparing the mortality rates of home and hospital births. Such analysis of UK data is fraught with problems because:

1. the number of women giving birth at home is small, so comparisons will lack statistical power (Buitendijk, 1993),
2. women who have home births are not a random sub-set of the population of pregnant women (Chamberlain et al, 1997; Anthony et al, 2005; Nove et al, 2011) and so cannot be directly compared with women having hospital births,
3. mortality rates for unplanned home births tend to be far higher than those for planned home births (Northern Region Perinatal Mortality Survey Coordinating Group, 1996; Campbell et al, 1984), so studies which cannot differentiate between the two will over-estimate the risk of mortality for home births, and
4. using crude mortality rates to compare different places of birth is inadvisable because they include babies with congenital abnormalities and/or low birthweight, conditions which are determined long before labour commences and therefore cannot be influenced by place of birth (Campbell and Macfarlane, 1994).

It seems to be generally accepted in all developed countries (including the Netherlands) that women with high-risk pregnancies should plan to deliver in hospital under the supervision of an obstetrician. Therefore, studies of the safety of home birth have tended to include only low-risk pregnancies, with the result that the safety of home birth for high-risk pregnancies is unevaluated. As noted in Section 2.1.2, the Netherlands has had a national guideline on risk classification for many years and England & Wales now has an equivalent (National Collaborating Centre for Women's and Children's Health, 2007), which is similar – but not identical – to the Dutch guideline. However, there is no universally-accepted definition of 'high-risk' or 'low-risk', with the result that different studies have used their own definitions. This makes it difficult to draw

evidence-based conclusions about which women (if any) should be advised against planning a home birth.

While (planned) home births tend to be relatively homogeneous in terms of the type of care provided, hospital birth includes a wide range of types of care, from entirely midwife-led care in home-like surroundings to obstetrician-led care in a high-technology consultant unit in clinical surroundings (Hall, 2003). Therefore, as Campbell (1986) pointed out, ideally comparison of home and hospital births should also take into account the type of care received. Support for this viewpoint was provided by Hatem et al (2008) in their Cochrane Review covering 11 randomised controlled trials from Australia, Canada, New Zealand and the UK. They found that the kind of positive outcomes often observed for home births (e.g. lower rates of episiotomy, instrumental delivery and use of anaesthesia) were evident among women receiving midwife-led care in hospital. Similar conclusions were drawn by Begley et al (2009) in North-east Ireland, by Janssen et al (2007) in Canada, and by Turnbull et al (1996) in Scotland. These studies suggest that at least some of the 'better' outcomes observed among home births may be accounted for by the type of birth attendant/model of care rather than place of birth *per se*. On the other hand, in a Canadian study, Janssen et al (2009) found that the outcomes for planned home births compared favourably with those for midwife-led hospital births, which suggests that there may be something about the home environment specifically which contributes to positive outcomes.

Care must also be exercised when using historical data to compare home and hospital births. Midwives and GPs who were trained before the 1970s had a different skillset to those trained more recently, and will have had considerably more experience of attending home births, so historical data showing better outcomes for home births may be due more to the skills of the birth attendants than to place of birth *per se*, and therefore it may not be advisable to generalise them to the present day (Magill-Cuerdin, 2005).

One small study (Dowswell et al, 1996) concluded that a randomised controlled trial (RCT) to compare the outcomes of home and hospital birth may be feasible[10], but most argue that it would not, because women tend to have strong views on their desired place of birth (Hendrix et al, 2009; Buitendijk, 1993). Macfarlane (1996) also made the point that it would be extremely difficult to design an effective RCT due to the wide variety of types of care and types of environment that exist under the heading of 'hospital birth' in particular, but also under the heading of 'home birth'. No RCT has yet been carried out in the UK. Existing studies comparing the two are all observational and therefore subject to selection effects. Because of these issues, it could be argued that attempting to compare the two is futile. Others contend that, if enough studies using observational data draw the same conclusions despite variations in setting and methodology, there is strong evidence to support those conclusions (Springer & Van Weel, 1996). Stephens (2005) argued that the Cochrane

[10] They noted, however, that outcomes would probably have to exclude mortality, because mortality rates are so low that the number of research participants required would be prohibitively large.

database's emphasis on RCTs is unhelpful in the context of home birth. The only Cochrane review of the topic (Olsen & Jewell, 1998) was based entirely on the study by Dowswell et al, which had a sample of only 11 women. The review is therefore unlikely to boost the confidence of a woman or midwife seeking reassurance about the safety of planned home birth, despite the existence of evidence from other types of study which may provide such reassurance.

Analysis of home versus hospital birth is further complicated by the existence of a group of women who plan a home birth but transfer to hospital before labour, during labour or after the birth. Chamberlain et al (1997) found that in 1994, relatively few women were transferred before labour, and those who were had usually had a premature rupture of their membranes. They found that most transfers took place during labour. Using data from a variety of sources, Magill-Cuerdin (2005) estimated that 30-40% of primiparae and 1-12% of multiparae who plan a home birth in the UK are transferred to hospital during labour. Redshaw et al (2007) found that, in England and Wales in 2006, 6% of women giving birth at home were transferred to hospital after the birth, but most of these were women having unplanned home births. Chamberlain et al (1997) reported that the main reasons given by midwives for transfer after delivery were postpartum haemorrhage and retained placenta[11].

The issue of transfers from home to hospital has led to debate over whether comparisons of home and hospital birth should focus on intended place of delivery or actual place of delivery (Buitendijk, 1993). There are arguments for both, depending on the outcome being considered. The mortality rate for home birth is higher if the analysis considers intended place of birth, because the home birth group will include cases that were transferred to hospital due to complications. Campbell and Macfarlane (1994) quoted an article by Tew (1986), in which Tew asserted that comparisons should focus on actual place of delivery, because of her belief that obstetric interventions in hospital increase the risk of perinatal death. Campbell and Macfarlane were, however, not convinced by this argument, because Tew drew her conclusion without knowing anything about the timing of or the reason for women being transferred to hospital. In this thesis, the main focus is on intended place of delivery, because to make a fair comparison between home and hospital, it is important to ensure that 'complicated' cases are included in the figures for both birth settings.

This long list of potential pitfalls led Vedam (2003) to produce the following description of the ideal study design when comparing outcomes of home and hospital birth: "Study design should:

- Distinguish between planned home births and unplanned out-of-hospital births
- Discriminate data from different types of providers
- Provide relevant and consistent inclusion criteria for study subjects across comparison groups

[11] They also reported some women being transferred for spurious reasons (e.g. relatively simple perineal suturing), which raised questions over the skill of the attending midwives.

- Adjust for differences in selection criteria for home birth and perinatal management
- Control for differences in transfer criteria and method
- Define terms, such as mortality and morbidity
- Select relevant and consistent outcome measures."

2.4.2.2 Studies in the UK

Over the period when hospital birth became the norm in the UK, there were great improvements in maternal and perinatal mortality rates. It was generally assumed that increased rates of hospitalisation had caused the improvement in mortality rates (e.g. Maternity Services Advisory Committee, 1984). A statistician was the first to question this assumption, arguing that the two shifts were merely coincidental, and that improved mortality rates were probably due to other causes (Tew, 1998). Tew theorised that the decrease in mortality was due to improvements to women's health, especially lower incidence of malformation of the pelvis due to poor childhood nutrition. Campbell and Macfarlane (1990) described how reactions from 'the medical establishment' to Tew's work were hostile. Her attempt to get her research published in a medical journal was rejected on the grounds that the editors felt it would not be of interest to the readership. However, Campbell and Macfarlane reported that when Tew's findings were published in a non-medical journal (Tew, 1977), they attracted attention from "the very highest of academic and government circles", yet her contract of employment with the Department of Community Health in Nottingham was not renewed.

Since that time, some UK-based research has been published on the subject (see below), but a definitive answer to the question 'are mortality rates affected by place of birth in the UK?' has so far eluded the research community. Even if research shows that planned home births are less likely to result in death than are hospital births or unplanned home births, it is unclear whether this is due to the place of birth, or to other factors that tend to accompany it (e.g. the health of the women or the type of maternity care received).

Part of the problem is that the number of women giving birth at home in the UK is so small as to make it extremely difficult to design a study with a sufficiently large sample to provide reliable comparisons (Magill-Cuerdin, 2005). Such studies as have been carried out have tended to conclude that there is no evidence to suggest that the risk of death is greater for planned home births in comparison to planned hospital births, but none of them was able adequately to overcome the problems described in Section 2.4.2.1. These studies include:

- The Northern Region Perinatal Mortality Survey Coordinating Group (1996) found that, over the period 1981-94 in the Northern region of England, the perinatal mortality rate (PMR) for planned home births was less than half the overall PMR for the region. However, no attempt was made to control for selection effects.

- Campbell et al (1984) analysed all home births in England and Wales in 1979, and found that the PMR for planned home births was far lower than for unplanned and unbooked home births, and lower than the overall figure for England and Wales. These patterns held true even for low birthweight babies (<2500g). However, it was not possible to identify women who had booked a home birth but transferred to hospital, which would have completed the picture.
- Tew (1998) analysed the 1970 England and Wales birth cohort study and found that the PMR for babies born in hospital was far higher than for babies born at home, when women in any given risk category[12] were compared with one another. She reported that the same pattern had been evident in the 1958 birth cohort study, but that the results had been misinterpreted at the time. Campbell and Macfarlane (1994) noted, however, that the data included babies who had died due to congenital malformations, who will have been born in hospital in disproportionately high numbers. This is likely to have contributed to the relatively high PMR for babies born in hospital.
- Tew (1998) also found that in England and Wales, "the correlation between the annual proportional increases in the rate of hospitalization and the annual proportional decreases in the rate of perinatal mortality [between 1969 and 1981] was strongly negative. This implies that, if births in obstetric hospitals had not increased, perinatal mortality would have fallen by more than it actually did." As Campbell and Macfarlane (1994) pointed out, however, Tew had done no more than discover a statistical association; therefore her conclusion was no more justifiable than the assumption that increased hospitalisation caused decreases in mortality rates.
- Campbell (1986) found that the increase in the PMR observed among babies born at home in England and Wales in the 1970s was due entirely to unplanned home births – the PMR among planned home births declined at a similar rate to the national PMR.
- Allison (1996) studied birth records from the years 1948-1972 in Nottingham and found that low-birthweight babies born at home had a similar mortality rate to those born in hospital, despite those born at home being mainly from lower social classes and therefore expected to have a higher mortality rate.
- Butler & Bonham (1963) found that, in England in 1958, the PMR for singleton births was lower if the mother had planned a home birth than if she had planned a hospital birth, but this study made no attempt to compensate for selection effects.

One recent study in England and Wales (Mori et al, 2008) reached the opposite conclusion, finding that planned home births which involved an intrapartum transfer to hospital had a *higher* infant mortality rate than planned hospital births. However, the study team was unable to identify the natural comparison group, i.e. planned hospital births which ran into complications, a group for which it would be reasonable to expect the mortality rate also to be high in comparison to all

[12] Campbell and Macfarlane (1994) pointed out that the risk prediction scores used by Tew were unvalidated and their accuracy unknown.

planned hospital births. Gyte et al (2009) described a number of other weaknesses of this study, which they felt rendered its conclusions invalid, including: an inability to identify accurately the women's intended place of birth, the inappropriate use of extrapolation to estimate the size of subgroups and the drawing of inappropriate conclusions from the data.

Another recent study in Scotland is relevant, although its aim was to assess the safety of independent midwifery care versus NHS care rather than home birth versus hospital birth. Symon et al (2009) compared women booked with independent midwives (IMs) in Scotland between 2002 and 2005 (87% of whom intended a home birth) with women receiving care from the NHS (nearly all of whom intended a hospital birth), having first matched the sample with respect to age, parity, year of birth and deprivation level of the area of residence. On most measures, the outcomes for the IM maternities were as good as or better than those for the NHS maternities. Crucially, however, the IM group was at higher risk of stillbirth or neonatal death, and the difference was accounted for entirely by women with 'high-risk' pregnancies[13]. In other words, the babies of low-risk women fared well under either system of care, but the babies of high-risk women were more likely to suffer stillbirth or neonatal death under the care of an IM.

The National Institute for Health Research and the Department of Health have commissioned a large-scale study in England which aims to provide a definitive answer to the question about whether mortality rates vary depending on place of birth (National Perinatal Epidemiology Unit, 2008). However, in the absence of the ability to assign women randomly to either home or hospital birth, there may still be questions about selection effects. Furthermore, the study uses a composite negative pregnancy outcome measure, which is likely to prove controversial in obstetric circles (see Section 5.3).

Campbell and Macfarlane (1994) noted that, due to the problems of comparing mortality, more recent studies have emphasized pregnancy outcomes other than mortality. They suggested that appropriate measures for healthy, full-term babies should include: "infections, unexpected serious illness and problems in the neonatal period and Apgar scores". They also felt it was appropriate to subdivide different measures of maternal morbidity into those which are life-threatening (e.g. postpartum haemorrhage) and therefore require prompt medical attention to avert death, and those which are not life-threatening but still cause (sometimes chronic) morbidity.

UK studies looking at pregnancy outcomes *other* than mortality by place of birth include:

- The large-scale 1994 study (Chamberlain et al, 1997) contained too few deaths to draw conclusions about comparative mortality. It did, however, conclude that women having planned home births were less likely to: have an assisted delivery, use pharmacological pain relief, have prolonged labour, experience perineal damage, have episiotomies, and/or

[13] Defined as: <34 weeks' gestation, breech presentation, multiple birth, previous obstetric complication, or existing medical condition.

experience postpartum haemorrhage. They were also less likely to report: being tired, being tearful, experiencing haemorrhoids, constipation, backache and/or headaches. Their babies tended to have higher Apgar scores, were less likely to need resuscitation and more likely to be breastfed. The analysis did not, however, attempt to control for other factors that may have influenced the above patterns, e.g. mother's age, parity, social class, health and pregnancy risk status.

- Shearer (1985) conducted a small-scale study in Essex comparing planned home birth with hospital birth. It concluded that parous women aged 20-35 who were booked for a home birth: were less likely to have labour induced, experienced less perineal damage, were less likely to have an episiotomy and less likely to have a baby with a low Apgar score. It did not, however, consider women having their first baby nor younger/older mothers, and did not attempt to compensate for selection effects.
- Campbell and Macfarlane (1994) quoted a study by Chamberlain et al (1978) which found that babies born at home were more likely than those born in hospital to have jaundice and/or minor infections, whereas those born in hospital were more likely to have more serious health problems, including fits, cerebral palsy and respiratory disorders. Again, however, the study did not compensate for selection effects.
- In a small-scale study at a single GP practice in inner London in 1977-1989, Ford et al (1991) found that 78% of women who planned a home birth went on to have an uncomplicated delivery at home, and that most of those who were transferred to hospital for specialist care were primiparae. They concluded that "birth at home is practical and safe for a self-selected population of multiparous women, but nulliparous women are more likely to require transfer to hospital during labour because of delay in labour".
- The NICE clinical guideline on Caesarean section (National Collaborating Centre for Women's and Children's Health, 2004) noted that, based on the available evidence, women should be informed that giving birth at home reduces the risk of delivery by Caesarean section.

2.4.2.3 Studies in other countries

Table 2.2 summarises the evidence on the safety of home birth from a number of studies from different countries. Although most of these studies were reasonably high-quality, all suffered to a greater or lesser extent from methodological problems, as described in the final column of Table 2.2. Most of them relied on matching rather than multivariate analysis to control for selection effects.

Table 2.2: Evidence from overseas on the safety of home birth

Study	Setting	Results	Methodological issues
Studies suggesting planned home birth is as safe or safer than hospital birth			
Janssen et al (2009)	British Columbia, Canada, 2000-2004	For low-risk pregnancies, the perinatal mortality rate was not significantly different for planned home births and planned hospital births. Obstetric interventions and other adverse outcomes were less common in the planned home birth group than in the planned hospital birth group.	Information on intended place of birth was collected postpartum and is therefore subject to recall error. No adjustment for confounders, but women were matched on obstetric variables.
de Jonge et al (2009)	Netherlands, 2000-2006	For low-risk pregnancies, there was no difference between planned home birth and planned hospital birth in terms of perinatal mortality or severe perinatal morbidity.	Intended place of birth was not recorded for 8.5% of women. Unable to adjust for social class.
Hutton et al (2009)	Ontario, Canada, 2003-2006	For low-risk pregnancies, there was no difference between planned home birth and planned hospital birth in terms of stillbirth/neonatal death or severe morbidity. Serious maternal morbidity was less common in the planned home birth group. Among primiparae, there was little difference in outcomes between the home and hospital groups.	No adjustment for previous obstetric history or other confounders, but women were matched on obstetric risk status.
Johnson & Daviss (2005)	USA & Canada, 2000	Planned home birth for low-risk pregnancies was associated with lower rates of medical intervention but similar intrapartum and neonatal mortality rates compared with low-risk hospital births.	No adjustment for previous obstetric history or other confounders, but women were matched on obstetric risk status.
Janssen et al (2002)	British Columbia, Canada, 1998-1999	The perinatal mortality rate was the same for planned home births and hospital births.	Some important confounders were held constant (age, partner status, income and parity) and women were matched on hospital and obstetric risk status, but no adjustment for social class, ethnicity or previous obstetric history.
Ackermann-Liebrich et al (1996)	Switzerland, 1989-1992	Women who attempted a planned home birth used less pharmacological pain relief, were less likely to have an operative or assisted delivery, and their babies tended to have higher Apgar scores.	Women were matched on age, parity, obstetric and medical history, partner status, social class and nationality. These strict matching criteria made it difficult to match women with unusual obstetric histories. The sample size was too small to compare the incidence of rare outcomes.

Table 2.2 (cont'd): Evidence from overseas on the safety of home birth

Study	Setting	Results	Methodological issues
Berghs et al (1995)	Netherlands, 1984-1985	The neurological condition of babies born to low-risk women was the same for babies born at home and those born in hospital.	Non-response rate = 33%. No adjustment for previous obstetric history or other confounders, but women were matched on obstetric risk status.
Durand (1992)	Rural Tennessee, USA, 1971-1989	For low-risk women, the perinatal mortality rate for midwife-attended home births was no higher than for hospital births.	Some important confounders were held constant (age, parity, education, marital status, birthweight, smoking status and number of antenatal checks). Possibility of under-reporting of complications in the planned home birth group.
<u>Studies suggesting planned home birth is less safe than hospital birth</u>			
Kennare et al (2010)	South Australia, 1991-2006	There was no difference between planned home births and planned hospital births in terms of overall perinatal mortality, but planned home births had a significantly higher rate of intrapartum death and low Apgar scores. Planned home births had significantly lower rates of negative maternal outcomes.	Some important confounders were held constant (age, parity, occupational status, smoking status, medical and obstetric complications, gestational age, small for gestational age, congenital abnormalities, city or country hospital and mode of delivery). Mode of delivery should probably not have been held constant (see Sections 6.6.3 and 7.6.3). The home birth figures were more affected than the hospital birth figures by the inclusion of post-term and twin pregnancies – for low-risk pregnancies the infant outcomes were the same.
Wax et al (2010b)	19 states in USA, 2006	Among low-risk pregnancies, home births were more likely than hospital births to have prolonged labours, and also to have very short labours. Home births were also more likely to have low Apgar scores at 5 minutes. Other outcomes were better for home births (e.g. signs of foetal distress, neonatal and maternal morbidity).	Home birth data did not distinguish between planned and unplanned home births, and hospital transfers from home were counted as hospital births. No adjustment for confounders, but only low-risk pregnancies were included.
Lindgren et al (2008)	Sweden, 1992-2004	For low-risk pregnancies, neonatal mortality rates were higher – but not significantly so - for planned home births (including intrapartum transfers to hospital) than for planned hospital births. Intervention rates were significantly lower in the planned home birth group.	No adjustment for previous obstetric history or other confounders, but women were matched on obstetric risk status. Some evidence of under-reporting of complications in the planned home birth group. High level of missing data.

Table 2.2 (cont'd): Evidence from overseas on the safety of home birth

Study	Setting	Results	Methodological issues
Pang et al (2002)	Washington State, USA, 1989-1996	The neonatal mortality rate was higher for planned home births than for planned hospital births, and the incidence of low Apgar scores was greater, even when preterm births were excluded from the analysis. Among primiparae, planned home birth was also associated with a greater likelihood of prolonged labour and/or postpartum bleeding.	Intended place of birth was not reliably known, and high level of missing data for confounders and effect modifiers.
Bastian et al (1998)	Australia, 1985-1990	In comparison to all births in Australia, the intrapartum death rate for planned home births was high, and the neonatal mortality rate for planned home births was high for babies with birthweight >2500g.	No adjustment for confounders. The home birth figures were more affected by the inclusion of post-term, breech and twin pregnancies than were the hospital figures.
Mehl-Medrona & Mehl Medrona (1997)	California, USA, 1969-1985	Mortality rates were relatively high for midwife-attended home deliveries.	Used a convenience sample, with women matched on age, insurance status, parity, ethnicity and medical risk score.

Olsen (1997) reported on a meta-analysis of the safety of home birth, involving the pooling of data from six studies emanating from five countries (the US, the Netherlands, Australia, Britain and Switzerland), most of which are reported in Table 2.2. He found no significant difference between planned home and hospital birth in terms of perinatal mortality, and that home birth was associated with less perineal damage, lower odds of delivery by Caesarean section (CS) and lower likelihood of low Apgar score.

Wax et al (2010a) also conducted a meta-analysis, involving the pooling of data from 12 studies emanating from seven countries (the US, the UK, Australia, Switzerland, the Netherlands, Sweden and Canada). The earliest of the 12 studies used data from 1976-1982, and the most recent used data from 2003-2006. Again, most of these individual studies are shown in Table 2.2, but as Gyte et al (2010) pointed out, Wax et al did not explain why other important, high-quality studies such as Johnson & Daviss (2005) were excluded. Wax et al found that maternal outcomes were better among planned home births and the perinatal mortality rate did not vary significantly, but that the *neonatal* mortality rate was significantly higher among planned home births when compared with planned hospital births.

There are probably a number of reasons why the findings from overseas are contradictory, including differences in methodological approach (e.g. some used matching to control for confounding and some used multivariate statistical analysis techniques; there was much variation in the methods used to ascertain intended place of birth). It is also important to consider home birth within the context of the healthcare system in place in a particular country or region. For example, in the Netherlands there is a nationally-agreed definition of high- and low-risk pregnancy, and as a rule, only low-risk women attempt home birth. Furthermore, Dutch midwives tend to be highly experienced in attending home births (see Section 2.1.2). In Australia and the US, for example, neither of these things is true, which may (at least partly) explain the contradictions in these research results. For this reason, the findings of a meta-analysis from several different countries will always be open to question, and it would be unwise to assume that the results from one country will apply to another. The contradictory findings also highlight the importance of the outcome measures selected for analysis; there has been a tendency to focus on perinatal mortality, but the findings of Wax et al (2010a) indicate that neonatal mortality should also be taken into account.

The analysis presented in later chapters of this thesis aims to overcome the pitfalls commonly associated with comparisons of different birth settings, and to a large extent, succeeds in doing so (see Section 3.2.4).

3 Data & methods

This chapter begins with a description of the different sources of data used to conduct the analyses described in this thesis, followed by a discussion of each data source's strengths and weaknesses, focussing mainly on the source that was most heavily used (St Mary's Maternity Information System). In Section 3.3, the statistical techniques and types of calculation used to conduct the analyses are described and explained.

3.1 Data sources

Four data sources have been used to produce the information and analysis in this thesis:

1. UK birth registration data. Most of these figures are publicly available, but some figures were produced specifically for this analysis, and these are identified within the main text.
2. The Growing Up in Scotland (GUS) birth cohort study. This dataset contains information about a sample of babies born in Scotland in 2004/5.
3. The Healthcare Commission review of maternity services in England. This dataset contains information on over 26,000 maternities taking place in England in January/February 2007.
4. The St Mary's Maternity Information System (SMMIS) database. This database contains records of maternities in the North West Thames Regional Health Authority area (as was) between 1988 and 2000.

The statistical modelling was based entirely on the SMMIS database, since none of the others was suitable for this type of analysis (see Section 3.2).

3.1.1 UK birth registration data

In the UK, live births and stillbirths must be registered within 42 days of the birth (21 days in Scotland). The local health authority notifies the registrar that the birth has taken place, and if the parents do not register the birth, another person who attended the birth (e.g. the midwife) must do so. Table 3.1 shows the information recorded in England and Wales. Similar information is recorded in Scotland and Northern Ireland.

Table 3.1: Information recorded at birth registration

Child	Father (if his details are to be entered into the register)	Mother
Date of birth	Forename(s) and surname	Forename(s) and surname
Place of birth	Date of birth	Date of birth
Sex	Place of birth	Place of birth
Forename(s) and surname in which it is intended that the child will be brought up	Occupation at the time of the child's birth, or if not employed at that time, the last occupation	Occupation at the time of the child's birth, or if not employed at that time, the last occupation
Time of birth (multiple births only)		Date of marriage, if married to the child's father at the time of the birth
		Usual address at the date of the birth
		Maiden surname (if applicable)
		Number of previous children by the present husband and by any former husband

Source: General Register Office, 2004

In England and Wales, this information is used to publish the Birth Statistics series (Office for National Statistics, 2009), giving summary tables of how maternities are distributed across different population groups. The Birth Statistics series was first published in 1955, and has been published annually since then. In Scotland and Northern Ireland, summary tables are published by the General Register Office for Scotland (GRO-Scotland) and the Northern Ireland Statistics and Research Agency (NISRA).

3.1.2 Growing up in Scotland (GUS) birth cohort study

For the GUS birth cohort study, a random sample of babies born across the whole of Scotland between 1 June 2004 and 31 May 2005 was selected. When each sampled child was 10.5 months old, the mother was interviewed to collect data about the pregnancy, birth and postnatal period. An 80% response rate resulted in data being collected on just over 5,000 children (Centre for Longitudinal Studies, 2006c).

The study data were downloaded from the UK Data Archive (Scottish Centre for Social Research, 2008). The question about place of birth was as follows:

MaBpla01
Where was ^*name of child* born?
1 In a hospital/maternity unit
2 At home – planned
3 At home – unplanned
4 Somewhere else

Out of the total sample of 5,217, just 69 babies (1.3%) were born outside hospital: 30 (0.6%) were planned home births, 23 (0.4%) were unplanned home births and 16 (0.3%) were born 'somewhere else' (e.g. in transit).

Initial exploratory analysis showed that the unplanned home births and those born 'somewhere else' had a similar demographic and obstetric profile, so they were combined for the analysis shown in this thesis. Thus, women having planned home births were compared and contrasted with women having hospital births and those having out-of-hospital births that were not planned home births.

3.1.3 Healthcare Commission review of maternity services in England

The Healthcare Commission's 2007 review of maternity services in England had several strands, one of which was a survey of women aged over 16 who had given birth to a live baby in January or February 2007. In May of that year, the sampled women were sent a self-completion questionnaire by post. A response rate of 59% resulted in data being collected for just over 26,000 maternities (Healthcare Commission, 2007a). The questionnaire was based on that used in the 2006 National Maternity Survey (Redshaw et al, 2007), but with a much larger sample to allow the results to be broken down by NHS trust. The questionnaire included the following questions:

C9. Where was your baby born?
1. In hospital
2. In a birth centre/maternity unit, separate from hospital
3. At home
4. Other

D1. Before your baby was born, did you plan to have your baby at home?
1. Yes
2. No

At NHS trust level, the survey data were standardised according to the mother's age and parity[14]. The home birth ratios recorded are therefore not reflective of the actual number of women giving birth at home, but do allow trusts to be compared without the comparison being confounded by different trusts having different age-parity profiles.

3.1.4 St Mary's Maternity Information System (SMMIS)

In the 1990s, most maternity units in the former North West Thames Regional Health Authority (RHA) area used the same IT system to create and maintain computerised records for pregnant

[14] The results were standardised so that each trust's age-parity profile reflected the national age-parity distribution with respect to three age groups (16-26, 27-32 and 33+) and two parity groups (first birth and second/subsequent birth) (Harrison, 2008). The national distribution was taken from the survey sample, so the percentages are those that would be expected if each trust had the same age-parity profile.

women. Nowadays the system is known as Ciconia, but during the period covered by the analysis in this chapter it was known as the St Mary's Maternity Information System, or SMMIS.

Attempts to find a map of the old North West Thames RHA area were unsuccessful, but some information about it was obtained via personal communication with the London Metropolitan Archives: the RHA "was responsible for health services in Bedfordshire, Hertfordshire, and the London Boroughs of Barnet, Brent, Ealing, Hammersmith & Fulham, Harrow, Hillingdon, Hounslow, Kensington & Chelsea and the City of Westminster. The North West and North East Thames RHAs were amalgamated in 1994 to form the North Thames RHA."

Out of the 20 units in the old North West Thames RHA, 17 took part in central collation of their SMMIS data between 1 January 1988 and 31 March 2001. The collation was performed annually by the Department of Epidemiology and Public Health at St Mary's Hospital (Patel et al, 2003). In 2001, funding for the central collation of the data was halted (National Centre for Health Outcomes Development, 2008). The analysis presented in this thesis is based on the years 1988 – 2000 inclusive. One of the reasons why central collation was halted was concern over the fact that the women had not been asked for their permission for their data to be used in this way.
Table 3.2 lists the 17 participating units. In 1989 some of the units merged, leaving 15 (Steer, 2008a): St Albans and Hemel Hempstead units merged, as did the West London and Westminster units. The 1988 data for these units were merged for analysis by maternity unit. The shaded sections in Table 3.2 represent years in which some units did not submit data, and show the reasons for this.

Table 3.2: Maternity units included in SMMIS database, by year

	Year												
Hospital	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**00**
Ashford	X	X	X	X	X	X	X	X	X	Closed 1997			
Bedford	X	X	X	X	X	X	X	X	X	X	X	X	X
Central Middlesex	X	X	X	X	X	X	X	Switched to different system					X
Ealing	X	X	X	X	X	X	X	Switched to different system					
Edgware	X	X	X	X	X	X	X	X	X	X	X	X	X
Hemel Hempstead*	X	X	X	X	X	X	X	X	X	X	X	X	X
St Albans*	X												
Luton & Dunstable	X	X	X	X	X	X	X	X	X	X	X	X	X
Hillingdon	X	X	X	X	X	X	X	X	X	X	X	X	X
Northwick Park	X	X	X	X	X	X	X	X	X	X	X	X	X
St Mary's	X	X	X	X	X	X	X	X	X	X	X	X	X
Stevenage	X	X	X	X	X	X	X	X	X	X	X	X	X
Watford	X	X	X	X	X	X	X	X	X	X	X	X	X
Welwyn Gdn. City	X	X	X	X	X	X	X	X	X	X	X	X	X
West Middlesex	X	X	X	X	X	X	X	X	X	X	X	X	X
Westminster**	X	X	X	X	X	X	X	X	X	X	X	X	X
West London**	X												

* Merged to become a single site in Hemel Hempstead in 1989.
** Merged to become the Chelsea & Westminster unit in 1989.

Within SMMIS, a record was created for each woman presenting for maternity care at one of the participating units, whether this was at the antenatal or intrapartum stage. A separate record was created for each pregnancy, so women having more than one pregnancy in that RHA area in the years 1988-2000 will have appeared in the dataset more than once. Because of disclosure rules, it was not possible to identify women who appeared more than once, so the resultant clustering effects cannot be taken into account in the analysis and interpretation.

The record was maintained on SMMIS until 28 days postpartum, assuming the pregnancy resulted in a birth (as opposed to termination or miscarriage) within the RHA area. According to the National Centre for Health Outcomes Development (2008), about 80% of pregnancies in the RHA area were captured on the database, the remainder being those receiving care from non-participating units. Home births will have been captured on the system as long as they were to women who had accessed NHS maternity care at some stage (Steer, 2008b), so there is no reason to suppose they were severely under-represented. It is possible that home births attended by independent midwives with no NHS involvement were under-represented, but these were almost certainly a tiny proportion (Sandall, 2007).

Data were entered by trained clerks or midwives (Steer et al, 2004). Medical and midwifery staff were responsible for supervising the data entry (Balchin et al, 2004). Range and consistency checks were built into the data entry system (National Centre for Health Outcomes Development, 2008). The system used standard definitions for clinical measurements (Balchin et al, 2007), but there were no explicit rules about how non-clinical variables should be recorded (National Centre for Health Outcomes Development, 2008), which led to some inconsistencies. For example, it is clear from Table 3.3 that, when a pregnancy ended due to termination or miscarriage, most inputters simply left the record blank, but some inputted a reason for the pregnancy not resulting in a birth.

Notwithstanding this, an audit of the accuracy of data input and the consistency across different maternity units (Cleary et al, 1994) found that accuracy and consistency were high, at least in the initial years of the period covered by this analysis. Another study (Bugg et al, 2002) found that, for data collected in 1996-8, the information recorded in the SMMIS database was accurate when compared to the women's casenotes, and therefore concluded that the SMMIS data are reliable. No study has assessed the reliability of the data for the full 13-year period, but there is no reason to suppose that the periods covered by the two studies mentioned above were different from other time periods.

The SMMIS database is stored at Imperial College Health NHS Trust, where a team of three health professionals is responsible for approving applications for secondary analysis of the data. External access to the database is permitted only with NHS ethics committee approval, which was granted in April 2008. To preserve confidentiality, the data provided for use in these analyses were in

anonymised form. The data disks were handed over in person, from a member of the team at Imperial to a member of the supervisory team at the University of Southampton.

Between 1988 and 2000, 585,291 records were created. Nearly 70,000 these were deleted before the analysis commenced, because the pregnancy did not result in a birth under the NHS in the North West Thames region. The various reasons for this are detailed in Table 3.3.

Table 3.3: Deletions from SMMIS database before analysis commenced

Reason for deletion of record	N
Little or no information recorded after booking*	67,910
No outcome of pregnancy recorded*	910
Record terminated antenatally, because only antenatal care was provided	317
Induced abortion	196
Spontaneous abortion / miscarriage	146
Woman left North West Thames RHA area before giving birth	27
Record terminated antenatally, because woman was not pregnant	2
Record terminated antenatally, because pregnancy was ectopic	1
Record terminated antenatally, no reason recorded	5
Total number of records deleted	69,514
Records remaining	515,777

* It is almost certain that these were mainly miscarriages, terminations, and movers. Some inputters recorded these outcomes, as evidenced by the lower rows in this table, but evidently most did not; if they had, the numbers of miscarriages, terminations and movers would be far higher than recorded here.

3.2 Data quality/limitations

3.2.1 UK birth registration data

According to Hansard (2007b), the General Register Office for England and Wales was aware of just 55 unregistered births in 2006, suggesting that the vast majority of births are captured within the published statistics. However, no distinction is made between planned and unplanned home births, which limits the usefulness of these data for the research questions posed in this thesis.

3.2.2 Growing up in Scotland

In this study, 1.3% of babies were recorded as having been born outside hospital. Birth registration data show that the percentage of live births in Scotland taking place out of hospital was 1.1% in 2004 and 1.3% in 2005, indicating that, on this measure, the GUS sample was broadly representative. However, the 1.3% represents only 69 babies, of which only 30 were planned home births.

The GUS analysis in this chapter uses the weighted survey data. Weights were applied firstly to correct for differential selection probabilities and then to correct for non-response. The non-response weights took into account: mother's age, deprivation quintile of area of residence, population density of area of residence, and number of children in household (Corbett et al, 2008).

The distinction between planned and unplanned home births was defined by the mother, almost a year after the birth, so it may be subject to recall problems and/or *post-hoc* rationalisation. Furthermore, it is impossible to identify which of the women giving birth in hospital had originally intended a home birth but had transferred to hospital. It is also important to note that only live births were included within the sample.

3.2.3 Healthcare Commission review of maternity services in England

The sample for this survey included only live births, so nothing can be concluded about stillbirths. Furthermore, a 59% response rate means that the results are almost certainly subject to response bias.

It should have been possible to use responses to this survey to produce separate profiles of women having planned and unplanned home births throughout England. The survey data were downloaded from the UK Data Archive (Healthcare Commission and Picker Institute Europe, 2008) with this objective in mind. Unfortunately, the data from question D1 ("Before your baby was born, did you plan to have your baby at home?") were missing. Further enquiries found that this was because this question had a very high level of item non-response. This was probably because it was placed under the section heading 'Babies born at home', which is likely to have led women who did not have a home birth to skip the entire section. It is therefore not possible to use the data from this survey to produce a national profile of women having *planned* home births. The profiling of *all* home birthing women would have added little to the analysis of UK birth registration data (see Section 3.1.1), so is not included in this thesis.

What this survey does permit, however, is an analysis of the home maternity ratios of individual NHS Trusts, which makes a valuable contribution to analysis of regional and local variations in the home maternity ratio. It is used for this purpose in Section 4.2.2. Out of the 151 trusts that provided maternity services at the time, 148 were included within the dataset; three were excluded due to small sample sizes leading to confidentiality concerns, or to errors in the sampling process (Healthcare Commission, 2007a).

3.2.4 SMMIS

The SMMIS database is almost certainly unique as a source of UK data that will help to answer the research questions. It overcomes nearly all of the problems that beset this type of study (see Section 2.4.2):

- It allows planned and unplanned home births to be identified and analysed separately, thus overcoming the problem of unplanned home births biasing the results because they are more likely to have negative outcomes.
- It allows intended place of birth at *the end of pregnancy* to be derived, which in this context is more useful than intended place of birth at *booking*.
- It contains over 500,000 observations, so even though fewer than 2% had a planned home birth, the absolute number of planned home births was large enough to give reasonable power to statistical tests. It also means that some rare outcomes (especially negative maternal outcomes which have often been ignored by previous studies) can be modelled, and that the outcomes for key sub-groups (e.g. those who experienced labour complications) can be scrutinised separately from overall outcomes.
- It allows those who transferred to hospital after an attempt at a home birth to be identified, thus overcoming the potential bias ensuing from only including cases who achieved a planned home birth, which will have been mainly uncomplicated pregnancies and labours, which would be expected to have positive outcomes.
- It allows women who experienced labour complications to be reasonably objectively identified wherever they gave birth. This permits a fair comparison between complicated home births and complicated hospital births.
- It allows pregnancies to be reasonably objectively classified into different risk categories, thus allowing us to adjust for any bias resulting from planned hospital births containing a disproportionately high number of high-risk cases.

Few, if any, existing studies of place of birth in the UK can claim to have overcome this many of the problems commonly associated with the study of home birth. Therefore, this study makes a novel and valuable contribution to what was previously known, both about the safety of home versus hospital birth, and about what might influence the decisions that that women take through pregnancy, labour and birth.

There were, however, limitations to the SMMIS database. It was collated over the period 1988-2000, so its applicability to the present day is questionable. Since the publication of *Maternity Matters* (Department of Health, 2007), NHS trusts have been under more pressure to offer women a real choice about where they give birth, and if this analysis were repeated in the present day, it is possible that external factors such as hospital would be less strongly associated with place of birth. This said, there is evidence from more recent data (National Childbirth Trust, 2009a; Healthcare Commission, 2007b) to suggest that significant variations by trust still exist.

The SMMIS data are also specific to one region of England: the former North West Thames Regional Health Authority area, so again care should be exercised when generalising these results to the rest of the UK. For example, women giving birth in the South-east of England tend to be older than average (Tromans et al, 2008) and the population of this area is more ethnically diverse than in most parts of the UK.

Because the SMMIS database covered a 13-year period, some women will have been included in the database more than once, due to having more than one pregnancy during those 13 years. There will therefore be clustering effects that were not controlled for in the analysis.

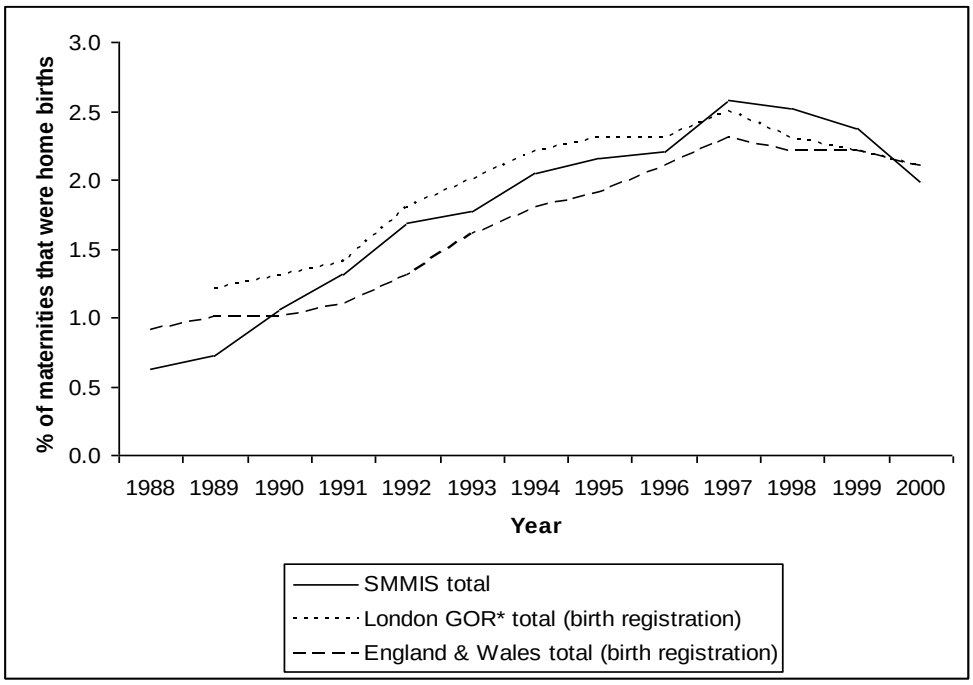
The data did not distinguish between hospital births taking place under the care of a consultant and those taking place under the care of a midwife. The literature review suggests that this is an important distinction (see Section 2.4.2). Another field recorded which type of health professional delivered the baby, which gave some indication as to the type of maternity care provided. It did not, however, allow the identification of women who started out under the care of a midwife in hospital but were transferred to consultant-led care during labour (Smith & Smith (2005) estimated that about 18% of UK women who started labour under the care of a midwife transferred to consultant-led care during labour).

Comparing SMMIS data with birth registration data

For each year between 1988 and 2000, Figure 3.1 compares the home maternity ratio (HMR)[15] within the SMMIS dataset with the HMRs for the London Government Office Region (GOR) and for England and Wales as a whole, as recorded in birth registration statistics. The SMMIS HMR follows roughly the same pattern as London, which indicates that the SMMIS data are a good reflection of the actual pattern of home births in these years. The SMMIS HMR tended to be slightly lower than that of the London GOR, which may be due to the HMR being higher in other parts of London and/or to the SMMIS database not having 100% coverage (see earlier). Furthermore, the North West Thames RHA area included Bedfordshire and Hertfordshire, which are not part of the London GOR. The SMMIS HMR was higher than the London HMR in 1997-1999, which may have been related to three hospitals not contributing data in those years (see Table 3.2); the three hospitals in question had relatively low HMRs (see Figure 4.9). It may also have been related to the fact that the Regional Health Authority was abolished in 1996, which may have led to some restructuring of services.

[15] The home maternity ratio is the percentage of all maternities taking place at home. This calculation includes all home births, to make it comparable with birth registration statistics, which do not distinguish between planned and unplanned home births.

Figure 3.1: Trends in home maternity ratio, 1988-2000



Source: ONS / SMMIS. * GOR boundaries were defined in 1996. For the years 1989-1996, the figures were derived by summing the published figures for London's district health authorities. These were not published before 1989.

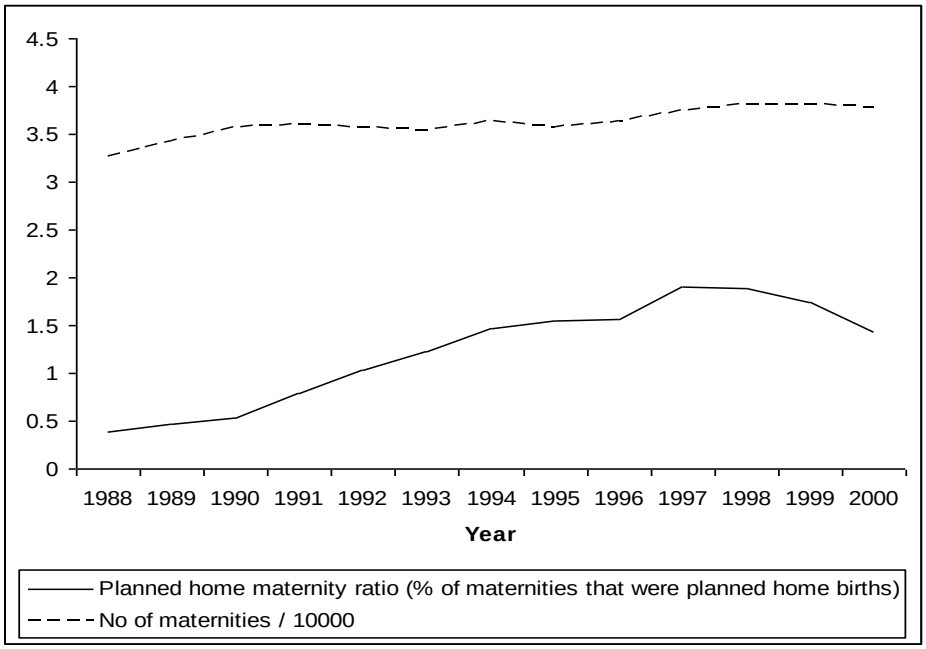
London is unique in among the regions and constituent countries of the UK, in that its HMR fell after 1997, although in 2004 it started to grow again (Nove et al, 2008). It would therefore seem that factors specific to London had a negative impact on the HMR in the late 1990s and early 2000s. Three obvious possibilities are:

1. The overall birth rate; if there was a sudden increase in the number of deliveries that was specific to this region, NHS midwives would have had to attend more births. An increase in midwife workload may have led to women being denied the option of home birth.
2. Midwife staffing levels; an acute midwife shortage may have led to home delivery services being withdrawn. If there was a more severe midwife shortage in London than in other areas, its HMR would show a different pattern.
3. Immigration; both birth registration data and the SMMIS database show that women from minority ethnic groups were among those least likely to have planned home births (see Section 4.4.6), so if the ethnic mix in a particular area changes in a way that is not typical, then its HMR may exhibit a different pattern to other areas.

Overall birth rate

Figure 3.2 shows how the planned HMR between 1988 and 2000 compared with the overall number of births within the SMMIS data. It shows that there was no clear relationship between the total number of births and the planned HMR. This would suggest that, in this region at least and while the number of births was not fluctuating much year-on-year, the HMR was not strongly influenced by the overall number of births.

Figure 3.2: Planned home maternity ratio vs number of births, North West Thames RHA area, 1988-2000



Base: Maternities at maternity units which provided data for the full 13-year period (i.e. excluding Ealing, Central Middlesex and Ashford). Source: SMMIS

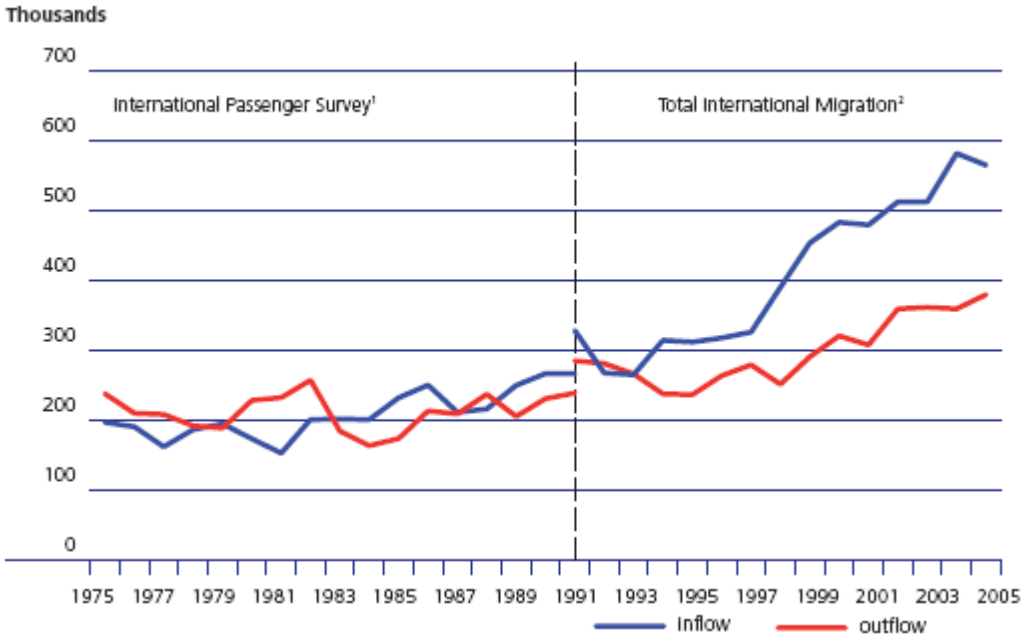
Midwifery staffing levels

Efforts to obtain information on midwifery staffing levels prior to 2000 were unsuccessful. It is not therefore possible to comment on the likelihood of this being a contributory factor to the drop in the London HMR in the late 1990s.

Immigration

As can be seen in Figure 3.3, international migration to the UK started to grow more sharply in 1996, and at this time, London was the destination of the majority of international in-migrants (Office for National Statistics, 2008b).

Figure 3.3: International migration flows UK, 1975-2005

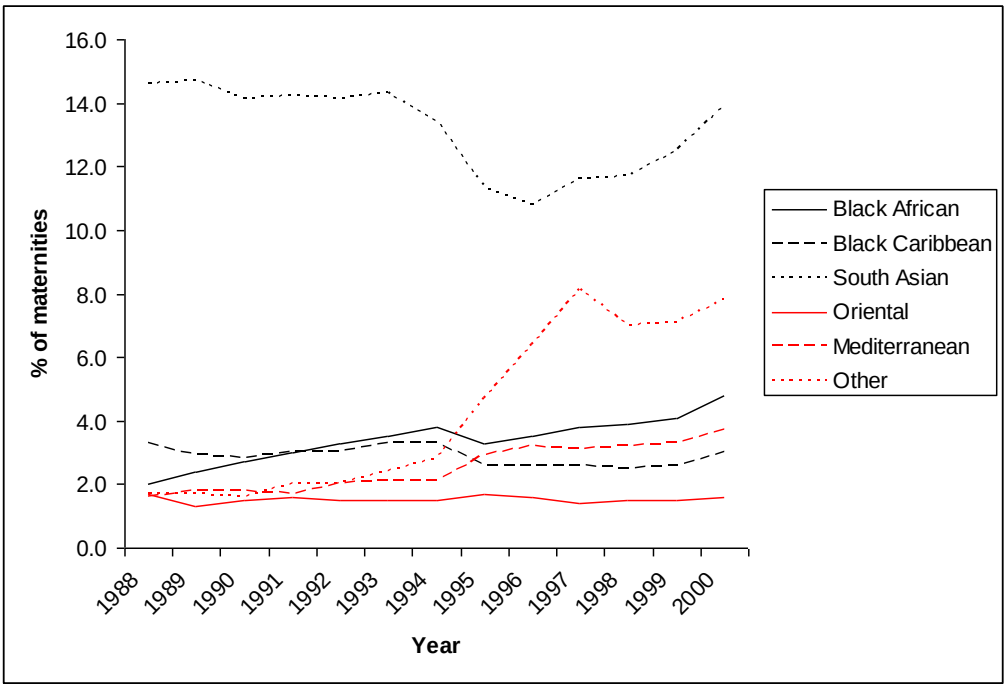


Source: Office for National Statistics (2007).

The percentage of maternities in the SMMIS database that were to women from ethnic groups other than 'white European' was fairly static between 1988 and 1995, but increased from 26.5% in 1995 to 34.8% in 2000, suggesting that increased international migration may have had an effect on the ethnic profile of women giving birth in the North West Thames area in the late 1990s.

Figure 3.4 shows, however, that this overall increase did not reflect increases in all ethnic groups, just Black African, Mediterranean and 'other'. Section 4.4.6 describes how women in Black African and Mediterranean ethnic groups recorded a low HMR in relation to other minority ethnic groups, so the fact that they made up a growing proportion of all childbearing women may partly explain why the HMR fell in London in the late 1990s. On the other hand, the 'other' ethnic group had a relatively high HMR, and its growth in Figure 3.4 is far more marked than that of the Black African and Mediterranean groups. This would suggest that factors other than immigration also had a part to play in influencing the overall decline in the HMR.

Figure 3.4: Time trends in percentage of maternities to ethnic groups other than 'white European', North West Thames RHA area, 1988-2000



Source: SMMIS.

3.3 Statistical methods

3.3.1 Exploratory analysis

Bivariate associations between the response variables and the explanatory variables were investigated using two-way contingency tables and chi-squared tests of association. Under the chi-squared test, the null hypothesis (H_0) is that the two variables are independent. The test compares the observed cell values with those that would be expected under H_0. The larger the difference between the two, the stronger the evidence for H_0 to be rejected. The test yields a p-value to illustrate the probability of the result occurring by chance. The smaller the p-value, therefore, the stronger the evidence for H_0 to be rejected.

Chapters 4, 6 and 7 discuss the exploratory analysis in some detail. This was done deliberately, in order to aid understanding of the complex relationships between the large number of explanatory variables included in the statistical modelling. Without this understanding, it would be difficult to judge whether the statistical models are appropriate tools for answering the research questions.

3.3.2 Type of statistical model used

For all models in this thesis the outcome variable was binary, so binary regression models (BRMs) were required (Pregibon, 1981). Long & Freese (2006) noted that there are three ways to build a binary regression model:

1. The latent-variable model
2. The non-linear probability model
3. The random utility or discrete-choice model

They concluded that the latent-variable approach was unnecessarily complicated, because it was possible to produce the same mathematical model without having to conceptualise the dependent variable as an underlying, unobserved construct. They suggested that the non-linear probability model was the most intuitively appealing, while producing the same results as the other options. Hosmer & Lemeshow (2000) also noted that the interpretation of these models lends itself particularly well to research questions relating to public health or epidemiology. For these reasons, this approach was adopted for this analysis.

The aim of logistic regression is to estimate the *conditional mean* of the outcome variable (Y), i.e. its mean value given a specific combination of explanatory variables (x). The estimate of the conditional mean can be expressed as $E(Y \mid x)$, which can be simplified to $\pi(x)$. The value of $\pi(x)$ must be between 0 and 1, because it represents a proportion (e.g. the proportion of women who intended a home birth at booking).

Agresti (1996) noted that the relationship between x and $\pi(x)$ is usually non-linear and often S-shaped, with the impact of a fixed change in an explanatory variable varying according to the value of π, and typically having less impact when π is near 0 or 1. It is therefore usually necessary to transform $\pi(x)$ to make the relationship between x and $\pi(x)$ more linear. For binomial data, there are three possible transformations (or link functions): logit, probit and complementary log-log. The logit link should be used if the underlying distribution of the outcome variable is logistic, the probit link should be used if the underlying distribution is normal, and the complementary log-log link should be used if there are extreme values. Fox (2002) noted that the logit and probit links are similar in that they approach probabilities of 0 and 1 symmetrically, and that the complementary log-log link should be used only if the other two do not produce a reasonably well-fitting model. Long & Freese (2006) demonstrated that the logit and probit links tend to produce similar results once their variances are equated.

For all models described in this thesis, the logit transformation was used because the model fit was good and resultant coefficients are relatively simple to interpret. This type of model is usually termed a logistic regression model, but is also known as a logit or log-odds regression model. The logit of the conditional mean can be expressed as $g(x)$, and is calculated thus:

$$g(x) = \ln\left[\frac{\pi(x)}{1-\pi(x)}\right]$$

Hosmer & Lemeshow (2000) noted that the main advantages of the logit transformation are that $g(x)$ is linear in the parameters, may be continuous and can take any value from -∞ to ∞ (thus overcoming the problem of $\pi(x)$ having to be in the range 0 to 1). In other words, in several important respects a logit model resembles a linear regression model and therefore many of the desirable features of a linear regression model also apply to a logit model.

There are two main ways in which logistic regression differs from linear regression:

1. In linear regression, the model's error term is assumed to be normally distributed with a mean of zero and constant variance. With a dichotomous outcome variable (y), however, the error term (ε) can take only two possible values. If y=1, then $\varepsilon = 1 - \pi(x)$ with probability $\pi(x)$. If y=0, then $\varepsilon = -\pi(x)$ with probability $1 - \pi(x)$. Thus, y has a binomial distribution with the probability dependent on the value of the conditional mean.
2. In linear regression, the *least squares* method is used to estimate the values of unknown parameters, but this method does not work with dichotomous outcome variables. Most statistical analysis packages (including the one used for this analysis) use the *maximum likelihood* (or ML) method for logistic regression. ML estimates are the values of the parameters that have the greatest likelihood of generating the observed data if the model's assumptions are true.

Long & Freese (2006) noted that ML estimation is only possible if the outcome variable varies within the categories of an explanatory variable; if it does not vary, the coefficient for the explanatory variable would be -∞. Therefore, if an outcome is predicted perfectly by an explanatory variable, the model cannot be fitted. Due to the rarity of some of the outcomes, this situation occurred several times during the model building process, which meant that some potentially useful interaction terms were not included (see Appendix F for details).

Two other types of model were considered: multilevel models and multinomial regression models. Multilevel models would have taken into account variability between hospitals at the same time as taking into account variability between individual pregnant women. If the decisions and outcomes for women within an individual hospital were positively correlated the standard errors for individual-level parameters in a regression model will be under-estimated. However, it was felt to

be important to treat hospital as a fixed effect in the models, because it was hypothesised that the policies and protocols of a hospital may influence the decisions taken by pregnant women and also the pregnancy outcomes. It was also felt to be important to have the ability to look across the results to see if any individual hospital(s) stood out as being associated with several negative outcomes. This would not have been possible using multilevel models.

A multinomial regression model was considered for the 'who plans/has a home birth' analysis, with the outcome variable 'place of birth' with four levels: planned home birth, planned hospital birth, unplanned home birth, intended a home birth but transferred to hospital in labour. However, it was felt that a series of BRMs would better explain the decision-making pathway as illustrated by Figure 4.1. Because decisions about place of birth tend to be taken over a period of time rather than at a single point in time (e.g. if the pregnancy risk status changes), a better understanding of this pathway was felt to be important.

Consideration was also given to the use of matching rather than regression modelling to control for confounding, i.e. selecting all the maternities for which a home birth was intended and taking a sub-sample of the maternities for which a hospital birth was intended, with cases matched on key variables such as pregnancy risk status, parity, hospital and mother's age. This approach has been taken for several recent studies of the relative safety of different birth settings (e.g. Hutton et al, 2009), and it would have made the dataset less imbalanced. An imbalanced dataset can result in models becoming numerically unstable, which can lead to problems when trying to include interaction effects. However, matching was rejected for two reasons: (i) there was a large number of potential confounders, and it would have been impossible to match successfully on all of them, and (ii) the sub-sample of those who intended a hospital birth would have been biased towards the types of women who choose home birth (i.e. parous, older, low-risk), so we would not have been able confidently to generalise the results to other types of women. Furthermore, for the 'who has a home birth' models, we would not have been able to assess the association between the outcomes and the characteristics on which subjects had been matched, e.g. parity, age, hospital and pregnancy risk status. As these were all important predictors of intended place of birth and/or actual place of birth, this would have been a major shortcoming.

3.3.3 Missing data

Records with missing data for the outcome variable were deleted from the data. The numbers involved were relatively small:

- 1,321 (0.3%) did not have their intention at booking recorded in SMMIS so they were deleted from the 'intended place of birth at booking' model

- 1,994 (0.4%) did not contain sufficient information to allow their intended place of birth at the end of pregnancy to be derived, and were therefore deleted from the 'change of intention' models
- For the remaining models, there were no missing data for the outcome variable. For the models reported in Chapters 6 and 7, it was assumed that if the outcome was not recorded, it did not occur

The approach for handling missing data for the explanatory variables depended on the extent of the problem. If fewer than 0.1% of records had data missing on a variable, those records were deleted. If 0.1% or more of records had data missing on a variable, a 'missing' category was created and included as a measure within the model. If more than 12% of records had missing data on an explanatory variable, that variable was not included as a covariate. Full details can be found in Appendix D.

3.3.4 Model selection process

All models were selected using manual forward selection (see Sections 6.7.3, 7.7.3 and Appendix F for a detailed account). First, a series of models with just one explanatory variable was run; one for each explanatory variable included in the model building process. The explanatory variable that resulted in the model with the highest $LR\chi^2$ value (see Section 3.3.8) was selected to be included in the model and was included in all models tested from that point on. This process was repeated with the remaining explanatory variables until Likelihood Ratio Tests (LRTs) showed that the addition of further explanatory variables did not make the model a significantly better fit overall (i.e. the p-value of the LRT was greater than 0.05).

Once the final additive model had been built, interaction terms were added to assess whether or not they made a statistically and substantively significant improvement to the model. The addition of interaction terms was mainly theory-driven, but in the case of the 'who plans/has a home birth' models, it was also partly driven by assessment of where the additive model fit was relatively poor. LRTs were used to assess whether interaction terms made a statistically significant improvement to the model ($p<0.05$). As will be seen in the relevant sections later, in most models, a large number of interaction terms made a significant improvement to the model fit. This is to be expected with such a large dataset, and it is likely that, in some cases, the statistical significance came about by chance rather than because a 'real' interaction effect exists. Certainly, it was not possible to include all of the statistically significant interaction terms without introducing collinearity problems. Therefore, interactions which made a statistically significant improvement to the model fit were assessed to see if they made a substantive difference to the conclusions of the model. Those which altered the overall conclusion in relation to the association between intended place of birth and the outcome were included in the model, and the rest were excluded. Please see Sections 6.7.3, 7.7.3 and Appendix F for full details of the approach and methodology relating to interactions.

For some of the models described in this thesis, numerous interaction terms involving the same covariates significantly improved the fit of the model, which resulted in collinearity problems (e.g. the model with foetal distress as the outcome – see Section 6.7.3). In such cases, judgements had to be made about which interaction terms to include in the final model, and these judgements are described and justified in the relevant sections of this thesis.

3.3.5 Calculating odds and odds ratios

The odds of a particular outcome (e.g. intending a home birth at booking) are calculated from its probability. If the probability of intending a home birth at booking is p_1 for women from Hemel Hempstead hospital, then the odds of a woman from Hemel Hempstead hospital intending a home birth are $p_1/(1-p_1)$. Thus, if p_1=0.0916, the odds would be 0.1, i.e. intending a home birth is 0.1 times as likely as intending a hospital birth.

The odds ratio (θ) is a way of comparing two groups in terms of their likelihood of experiencing the outcome in question. Let p_2 represent the probability of a woman receiving care from Ashford hospital intending a home birth at booking. To compare women from the two hospitals, θ was calculated thus:

$$\theta = \frac{p_1/(1-p_1)}{p_2/(1-p_2)}$$

3.3.6 Calculating predicted probabilities

Because the logistic regression model transforms the estimated conditional means using the logit function (see Section 3.3.2), to interpret the model coefficients it is necessary to transform them back into estimated means using the following formula:

$$\frac{\exp(\alpha+\beta_x)}{1+\exp(\alpha+\beta_x)}$$

Where α was the constant coefficient and β_x was the coefficient for the variable or factor level under consideration.

For example, according to the final 'intention at booking' model, the predicted probability of a woman with the reference characteristics intending a home birth at booking was:

$$\frac{e^{-2.2946}}{1+e^{-2.2946}} = 0.0916$$

(-2.2946 being the constant coefficient – see Table 4.12). In other words, a woman with the reference characteristics had an estimated 9.2% chance of intending a home birth at booking.

The formula used to calculate predicted probabilities for interactions was:

$$\frac{\exp(\alpha + \beta_{m1} + \beta_{m2} + \beta_i)}{1 + \exp(\alpha + \beta_{m1} + \beta_{m2} + \beta_i)}$$

Where β_{m1} was the coefficient for the relevant factor level of the main effect for the first explanatory variable, β_{m2} was the coefficient for the relevant factor level of the main effect for the second explanatory variable, and β_i was the coefficient for the relevant factor level for the interaction between the two.

When predicted probabilities are used to present the results relating to interaction terms (as they are in Chapter 4), the predicted probabilities assume that all covariates except those involved in the interaction term are held at their reference values.

3.3.7 Calculating relative risk

Relative risk is used to present the results of the 'safety' models, as it is relatively simple to interpret and lends itself well to the description of results involving negative events. With a rare outcome such as perinatal death, the relative risk was virtually the same as the odds ratio, but for consistency across all models, the relative risk was calculated even if the outcome was rare. The relative risk for a sub-group of women was calculated by dividing the predicted probability of that sub-group experiencing the outcome by the predicted probability of a reference case experiencing the same outcome. Thus, the relative risk was 1 for all reference categories. A relative risk of greater than 1 indicated elevated risk of experiencing the outcome for that sub-group of women compared with the reference group, and a relative risk of less than 1 indicated a reduced risk.

3.3.8 Interpreting confidence intervals

The confidence interval calculation is based on the assumption that the observations comprise a random sample of a population. Because the SMMIS database is effectively a census of all pregnancies from a selection of hospitals, it could be argued that a confidence interval calculation is unnecessary. However, it could also be argued that the conclusions from these hospitals can be generalised to other parts of the country with a similar demographic and geographic profile, in which case the pregnancies analysed here can be considered as a sample rather than a census. If we accept this argument, then the use of confidence interval calculations is justified, as long as the population of the North West Thames RHA area is not completely atypical of the wider population (see Section 3.2.4).

3.3.9 Model diagnostics/assessment

As an initial check of the model fit, a summary measure of goodness-of-fit (GoF) was calculated for each model, based on the difference between the model's fitted values and the observed data. This was done by computing the log likelihood of the model with all coefficients but the intercept constrained to zero and comparing it with the log likelihood of the same model with no constraints on the coefficients (Long & Freese, 2006). The resultant statistic (LRχ^2) tests the null hypothesis that the model coefficients are zero. It has a chi-square distribution and yields a p-value. The lower the p-value, the stronger the evidence to reject the null hypothesis.

Hosmer & Lemeshow (2000) noted that this approach has an inherent problem, i.e. that when the number of observations (n) is approximately equal to the number of covariate patterns (J), the p-value of LRχ^2 will be incorrect. In such cases, they proposed a different summary measure, called the Hosmer-Lemeshow statistic (*HL*), which overcomes this problem by grouping the data. This test divides observations into a number of groups (typically deciles) based on the model's predicted probabilities, then computes a chi-square statistic derived from comparing the observed and expected frequencies within each group. For this test, the null hypothesis is that the model fits well. Therefore, when the p-value of the HL statistic is small, there is cause for concern about the model's goodness-of-fit. However, because of the large number of observations and the fact that many of the models described in this thesis contained only categorical variables, in most cases J was considerably smaller than n. For these models, therefore, LRχ^2 was an adequate indicator of overall GoF without the need to consider *HL* as well. Some models, however, included continuous variables, so for these models both LRχ^2 and *HL* were calculated.

Summary measures of goodness-of-fit are, however, of limited usefulness, providing only a rough idea of whether or not a model is adequate. In order to understand exactly where the model fit was good and bad:

1. predicted probabilities were compared against observed percentages,
2. standardised residuals were calculated and examined,
3. cases with large standardised residuals (outside the range -2 to 2) were profiled to identify sub-groups for which the model fit was relatively poor, and
4. Cook's statistic[16] was calculated to identify influential observations

Full details of the results of these diagnostic tests can be found in Appendix G.

[16] Cook's Distance applies only to linear regression, but Long & Freese (2006) recommended an approximation for use with logistic regression (termed 'Cook's statistic'), which was used here. Hosmer & Lemeshow (2000) described the approximation as examining "the effect that deleting all subjects with a particular covariate pattern has on the value of the estimated coefficients and the overall summary measures of fit." The difference in the coefficients approximates to Cook's Distance.

4 Who plans a home birth in the UK, and who achieves a planned home birth?

This chapter aims to identify the characteristics associated with planning a home birth in the UK, and among those who do plan a home birth, what characteristics are associated with achieving one. The method of analysis is based on the understanding that pregnant women and their partners often make the decision about place of birth over a period of time, and even if there is a definite decision early in pregnancy, this decision can be changed in response to circumstances that arise as pregnancy progresses. For example, a woman who plans a home birth may develop a 'high-risk' condition which makes hospital birth a preferable option for her, a woman who assumes that hospital birth is the only option may find out relatively late in pregnancy that home birth is an option for her, or a woman may plan a home birth and begin her labour at home, but find that her labour is complicated and she needs to transfer to hospital to deliver the baby. To gain a detailed understanding of the types of women who make different decisions about place of birth, therefore, it is necessary to trace the paths that different women take through the decision-making process. Section 4.1 of this chapter explains the approach used to trace these paths.

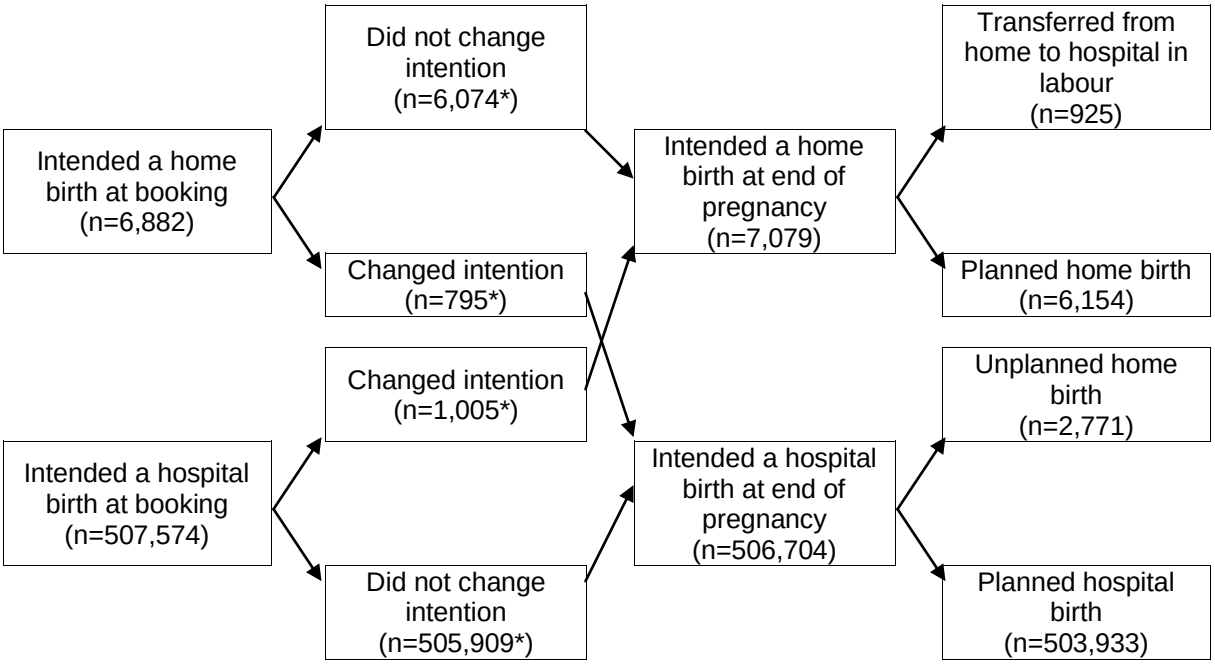
In Sections 4.2-4.4, four data sources are used to produce a descriptive profile of the kind of woman who plans and/or has a home birth in the UK. The different explanatory variables that are or may be associated with a desire to give birth at home are identified via a detailed literature search, and arranged into three groups: (1) external factors, i.e. characteristics of the pregnancy/birth that were external to the pregnant woman, such as the year of birth, (2) characteristics of the pregnancy/labour, e.g. pregnancy risk status and duration of labour, and (3) characteristics of the pregnant woman, e.g. age, ethnic group. The use of four different data sources helps to compensate for the fact that none of the four contains data on all the explanatory variables of interest. Furthermore, because the four sources generally showed a similar relationship between the response and explanatory variables, we can have confidence in the reliability and validity of the data source used for the statistical modelling in Section 4.6. In this section, four models are used to identify variables that have an independent association with: planning a home birth at the start of pregnancy, changing the intended place of birth during pregnancy, and actually having a home birth if one has been planned.

4.1 Conceptual and analytical frameworks

Figure 4.1 illustrates the possible paths that the vast majority of UK women take through pregnancy in terms of deciding where to give birth, and shows the number of women in the SMMIS dataset following each path. It takes into account the fact that intentions can and do change during the pregnancy, either for clinical or non-clinical reasons. It shows that, in the SMMIS database:

- 14% of those who intended a home birth at the end of pregnancy had intended a hospital birth at the booking appointment[17]
- 12% of those who intended a home birth at booking changed to intending a hospital birth at the end of pregnancy
- Just 0.3% changed their intended place of birth between booking and the end of pregnancy
- 87% of those who intended a home birth at the end of pregnancy went on to have a planned home birth

Figure 4.1: Possible paths through pregnancy



* It was not possible to establish for all the records whether or not intentions changed between booking and the end of pregnancy. Therefore, the 'changed intention' figures do not sum to the 'intention at booking' figures.

Intended place of delivery at the booking appointment and actual place of delivery were recorded in separate fields. The categories used are shown in Table 4.1:

Table 4.1: Categories for intended/actual place of birth in SMMIS

Intended place of delivery at booking		Actual place of delivery	
Category	**% of records**	**Category**	**% of records**
Hospital	98.4	Hospital	98.1
Home	1.3	Home	1.8
None	*	In transit	0.1
Unbooked	0.2	Other	*
Missing	0.1	Missing	*

* Less than 0.05%

[17] The 'booking appointment' is the woman's first consultation with a midwife. It tends to take place when the woman is 10-12 weeks' pregnant.

If a woman's actual place of delivery was different from her intended place of delivery at booking, SMMIS recorded the reason for the change in one of six categories: (1) change of address, (2) unintentionally in labour, (3) clinical reasons – pregnancy, (4) clinical reasons – labour, (5) other reasons – pregnancy and (6) other reasons – labour. This information permitted the derivation of a 'place of birth' variable which took into account both the fact that women can change their intended place of birth after the booking appointment and the fact that some of the women who intended a hospital birth actually gave birth at home and some of those who intended a home birth actually gave birth in hospital. Had it been necessary to rely solely on 'intention at booking' to classify women as having intended a home or hospital birth, there would have been numerous cases of misclassification. This would have made it very difficult to draw reliable conclusions about the type of woman who, having intended a home birth, went on to have one[18].

Table 4.2: Derivation of 'place of birth' variable in SMMIS

Place of birth category	Intended place of delivery at booking	Actual place of delivery	Timing of change of place of delivery	N	%
Home – planned	Home	Home	n/a	5,149	1.0
	Hospital	Home	Pregnancy	1,005	0.2
				6,154	**1.2**
Home – unplanned	Hospital	Home	Labour	**2,771**	**0.5**
Home – intention unknown	None or unbooked	Home	n/a	**141**	*
Transferred to hospital during labour (clinical reasons)	Home	Hospital	Labour (clinical reasons) or unintentionally in labour	**702**	**0.1**
Transferred to hospital during labour (other reasons)	Home	Hospital	Labour (other reasons)	**223**	*
In transit	Any	In transit	n/a	**312**	**0.1**
Other non-hospital	Any	Other	n/a	**113**	*
Hospital – planned	Hospital	Hospital	n/a	503,138	97.5
	Home	Hospital	Pregnancy	795	0.2
				503,933	**97.7**
Hospital – intention unknown	None or unbooked	Hospital	n/a	**865**	**0.2**
Missing	Intended and/or actual place of delivery and/or timing of change missing			**563**	**0.1**
Total				**515,777**	**100.0**

* Less than 0.05%

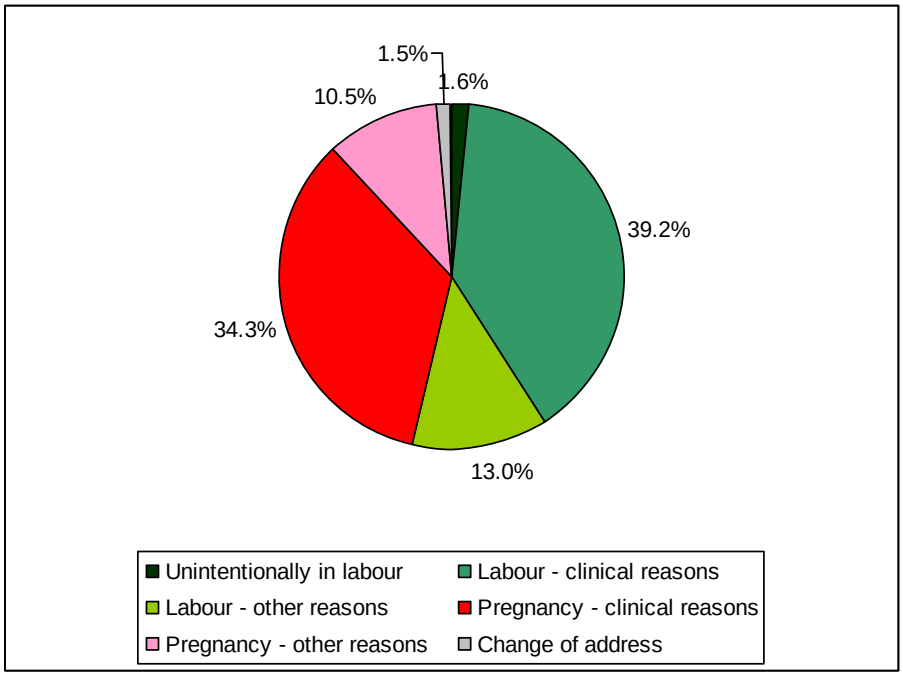
Intended place of birth at booking should have been recorded by the midwife after discussion with the woman (Steer, 2008b). If the evidence reported in Section 1.1 is accurate, it is likely that some

[18] This also makes a big contribution to the validity of the analyses of the safety of home birth in Chapters 6 and 7, because a common reason for changing from intending a home birth to intending a hospital birth is the development of 'high-risk' conditions during pregnancy. Because being 'high-risk' is a predictor of negative pregnancy outcomes, had women who intended a home birth at booking but changed to intending a hospital birth due to developing a 'high-risk' condition been classed as having intended a home birth, this would have made it appear as though intending a home birth was riskier than it actually was.

midwives automatically booked women to deliver in hospital without asking for their preference. If so, some women will have been recorded as intending a hospital birth at booking even if they would have stated a preference for home birth had they felt it was an option.

Nearly all (99%) of those who intended a home birth at booking but gave birth in hospital had a reason recorded for the change. Figure 4.2 shows that 52% changed in labour (as represented by the green segments of the pie) and 45% during pregnancy (as represented by the red and pink sections), and that 74% were classed as having changed for clinical reasons with 23% (n=403) changing for non-clinical reasons.

Figure 4.2: Reasons for changing from home birth to hospital birth in SMMIS



Base: All who intended a home birth at booking but gave birth in hospital with a reason recorded for the change (n=1,720)

The analysis in this chapter aims to contribute to our understanding of what types of women are likely to follow different paths, with a particular focus on women who have planned home births. The pathway begins at the booking appointment, because women's attitudes and intentions in advance of the booking appointment were not recorded on the SMMIS database. However, during the period covered by the SMMIS dataset, most women in the UK will have presented to their GP in the first instance. It is possible (some would say likely) that some women expressed a desire for a home birth at this initial consultation but were persuaded against it by their GP. Others may have been 'talked out of it' at the booking appointment. These women will probably have been recorded on the SMMIS database as having intended a hospital birth from the outset, when in fact this did not reflect their actual preference.

Previous research and commentary has identified a number of concepts that are, have been or may be associated with place of birth. These are summarised in Table 4.3, which also shows references for published studies or commentaries which have found or suggested a link between that concept and place of birth.

Table 4.3: Conceptual framework for analysis of 'who plans/has a home birth'

Category	Concepts	Reference(s)
External factors	Year of delivery	Macfarlane & Mugford (2000); Nove et al (2008)
	Local NHS policy/attitudes towards home birth	Hansard (2007a); National Childbirth Trust (2001); Green et al (1998)
	Local midwifery staffing level	Davies (2004)
	Skill of attending midwife	Magill-Cuerdin (2005)
	Distance from home to hospital	Pitchforth et al (2007)
Characteristics of pregnancy / labour	Risk status of pregnancy	e.g. Chamberlain et al (1997); Davies (2004)
	Duration of labour	Chamberlain et al (1997)
	Pain relief used in early labour	Chamberlain et al (1997)
	Size of foetus	Davies (2004)
	Amount of medical attention received during pregnancy	Tew (1998)
Characteristics / circumstances of mother	Age	Chamberlain et al (1997); Redshaw et al (2007); Nove et al (2008)
	Parity	Chamberlain et al (1997); Healthcare Commission (2008); Redshaw et al (2007); Nove et al (2008)
	Reproductive history	Chamberlain et al (1997)
	Relationship status	Nove et al (2008)
	Social class	Chamberlain et al (1997)
	Culture/ethnicity/language	Nove et al (2008); Leap (1996)
	Pelvis size	Bull (1994)
	Attitudes to pregnancy/childbirth/childrearing	Edwards (2005)
	Level of deprivation in local area	Nove et al (2008)
	Suitability of housing for home birth	Allison (1996)

Figure 4.3 presents this information diagrammatically. It breaks the process into three distinct stages with three outcomes represented by the shaded boxes: (1) intended place of birth at booking, (2) a change in intended place of birth during pregnancy and (3) actual place of birth. It was hypothesised that several factors may have predicted the outcome at all three stages, and for

simplicity these are represented by the three boxes in the upper left-hand corner. Factors which were hypothesised to predict the outcome at just one or two stages are shown in their own boxes.

Figure 4.3: Conceptual framework for analysis of 'who plans/has a home birth'

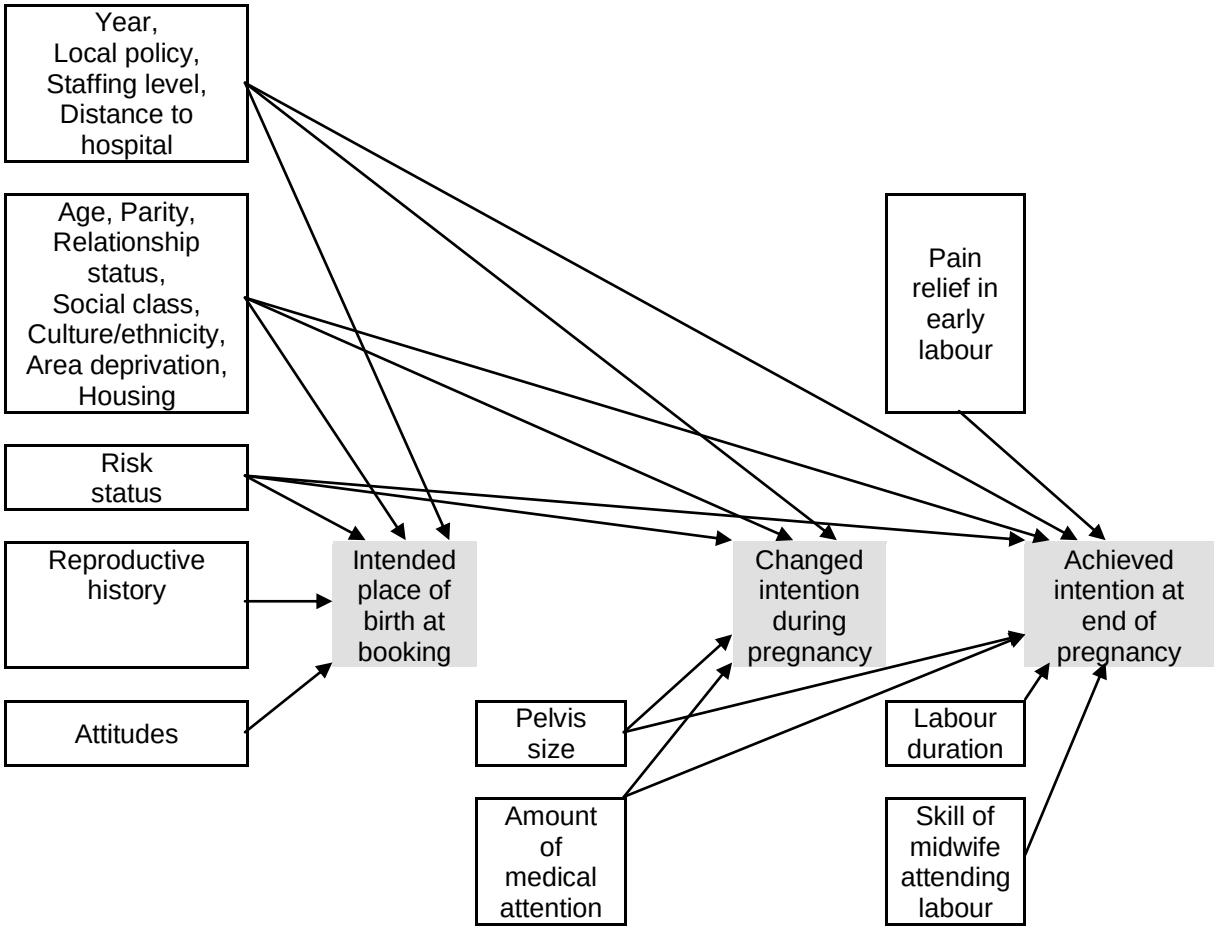


Table 4.3 and Figure 4.3 describe the *ideal* in terms of analysing the type of women who give birth in different places. Table 4.4 describes what was *actually done*; it shows which of the concepts in the conceptual framework were included in the analysis, and what measure(s) was/were used to represent each concept. It also shows which of the four data sources contained measures of each concept. It thus describes the analytical framework of the analysis described in this chapter.

Table 4.4: Analytical framework for 'who plans/has a home birth'

Concept	Variable(s)	Data source(s)
External factors		
Year of delivery	Year of delivery	Birth registration, SMMIS
Local NHS policy/attitudes towards home birth	Region	Birth registration
	Local authority	Birth registration
	NHS Trust	Healthcare Commission
	Hospital providing care	SMMIS
Local midwifery staffing level	Unable to obtain data*	
Skill of attending midwife	Unable to obtain data**	
Distance from home to hospital	Urban/rural classification	GUS
Pregnancy characteristics		
Pregnancy risk status	Pre-pregnancy risk status	SMMIS (derived)
	Developed risk factors during pregnancy	SMMIS (derived)
	Overall antenatal risk status	SMMIS (derived)
	Development of risk factors in labour	SMMIS (derived)
Duration of labour	Duration of labour	SMMIS
Pain relief used in early labour	Type of pain relief used in labour	SMMIS
	Use of birth pool	SMMIS
Size of foetus	Birthweight	SMMIS
Amount of medical attention received	Number of ultrasound scans	SMMIS
	Number of antenatal clinic visits	SMMIS
Mother's characteristics		
Age	Age at delivery	Birth registration, SMMIS, GUS
Parity	Parity	SMMIS, GUS
Reproductive history	Age at first delivery	GUS
	Number of previous miscarriages	SMMIS
	Number of previous terminations	SMMIS
	Birthweight of last baby	SMMIS
	Gestation of last pregnancy	SMMIS
Relationship status	Marital status	Birth registration, SMMIS
	'Single unsupported mother'	SMMIS
Social class	Educational qualifications	GUS
Culture/ethnicity/language	Country of birth	Birth registration, GUS
	Ethnic group	SMMIS, GUS
	Whether interpreter needed	SMMIS
Pelvis size	Height	SMMIS
Attitudes to pregnancy/childbirth/ childrearing	Was current pregnancy planned?	GUS
	Attended antenatal classes	GUS
	Intention to breastfeed	GUS
	Method of feeding baby	GUS
	Tolerance of corporal punishment	GUS
	Openness to learning parenting skills	GUS
	Baby-led routine vs imposed routine	GUS
Deprivation level of local area	Household income	GUS
	Index of Multiple Deprivation	GUS
	Carstairs quintile	SMMIS
(Suitability of) housing	Housing type	GUS

* Attempts were made to obtain data on midwifery staffing levels at the maternity units covered by the SMMIS database from the years 1988-2000, but the NHS Information Centre was able to provide data from 2000 onwards only. Other sources (e.g. Westminster PCT, Department of Health and LSA Midwife for London) were unable to help.

** SMMIS recorded who performed the delivery, but for each record only one person was recorded. In situations where a woman started labour under the care of one type of clinician but was delivered under the care of another type, only the clinician who delivered the baby would have been recorded.

4.2 Descriptive analysis: external factors

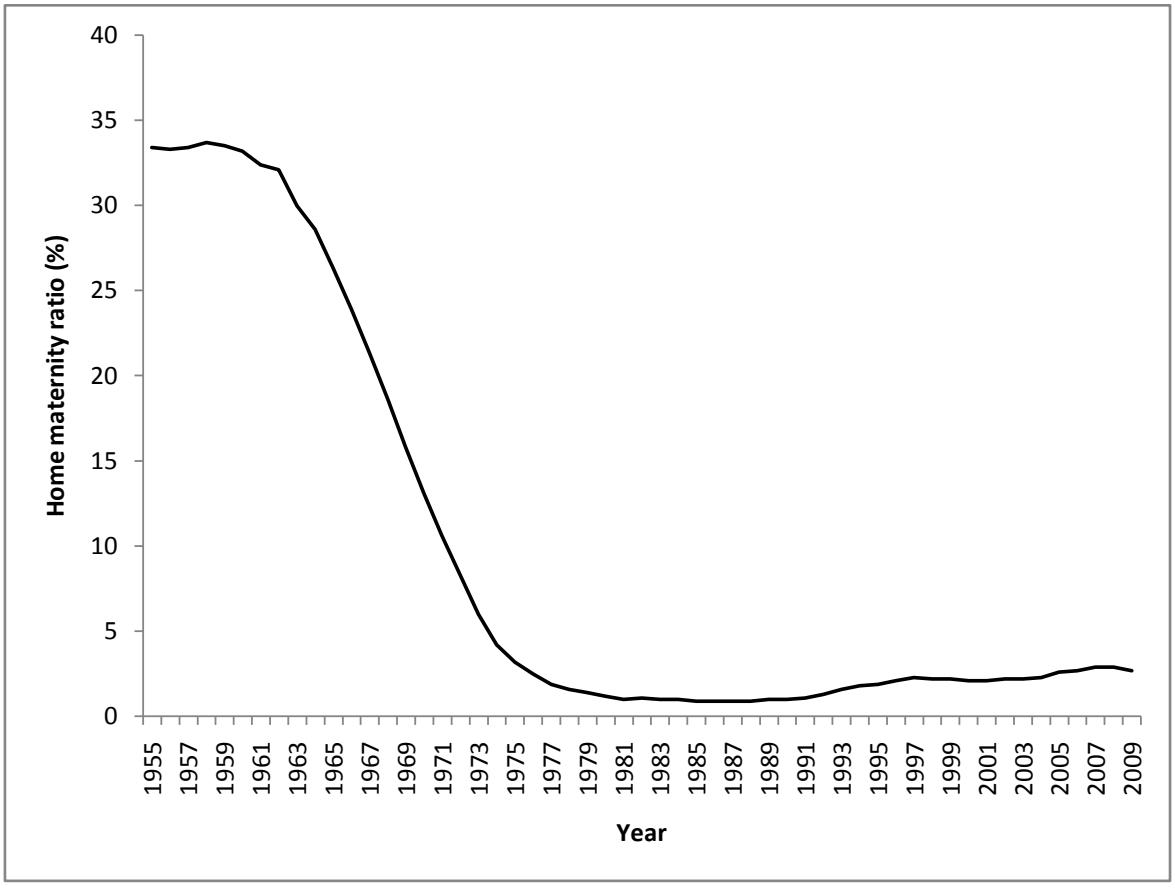
Some of the descriptive analysis shown in this section of the thesis was published as a journal article by the Office for National Statistics (Nove et al, 2008).

4.2.1 Year of delivery

Birth Registration data

In 1955, 33.4% of maternities in England and Wales took place at home, including both planned and unplanned home births. Figure 4.4 shows that the home maternity ratio (HMR) fell sharply between 1963 and 1974 (down from 30.0% to 4.2% over a period of just 11 years). It reached an all-time low of 0.9% in 1985, and then started to climb slowly in 1988, reaching 2.9% in 2008. In 2009, however, it fell slightly to 2.7% (Office for National Statistics, 2010b).

Figure 4.4: Time trends in home maternity ratio, England & Wales, 1955-2009

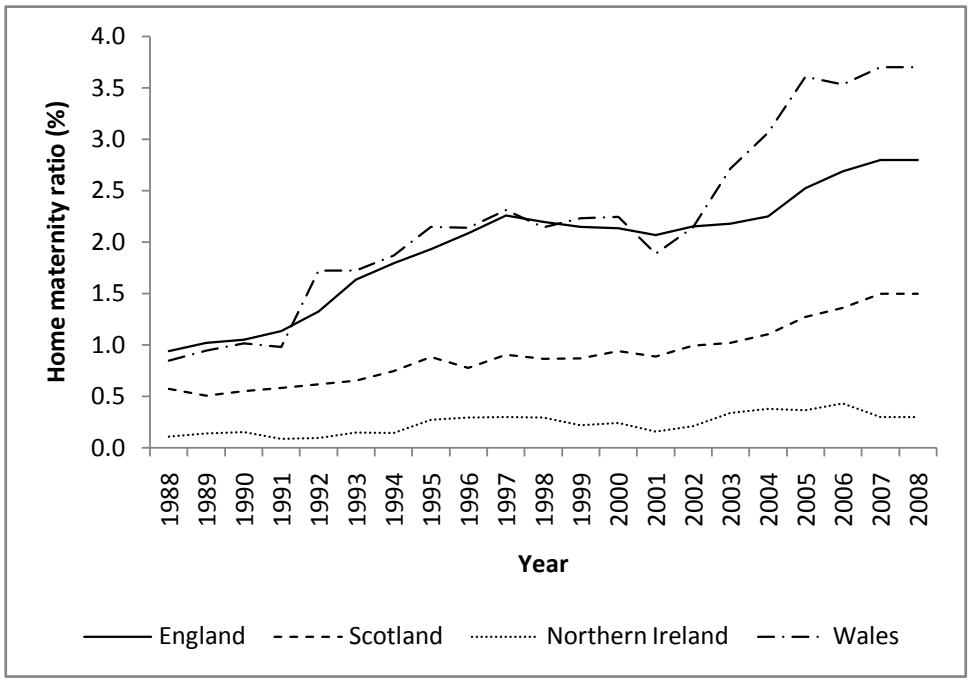


Source: Office for National Statistics (ONS): Birth Statistics, Series FM1

Most of the analysis in this chapter focuses on the period since 1988; as well as being the year in which the HMR started to rise in England and Wales, it was also the year in which the SMMIS central data collation began (see Section 3.1.4). Figure 4.5 has a smaller scale than Figure 4.4, to allow the changes in England and Wales since 1988 to be seen more clearly, and also shows the

equivalent figures for Scotland and Northern Ireland. Scotland has seen a small increase in its out-of-hospital birth ratio since 1992 (up from 0.6% in 1992 to 1.5% in 2008), but Northern Ireland's ratio has stayed very low (up from 0.1% in 1994 to 0.3% in 2008).

Figure 4.5: Time trends in home maternity ratio[19] by country, UK, 1988-2008



Source: England and Wales: ONS Birth Statistics, Series FM1 / Scotland & N Ireland 2007-08: BirthChoice UK (2009) / Scotland 1988-2006: GRO-S special tabulation / N Ireland 1988-2006: NISRA special tabulation.

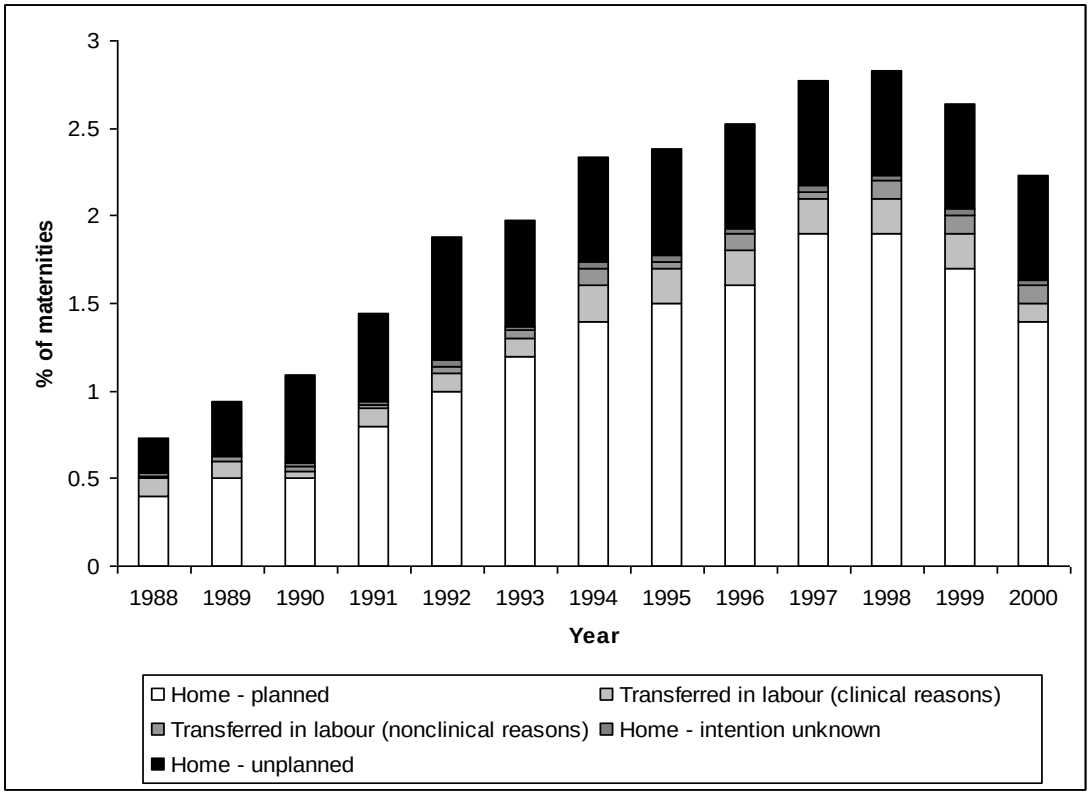
It is clear that over the period 1988-2008, home birth has been more common in England and Wales than in Scotland and Northern Ireland. It is also clear that, since 2003, the HMR in Wales has outgrown that of England. In 2002, the Welsh Assembly set a target for 10% of births to take place at home by 2007 (Welsh Assembly, 2002), which probably explains the recent increase. This is the first of several indications that a woman's likelihood of giving birth at home depends to some extent on where she lives.

SMMIS data

In the former North West Thames RHA area, the planned HMR (represented by the white sections of the bars in Figure 4.6) grew between 1988 and 1998, and then began to fall. This indicates that analysis of the SMMIS dataset must take account of time trends (which it does – please see Section 4.6 and Chapters 6 and 7). Please see Table 4.2 for an explanation of the categories used in the legend of Figure 4.6.

[19] The figures for Scotland and Northern Ireland are based on live births rather than maternities, and include all out-of-hospital births rather than just births at home. It is estimated that about 8% of out-of-hospital births in these two countries took place in transit (Nove et al, 2008), so we can assume that the majority were home births.

Figure 4.6: Time trends in intended and actual home maternity, North West Thames RHA area, 1988-2000



Source: SMMIS. Chi-squared test p-value = 0.000.

It is clear from Figure 4.6 that changes in the HMR over time were mainly due to variations in the *planned* HMR. The unplanned HMR was relatively small in 1988 and 1989, but after that remained reasonably constant at about 0.6%.

Three previous UK studies have attempted to calculate the unplanned HMR, and reached different conclusions:

1. A study in Cardiff over the years 1970-79 (Murphy et al, 1984, cited in Mori et al, 2008) found that about 0.4% of all births were unplanned home births, and that the unplanned HMR remained constant during a period when the overall HMR was declining.
2. A study in the Northern region of England over the years 1981-94 (Northern Region Perinatal Mortality Survey Coordinating Group, 1996) concluded that about 0.3% of all births in the region were unplanned home births.
3. A survey of women who had recently given birth in England (Redshaw et al, 2007) concluded that about 0.8% of all births were unplanned home births.

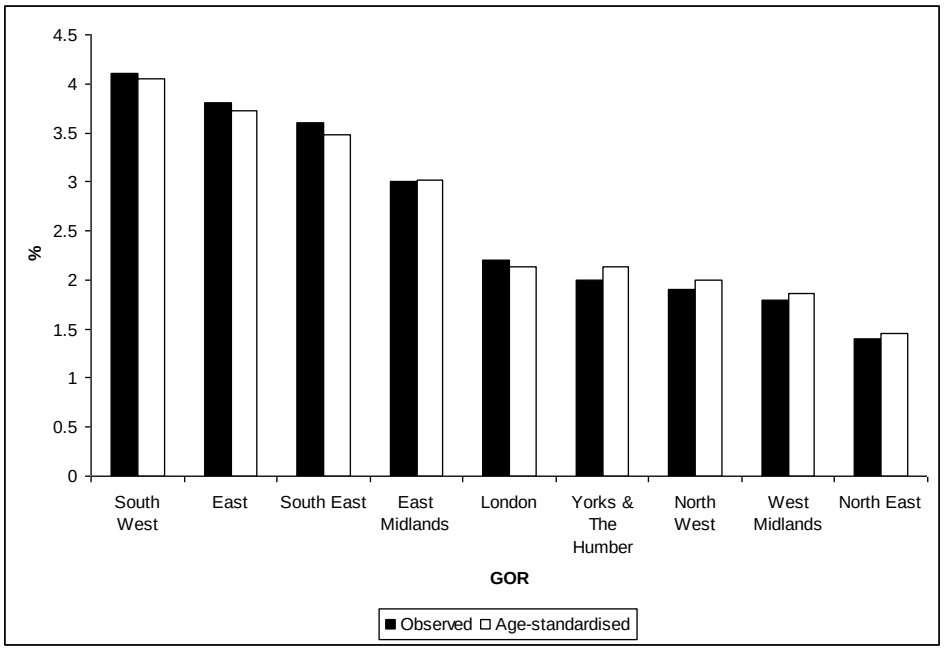
It is possible that these variations are due to different methods of defining 'unplanned'. If they do accurately reflect what was happening at the time, however, the fact that the studies yielded slightly different results suggests that either the unplanned HMR varies over time, and/or that it varies according to geographical area. The SMMIS data suggest it is primarily the latter (see Figure 4.9).

4.2.2 Geographic variations

Birth registration data

Since Government Office Regions (GORs) were defined in 1996, the Birth Statistics series has broken down birth registration data by GOR. Figure 4.7 shows the 2006 figures, and reveals a high level of variation by GOR, with the highest HMR in the South West (4.1%) and the lowest in the North East (1.4%). A similar pattern was evident in 2009 (Office for National Statistics, 2010). Because the age profile of women giving birth varied by region (Tromans et al, 2008), Figure 4.7 also shows the age-standardised HMR[20] for each GOR. This shows that the regional variations were not due to differences in age profile.

Figure 4.7: Age-standardised home maternity ratio, by GOR, England, 2006



Source: ONS (2008a); age-standardised figures calculated by the author.

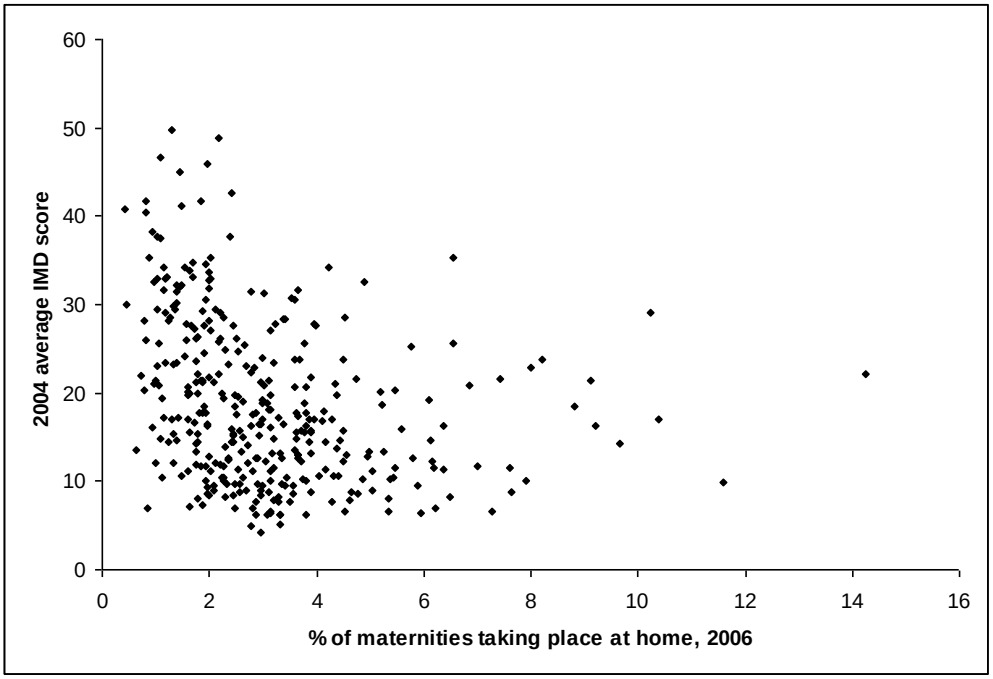
Even within GORs, there was a high level of variation at local authority (LA) level in 2006 (Nove et al, 2008), indicating that local factors had a strong association with the HMR. A special tabulation provided by ONS showed that in 2006, five local authority (LA) areas in England and Wales had HMRs above 10%: West Somerset (14.2%), Mid Suffolk (11.6%), Powys (10.7%), Teignbridge (10.4%) and Penwith (10.2%). Nineteen LAs had ratios below 1%, with the lowest in: Middlesbrough (0.4%), Blyth Valley (0.4%) and Wirral (0.5%).

[20] For each GOR, the age-specific HMR was calculated for each of six age groups (<20, 20-24, 25-29, 30-34, 35-39, 40+). From these, the number of home maternities that would have been expected in that GOR was calculated, had women giving birth in that GOR had the same age profile as women giving birth in England & Wales as a whole. The expected number of home maternities was divided by the total number of women giving birth in England & Wales, then multiplied by 100 to indicate the percentage of home maternities that would have occurred in that GOR if women giving birth in the GOR had had the same age profile as England & Wales as a whole.

It would have been interesting to age/parity-standardise the LA-level HMRs, but, this could not be done because the numbers of home maternities in some LAs were very small and ONS disclosure rules prevented it from providing the data. However, the age-standardisation of the regional figures (see Figure 4.7) showed that differences in age profile had little influence over home birth ratios at regional level, so it seems unlikely that they would explain all of the variation at LA level.

Middle-class women tend to have a higher HMR (see Section 2.3), so it is possible the LA-level variation was due to differing socio-economic profiles. If so, there would be a strong correlation between an LA's HMR and its level of deprivation. Figure 4.8 plots the 2006 HMR against the 2004 Index of Multiple Deprivation average score (Department of Communities and Local Government, 2007) for 343 of the 346 LAs in England[21], and shows that there was a weak negative correlation (correlation coefficient -0.3), i.e. variations in the level of deprivation may explain some of the LA-level variation in the HMR. The fact that the correlation is not stronger may be due in part to some LAs containing areas of both high and low deprivation, but it may also be due to local variations in ease of access to a home maternity service.

Figure 4.8: 2006 home maternity ratios against 2004 average Index of Multiple Deprivation (IMD) score, LAs in England



Source: Nove et al (2008).

Analysis of the 2006 HMRs in the most and least deprived LAs in England confirms that there was an aggregate link between deprivation and home maternity; Nove et al (2008) noted that the median HMR in the 20 most deprived LAs in England was 1.4%, compared with 3.1% in the 20 least

[21] Two of the other three (City of London and Alnwick) recorded fewer than three home maternities in 2006 and therefore their figures could not be provided under ONS disclosure rules. The other (Isles of Scilly) recorded 4 home maternities out of a total of only 20 maternities, which would have skewed the figures if included.

deprived LAs. However, this analysis also revealed some notable exceptions to this general rule (e.g. Southwark, which was the 17th most deprived LA in England in 2004, but had a 2006 HMR of 6.6%, i.e. about three times the national average). These exceptions suggest that factors other than deprivation can have a stronger influence on the local HMR, and perhaps that the observed bias towards middle-class women giving birth at home may become less pronounced if home birth were to become more easily accessible.

Healthcare Commission data

The 2007 Healthcare Commission study found wide variations at NHS trust level in the age- and parity-standardised HMRs (see Section 3.1.3 for details), and found that two trusts recorded exceptionally high HMRs: South Devon Healthcare and King's College Hospital. At the other end of the scale, 22 trusts[22] recorded standardised HMRs of zero. It is likely that the high HMR in King's College Trust was partly responsible for Southwark's high HMR (see previous section). At South Devon and King's College, active steps had been taken to promote home birth as a safe and realistic option (Leyshon, 2004; Sandall et al, 2001a). Neither trust operated in an especially affluent area.

SMMIS data

Within the North West Thames RHA area as a whole, there was variation according to which maternity unit was responsible for the woman's maternity care. Figure 4.9 shows that neither the planned HMR nor the unplanned HMR was constant across maternity units, but that there was more variation in the *planned* HMR.

The planned HMR was relatively high among women receiving care from the Hemel Hempstead, West Middlesex and Welwyn Garden City units (2.8%, 2.3% and 2.0% respectively), and relatively low among women receiving care from the Watford and Northwick Park units (both 0.4%). The unplanned HMR was relatively high among women receiving care from the Bedford and Stevenage units (0.9% and 0.8% respectively, compared with 0.5% across the region as a whole, and just 0.3% at Northwick Park).

Place of birth is associated with deprivation (see Section 4.4.9), so it is possible that these hospital-level variations were a function of variation in the socio-economic profile of the women using the different hospitals. The line in Figure 4.9 shows the percentage of women receiving care from each hospital who lived in the two least deprived quintiles according to the Carstairs deprivation index[23].

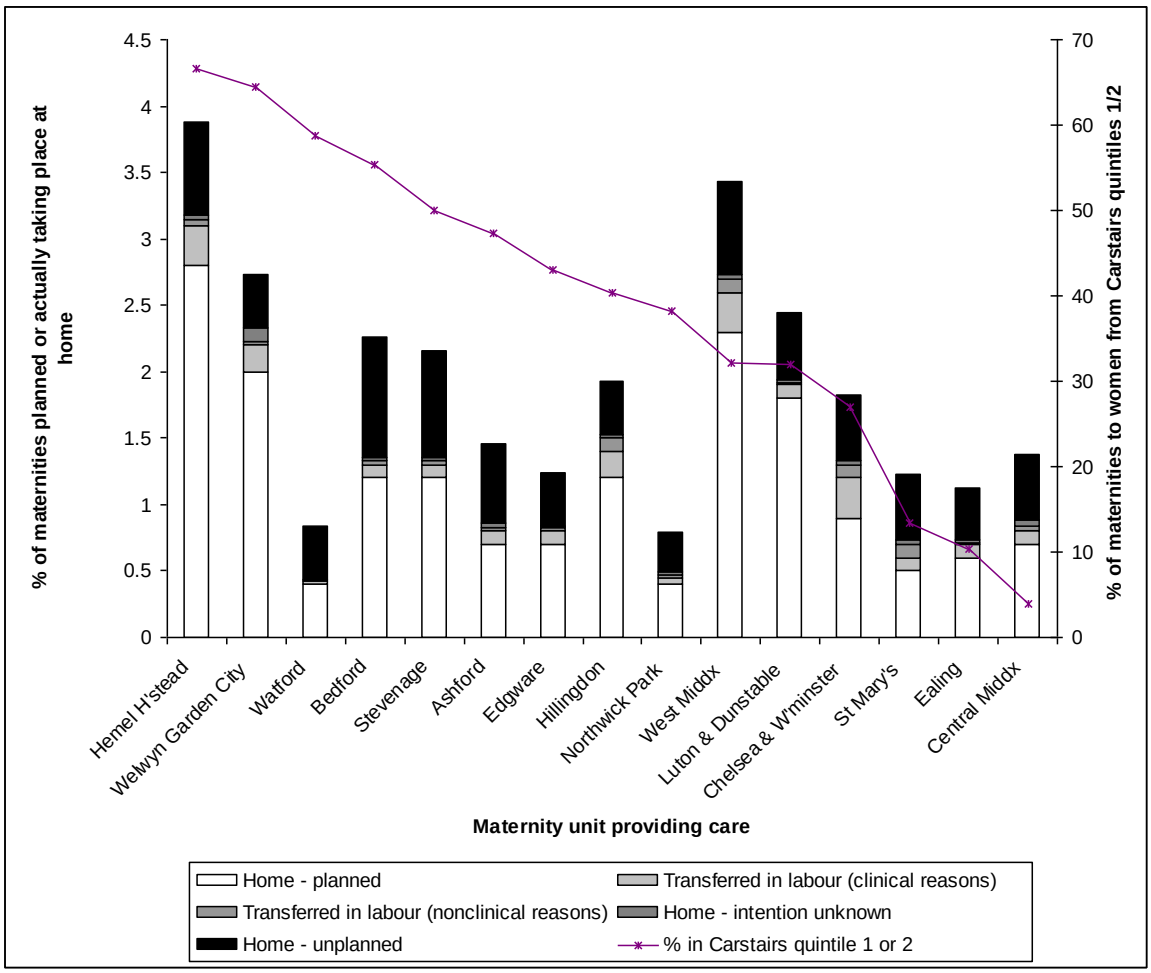
---

[22] Barnsley Hospital, Central Manchester & Manchester Children's University Hospital, City Hospitals Sunderland, East Cheshire, East Lancashire Hospitals, Epsom & St Helier University Hospitals, Gateshead Health, Hammersmith Hospitals, Heart of England, Mid Staffordshire General Hospitals, Mid Yorkshire Hospitals, North Cheshire Hospitals, North Middlesex University Hospital, Nottingham University Hospitals, Sandwell & West Birmingham Hospitals, St George's Healthcare, Tameside & Glossop Acute Services, The Newcastle upon Tyne Hospitals, University Hospitals of Morecambe Bay, Walsall Hospitals, Whipps Cross University Hospital and Wrightington, Wigan & Leigh

[23] The Carstairs Deprivation Index (Carstairs & Morris, 1991) is a summary measure of relative deprivation. Localities were allocated to deprivation categories according to a combination of socio-economic variables (e.g. car ownership, male unemployment, housing overcrowding). This was the only measure of deprivation

This chart clearly indicates that hospital-level variations cannot be explained fully by variations in the socio-economic profile of the women using the different hospitals, because some hospitals serving more affluent areas had a relatively low planned HMR (e.g. Watford) and some hospitals serving relatively deprived areas had a relatively high planned HMR (e.g. West Middlesex).

Figure 4.9: Intended/actual place of birth and percentage of women living in areas classed as Carstairs quintile 1 or 2, by maternity unit providing care, North West Thames RHA area, 1988-2000[24]



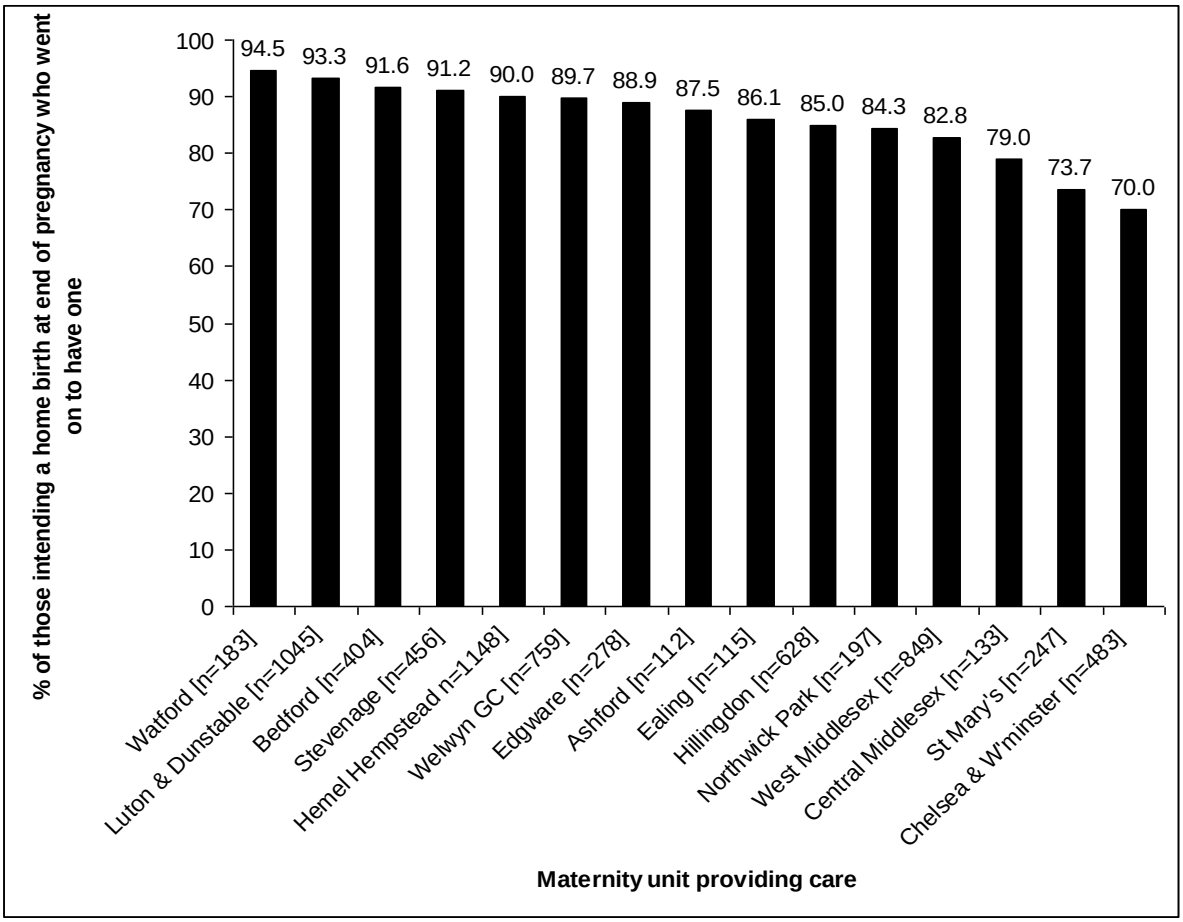
Source: SMMIS. P = 0.000.

Overall, 86.9% of those who intended a home birth at the end of pregnancy went on to have one. Figure 4.10 shows that this figure varied widely according to the hospital providing maternity care, from 94.5% at Watford to 70.0% at the Chelsea & Westminster.

recorded on the database, and the fact that the database was anonymised meant that we could not append other measures based on, for example, the mother's postcode.

[24] The Ashford, Ealing and Central Middlesex units did not provide data for all 13 years (see Table 3.2), so the figures for these units are based on the years for which they did provide data. Because the HMR varied over time (see Section 4.2.1), this affects the degree to which these three units can be compared with the others.

Figure 4.10: Percentage of those intending a home birth at the end of pregnancy who had a home birth, by maternity unit providing care, North West Thames RHA area, 1988-2000



Source: SMMIS. P=0.000.

4.2.3 Distance from home to hospital

GUS data

Women having planned home births in Scotland in 2004/5 were less likely than those having hospital births to live in large urban areas (27.6% of women having planned home births did, compared with 39.4% of women having hospital births). They were more likely to live in small accessible towns or accessible rural areas[25] (34.5% compared with 22.0%), which suggests that the urban/rural variation may have had more to do with social class than with the area of residence *per se*. In a qualitative study, Pitchforth et al (2007) found that women in remote parts of Scotland tended to prefer hospital delivery because of the length of the journey to hospital should emergency care be required. The GUS data did not support this conclusion; 6.9% of women having planned home births and the same proportion of women having hospital births lived in remote towns or

[25] The survey used the Scottish Executive Urban Rural Classification, which defined settlements of 3,000 or fewer people as 'rural', and used drive times from settlements of 10,000 or more people to define 'remote'. See Scottish Executive (2004) for more details.

remote rural areas. Furthermore, 15% of women in the 'other' category were from remote areas. However, the numbers involved are small; just 2 women having planned home births and 6 women in the 'other' category lived in remote areas.

4.3 Descriptive analysis: characteristics of the pregnancy

4.3.1 Pregnancy risk status

Statements about the safety of home birth nearly always include the caveat 'for low-risk pregnancies'. Decisions about place of birth are therefore likely to be influenced by the risk status of an individual pregnancy, and any analysis of the profile of women giving birth in different environments should take into account risk status.

SMMIS data

SMMIS did not record the risk status of the pregnancy, perhaps because at the time there was no nationally-agreed definition of the term (Campbell, 1999). It did, however, record relevant medical and obstetric conditions that were noted or diagnosed during pregnancy/labour. Some conditions were recorded in their own specific field, but most were recorded using International Classification of Diseases (ICD) codes (World Health Organisation, 1992). This information was used to derive a risk status for each record (see Appendix C).

SMMIS had separate fields for conditions that were recorded during the antenatal period and those recorded during labour/delivery. For the analysis of women's intentions, only conditions recorded during the antenatal period were considered, since only they would have influenced decisions about intended place of birth. For the analysis of whether or not a planned home birth was achieved, conditions occurring during labour/delivery were also considered.

4.3.1.1 Pre-pregnancy risk status/risk status at end of pregnancy

The derivation of risk status was based on the 2007 NICE guideline (National Collaborating Centre for Women's and Children's Health (NCCWCH), 2007), which contained lists of medical and obstetric conditions which indicate increased risk of negative outcomes to a pregnancy. Some were listed as "suggesting planned birth at an obstetric unit" and some as "indicating individual assessment when planning place of birth". For this analysis, pregnancies with conditions in the former list were classed as 'high-risk', and those with conditions in the latter list as 'medium-risk'. All other pregnancies were classed as 'low-risk'.

Tables 4.5 and 4.6 list conditions leading to a pregnancy being classed as high- or medium-risk respectively. Those which would usually have been evident at the booking appointment are in green type, and those which would usually have arisen after the booking appointment are in red. This

distinction was made so the statistical modelling could take into account factors that may influence decisions at different stages of pregnancy.

Table 4.5: Conditions "suggesting planned birth at obstetric unit" (high-risk)

Cardiovascular	Confirmed cardiac disease; Hypertensive disorders
Respiratory	Asthma requiring an increase in treatment or hospital treatment[26]; Cystic fibrosis
Haematological	Haemoglobinopathies (sickle-cell disease, beta-thalassaemia major); History of thromboembolic disorders; Immune thrombocytopenia purpura or other platelet disorder or platelet count below 100,000; Von Willebrand's disease; Bleeding disorder in the woman or unborn baby; Atypical antibodies which carry a risk of haemolytic disease of the newborn
Infective	Risk factors associated with group B streptococcus whereby antibiotics in labour would be recommended; Hepatitis B/C with abnormal liver function tests; Carrier of/infected with HIV; Toxoplasmosis (women receiving treatment); Current active infection of chicken pox/rubella/genital herpes in the woman or baby; Tuberculosis under treatment
Immune	Systemic lupus erythematosus; Scleroderma
Endocrine	Hyperthyroidism; Diabetes
Renal	Abnormal renal function; Renal disease requiring supervision by renal specialist[27]
Neurological	Epilepsy; Myasthenia gravis; Previous cerebrovascular accident
Gastrointestinal	Liver disease associated with current abnormal liver function tests
Psychiatric	Psychiatric disorder requiring current inpatient care
Previous obstetric complications	Unexplained stillbirth/neonatal death or previous death related to intrapartum difficulty; Previous baby with neonatal encephalopathy; Pre-eclampsia requiring preterm birth; Placental abruption with adverse outcome; Eclampsia; Uterine rupture; Primary postpartum haemorrhage requiring additional treatment or blood transfusion; Retained placenta requiring manual removal in theatre; Caesarean section; Shoulder dystocia
Current pregnancy	Multiple birth; Placenta praevia; Pre-eclampsia or pregnancy-induced hypertension; Preterm labour or preterm prelabour rupture of membranes; Placental abruption; Anaemia (haemoglobin less than 8.5 g/dl at onset of labour[28]; Confirmed intrauterine death; Induction of labour[29]; Substance misuse; alcohol dependency requiring assessment or treatment; Onset of gestational diabetes; Malpresentation (breech or transverse lie); Body mass index at booking of greater than 35 kg/m^2; Recurrent antepartum haemorrhage[30]
Foetal indications	Small for gestational age (less than 5th centile or reduced growth velocity on ultrasound); Abnormal foetal heart rate (FHR)/Doppler studies; Ultrasound diagnosis of oligo-/polyhydramnios
Previous gynaecological history	Myomectomy; Hysterectomy

Source: NCCWCH, 2007.

[26] SMMIS did not record whether or not the asthma required an increase in treatment or hospital treatment, so all women with asthma were classed as high-risk.
[27] SMMIS did not record whether or not a specialist was involved, so all women with renal disease were classed as high-risk.
[28] SMMIS did not record the haemoglobin level at labour onset, so any women whose lowest haemoglobin level recorded in pregnancy was below 8.5 g/dl was classed as high-risk.
[29] SMMIS recorded the method of induction used; those induced using artificial rupture of membranes only were not classed as high-risk.
[30] SMMIS did not record whether or not bleeding was recurrent, so any woman recorded as experiencing bleeding after 16 weeks of gestation was classed as high-risk.

Table 4.6 lists the conditions leading to a pregnancy being classed as medium-risk (assuming no high-risk factors were present). Again, those which would usually have been evident at the booking appointment are in green type, and those which would usually have arisen after the booking appointment are in red.

Table 4.6: Conditions "indicating individual assessment when planning place of birth" (medium-risk)

Cardiovascular	Cardiac disease without intrapartum implications[31]
Haematological	Atypical antibodies not putting the baby at risk of haemolytic disease[32]; Sickle-cell trait; Thalassaemia trait; Anaemia (haemoglobin 8.5-10.5 g/dl at onset of labour)
Infective	Hepatitis B/C with normal liver function tests[33]
Immune	Non-specific connective tissue disorders
Endocrine	Unstable hypothyroidism such that a change in treatment is required
Skeletal/neurological	Spinal abnormalities; Previous fractured pelvis; Neurological deficits
Gastrointestinal	Liver disease without abnormal liver function[34]; Crohn's disease; Ulcerative colitis
Previous complications	Stillbirth/neonatal death with a known non-recurrent cause[35]; Pre-eclampsia developing at term; Placental abruption with good outcome; History of previous baby more than 4.5kg[36]; Extensive vaginal, cervical, or 3rd- or 4th-degree perineal trauma; Previous term baby with jaundice requiring exchange transfusion
Current pregnancy	Antepartum bleeding of unknown origin (single episode after 24 weeks of gestation)[37]; Body mass index at booking of 30-34 kg/m^2; Blood pressure of 140mmHg systolic or 90 mmHg diastolic on two occasions[38]; Clinical or ultrasound suspicion of macrosomia; Para 6 or more; Recreational drug use; Under current outpatient psychiatric care[39]; Age over 40 at booking
Foetal indications	Foetal abnormality
Previous gynaecological history	Major gynaecological surgery; Cone biopsy or large loop excision of the transformation zone; Fibroids

Source: NCCWCH, 2007.

Although most relevant conditions were captured in the SMMIS database, some conditions that would have resulted in a high- or medium-risk classification were not, and these are listed in Table

[31] SMMIS did not record whether or not there would be intrapartum implications, so all women with cardiac disease were classed as high-risk.
[32] SMMIS did not record whether or not the baby would have been at risk of haemolytic disease, so all women with atypical antibodies were classed as high-risk.
[33] SMMIS did not record whether or not the liver function tests were normal, so all women with hepatitis B/C were classed as high-risk.
[34] SMMIS did not record whether or not the liver function tests were normal, so all women with liver disease were classed as high-risk.
[35] SMMIS did not record the cause of previous stillbirths/neonatal deaths, so any woman who had experienced one was classed as high-risk.
[36] SMMIS recorded the birthweight of the most recent baby only, so if a woman had had more than one previous baby this information will not have been recorded and she may have been misclassified.
[37] SMMIS did not record whether or not bleeding was recurrent, so any woman recorded as experiencing bleeding after 16 weeks of gestation was classed as high-risk
[38] SMMIS did not record the number of occasions, so the woman's highest blood pressure in pregnancy was used to derive this measure.
[39] SMMIS did not record the type of care required, so all women with psychiatric disorders were classed as high-risk.

4.7. Women with these conditions may therefore have been misclassified in terms of their risk status. Most of them relate to the woman's obstetric history, so will apply only to multiparae.

Table 4.7: High- and medium-risk conditions not captured by SMMIS

	High-risk	Medium-risk
Immune		Non-specific connective tissue disorders
Previous complications	Previous baby with neonatal encephalopathy; Pre-eclampsia requiring preterm birth; Placental abruption with adverse outcome; Eclampsia; Uterine rupture	Pre-eclampsia developing at term; Placental abruption with good outcome; Previous term baby with jaundice requiring exchange transfusion
Current pregnancy		Recreational drug use
Previous gynaecological history	Myomectomy	Major gynaecological surgery; Cone biopsy or large loop excision of the transformation zone

As demonstrated by the footnotes to Tables 4.5 and 4.6, if there was doubt over which risk category to use because clinical judgement was required, the woman was classed in the higher risk category. Therefore, some pregnancies will have been classed as higher risk than they actually were. On the other hand, the fact that some conditions were not coded (see Table 4.7) and the likelihood that some women were probably classed as low-risk simply because they did not engage fully with maternity services (and therefore did not have their ICD codes recorded) means that other pregnancies will have been classed as lower risk than they actually were.

Taking into account conditions that would have been evident before labour commenced, 43% of the SMMIS records were classed as 'high-risk', 15% as 'medium-risk' and 42% as 'low-risk'. Taking into account just conditions that would usually have been evident before conception, 14% of pregnancies were 'high-risk' at booking, 8% were 'medium-risk' and 78% 'low-risk'. Therefore, most of those classed as 'high-risk' would have been so classified later on in pregnancy rather than at booking.

In the Netherlands, about 70% of deliveries are attended by midwives (Borquez & Wiegers, 2006), which implies that, at most, 30% are classed as 'high-risk' antenatally. Therefore, women in the SMMIS database were more likely than women in the Netherlands to be classed as having a 'high-risk' pregnancy. This is mainly due to the two countries having different systems for classifying risk, specifically to the fact that the UK definition includes women who have induction of labour, whereas the Dutch definition does not. If induction of labour is excluded from the definition of 'high-risk', the percentage of pregnancies in the SMMIS dataset classed as 'high-risk' falls from 43% to 33%, i.e. far closer to the Dutch figure. It may also be partly due to UK women actually being more likely to have high-risk pregnancies (e.g. the UK Caesarean rate has traditionally been higher than the Dutch rate (Parliamentary Office of Science and Technology, 2002), so UK women will be more likely to be

classed as high-risk because of a previous Caesarean), and to SMMIS containing a relatively high proportion of older mothers and ethnic minority groups, who are more likely to be classed as 'high-risk'.

As noted in Section 2.2, the NICE guideline is not evidence-based. The equivalent Dutch guideline (Obstetric Working Group of the National Health Insurance Board of the Netherlands, 2000) was considered as an alternative for use in this analysis. It does have some advantages over the NICE one, e.g. it was in existence throughout the time period in question, and it contains more specific definitions of some conditions (e.g. hypertension and anaemia). However, it was decided to use the NICE guideline because some of the assumptions made by the Dutch guideline (e.g. that all midwives attending home births have the requisite skills/competence) may not have applied in the UK, and the Dutch guideline does not appear to be evidence-based either.

In SMMIS, risk status had a bivariate association with: age (younger women were less likely to be classed as high-risk); parity (lower parity women were less likely to be classed as high-risk); ethnicity (black women were more likely than those from other ethnic groups to be classed as having a high-risk pregnancy); deprivation (women from more deprived areas were slightly more likely to be classed as high-risk); maternity unit (St Mary's and West Middlesex recorded the highest proportion of high- or medium-risk pregnancies (both 63%, compared with 58% overall), and Ashford the lowest (50%). The West Middlesex and Ealing units had the highest proportions of high-risk pregnancies (both 48%, compared with 43% overall)); year (the proportion of pregnancies classed as high-risk increased steadily between 1988 and 1994, then fell between 1994 and 1995 and fluctuated slightly thereafter. Between 1995 and 1998, the lower proportion of 'high-risk' pregnancies was accompanied by a higher proportion of 'medium-risk' pregnancies, such that the total proportion of 'high- or medium-risk' pregnancies continued to rise slowly[40]); and place of birth (both planned and unplanned home births were more common for medium- and low-risk pregnancies than for high-risk pregnancies (p=0.000 for both planned and unplanned home births).

Given that these data were collected in the late 1980s and 1990s (i.e. a time when home birth was not generally encouraged in the UK), it is perhaps surprising that 11% of planned home maternities (n=658) were to 'high-risk' women. This may be a function of the fact that official risk classification guidance did not exist at the time. Women having 'high-risk' planned home births are included in the analysis of the safety of home birth in Chapters 6 and 7.

[40] Nationally, the Caesarean section (CS) rate climbed steadily between 1988 and 2000 (Health and Social Care Information Centre, 2009). Assuming the same pattern was evident in the North West Thames RHA area, factors other than the CS rate must have led to the reduction in the proportion of pregnancies classed as 'high-risk' after 1994.

4.3.1.2 Development of complications in labour

The UK risk classification guideline lists a number of "indications for intrapartum transfer", i.e. situations in which, if they arise during labour at home, the mother should consider transferring to hospital. These are listed in Table 4.8.

Table 4.8: Complications which indicate a transfer from home to hospital during labour[41] should be considered, and how these were coded in SMMIS

Complication	How dealt with in SMMIS
Indications for electronic foetal monitoring including abnormalities of the foetal heart rate (FHR)	Coded as having abnormal FHR reading in the relevant SMMIS field or ICD coded as such
Delay in the first or second stages of labour*	ICD coded as 'failure to progress'
Significant meconium-stained liquor	Coded as having meconium-stained liquor in the relevant SMMIS field or ICD coded as such
Obstetric emergency – antepartum haemorrhage, cord presentation/prolapse, maternal collapse	Cord prolapse: coded as having experience prolapse in the relevant SMMIS field or ICD coded as such Intrapartum stillbirth, antepartum haemorrhage, placental abruption were all coded from ICD codes.
Maternal pyrexia in labour (38.0°C once or 37.5°C on two occasions 2 hours apart)	Coded as having pyrexia in the relevant SMMIS field or ICD coded as such
Malpresentation or breech presentation diagnosed for the first time at the onset of labour	ICD coded as 'abnormal presentation' diagnosed during labour
Either raised diastolic blood pressure (over 90 mmHg) or raised systolic blood pressure (over 140 mmHg) on two consecutive readings taken 30 minutes apart	ICD coded as having pregnancy-induced hypertension during labour
Uncertainty about the presence of a foetal heartbeat	Not included because this information was not recorded in SMMIS.
Maternal request for epidural pain relief	Not included in definition because this information was not recorded in SMMIS. We know which women had an epidural, but not whether this was due to their own request.

Source: NCCWCH (2007)
* The guideline did not indicate how 'delay' should be defined. Therefore, although SMMIS recorded the length of the first and second stages of labour, only those who were coded as experiencing 'failure to progress' were included in the definition of developing complications in labour. Duration of labour was analysed separately (see Section 4.3.2). The Dutch guideline defines failure to progress in stage 1 as "if the contractions are strong and frequent but there is no change in the cervix or progress in dilation after the latent phase for a period of 4 hours", and in stage 2 as "lack of progress, after a maximum of one hour, in cases with full dilation, ruptured membranes, strong contractions and sufficient maternal effort".

[41] The guideline also included 'postpartum haemorrhage', 'retained placenta' and 'third- or fourth-degree tear', but because these would not become apparent until after the birth, they have not been included in this analysis.

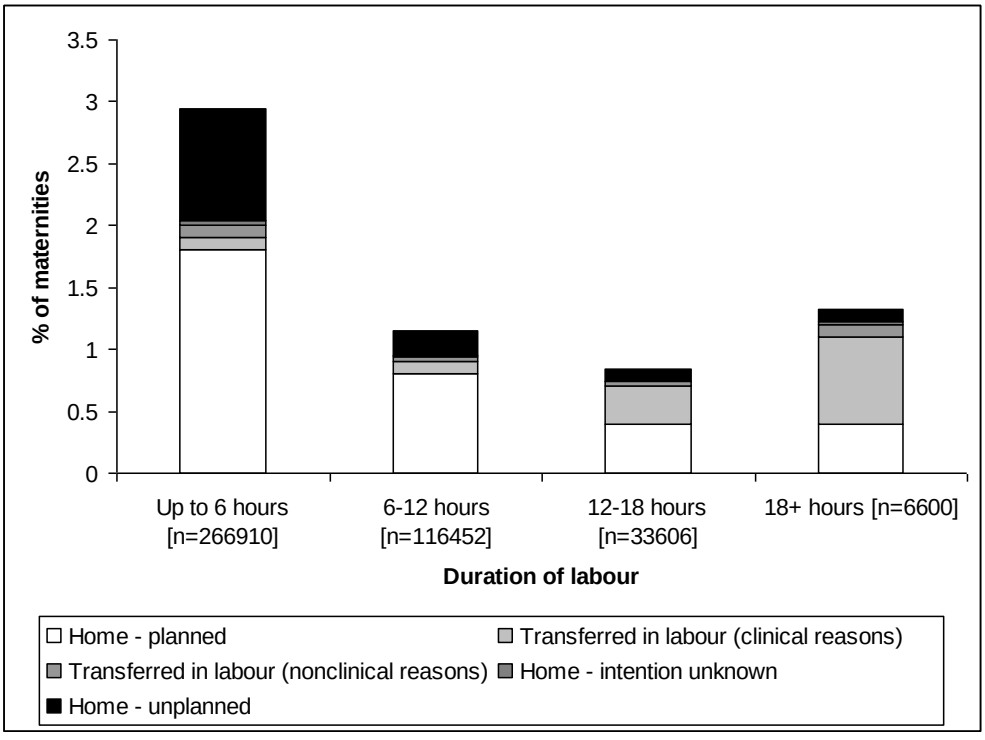
Under this system, 34.8% of SMMIS pregnancies were classed as developing complications during labour (16.8% of those who intended a home birth at the end of pregnancy and 35.2% of those having planned hospital births). Among those who intended a home birth at the end of pregnancy, those who developed labour complications were more likely to be transferred to hospital (37.2% were, compared with just 8.2% of those who did not develop such conditions). This does, however, mean that even among those developing complications, the majority went on to deliver at home.

4.3.2 Duration of labour

SMMIS data

Figure 4.11 shows that the unplanned HMR was highest among women who had labours lasting up to 6 hours (91% of unplanned home births were to women in this group). The planned HMR was lower among those having longer labours (12+ hours), and those with longer labours were far more likely to be transferred from home to hospital during labour. These results suggest that duration of labour was a strong predictor of a woman's likelihood of achieving a planned home birth.

Figure 4.11: Actual/intended place of birth, by duration of labour, North West Thames RHA area, 1988-2000



Source: SMMIS. P = 0.000.

4.3.3 Pain relief used in labour

SMMIS data

Ideally, it would have been useful to establish whether women who had certain types of pain relief at home were more likely to be transferred to hospital during labour. SMMIS recorded the types of pain relief separately for labour and delivery. The data show a strong association (p=0.000) between type of pain relief used during labour and likelihood of being transferred to hospital (just 6% of those who started labour at home and had no pain relief were transferred, compared with 38% of those who started labour at home and had pethidine). Unfortunately, SMMIS did not record *when* the pain relief was given. If the woman started her labour at home, the pain relief could have been administered either at home or after arrival at hospital. It would therefore be impossible to judge whether the use of certain types of pain relief were more likely to result in transfer to hospital. For this reason, pain relief was not included in the modelling process.

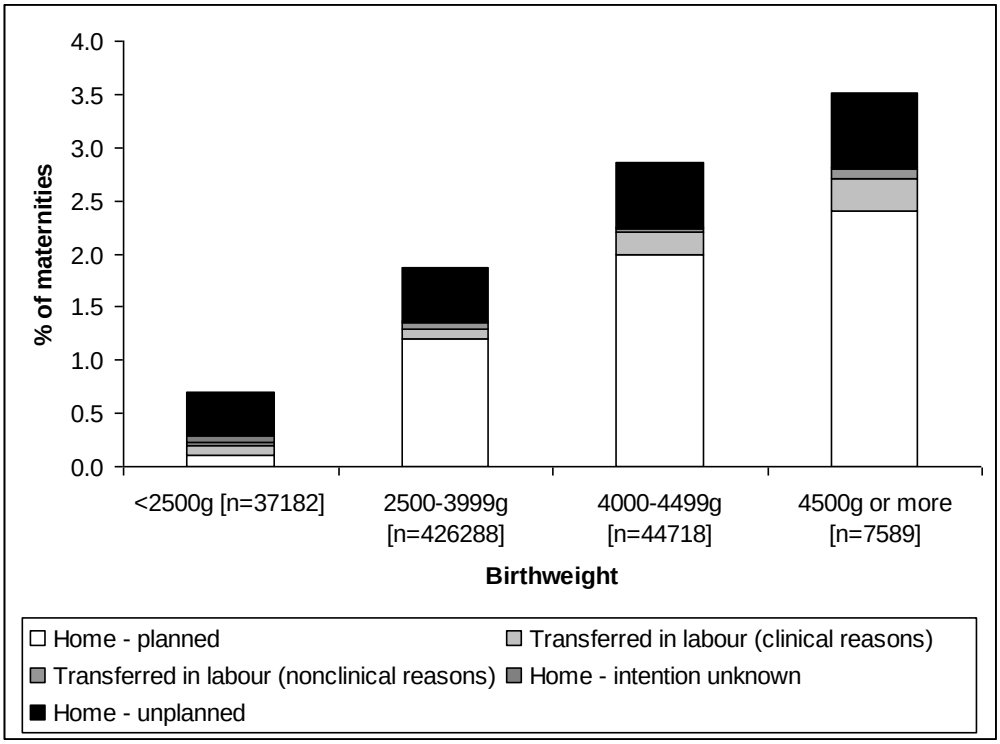
Among those intending a home birth at the end of pregnancy, those who used a birth pool were just as likely as those who did not to be transferred to hospital during labour. Again, SMMIS did not record whether the pool was used at home or after transfer to hospital, but in this case it seems reasonable to assume that it was used at home, because after intrapartum transfer to hospital a woman is unlikely to use a birth pool.

4.3.4 Size of foetus

SMMIS data

Anecdotal evidence suggests that women who are predicted to be carrying an unusually small or large baby can be advised not to attempt a home birth (Davies, 2004; Horn, 2010), despite the fact that attempts to predict the weight of a baby before it is born are notoriously unreliable and tend to over-estimate the actual birthweight (Confidential Enquiry into Stillbirths and Deaths in Infancy, 1999). Figure 4.12 shows that, the heavier the baby, the more likely the mother was to intend/have a home birth. The anecdotal evidence mentioned above would lead one to expect the planned home maternity ratio to be lower for very heavy babies, so it is perhaps surprising that the planned home maternity ratio for those weighing 4,500g (c.10lb) or more was as high as it was.

Figure 4.12: Actual/intended place of birth, by birthweight, North West Thames RHA area, 1988-2000



Source: SMMIS. P = 0.000.

4.3.5 Amount of medical attention received

SMMIS data

Women having home births – whether planned or unplanned - tended to have fewer ultrasound (US) scans than women giving birth in hospital (p=0.000). Similarly, women having planned home births tended to make relatively few visits to an antenatal clinic (p=0.000); indeed, 34.9% made none at all, compared with just 3.3% of women having planned hospital births. It is likely that women planning to give birth at home had some or all of their antenatal check-ups at home, so this may at least partly explain why they recorded fewer clinic visits, since home visits were probably not captured on the database (Steer, 2008b). There was a positive correlation between the number of ultrasound scans and the number of antenatal clinic visits (correlation coefficient = 0.342).

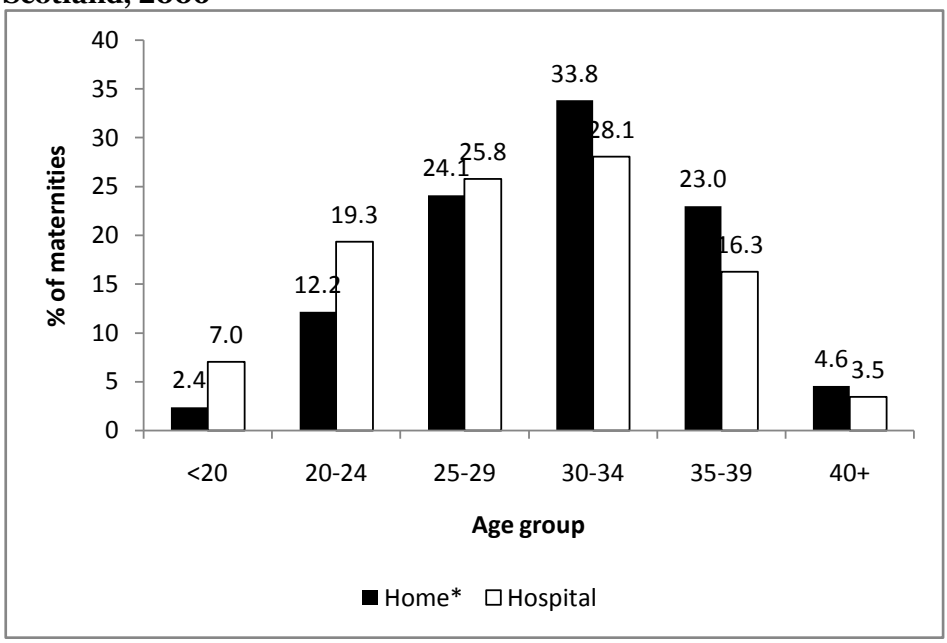
4.4 Descriptive analysis: mother's characteristics

4.4.1 Age at delivery

Birth registration data

Figure 4.13 combines the 2006 birth registration data from England, Wales and Scotland[42], and shows that women giving birth at home had an older age profile than women giving birth in hospital. The difference between the home and hospital birthing groups is, however, smallest in the 40 and over age group. This may be an indication of women of this age being more likely to have high-risk pregnancies.

Figure 4.13: Age profile of women giving birth, by place of birth, England, Wales & Scotland, 2006



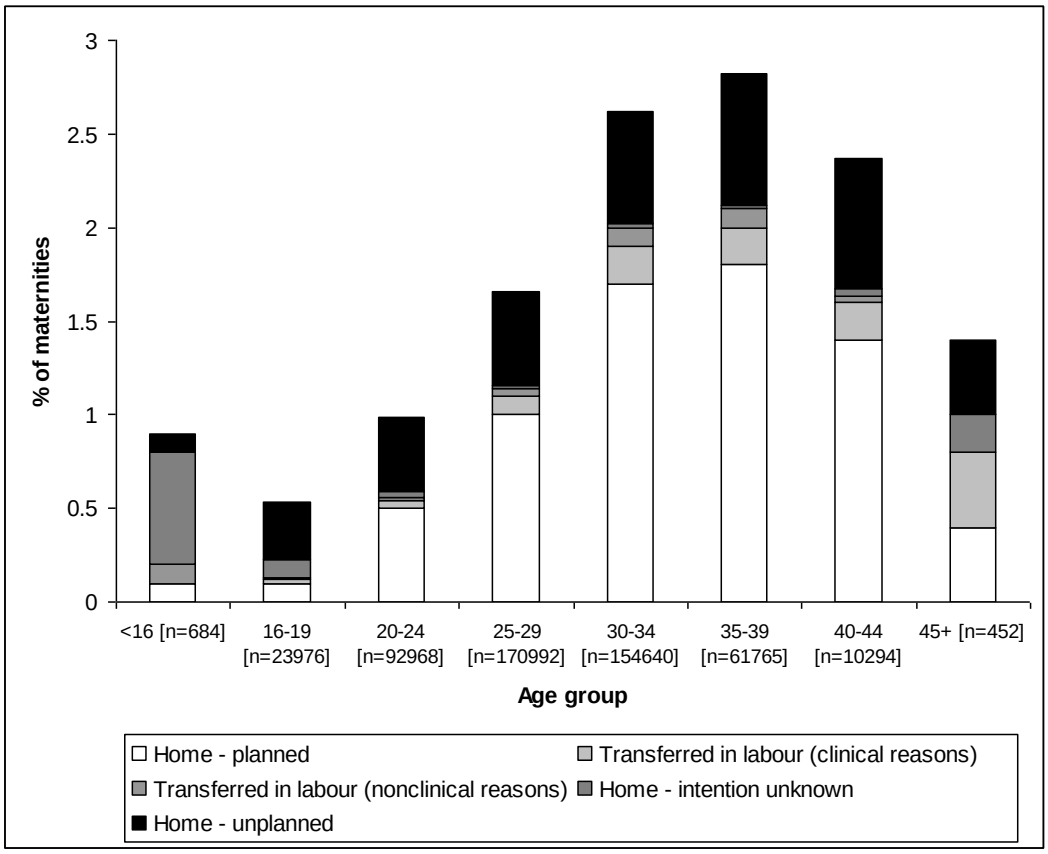
Source: ONS (2008a) / GRO-Scotland. * The Scottish 'home' figures include all out-of-hospital births.

SMMIS data

The SMMIS dataset allows the general pattern evident from birth registration data to be 'unpacked' in more detail, because it has more detailed age bands, and it allows separate age profiling of women having planned and unplanned home births. Figure 4.14 shows that *both* planned and unplanned home births were more common in each successive age group until the age of 40, then less common in the older age groups, but the pattern was more marked for planned home birth. It also shows that women aged 30+ were more likely to be transferred from home to hospital during labour.

[42] There were only 101 out-of-hospital births in Northern Ireland in 2006; disclosure rules prevented NISRA from providing an age breakdown.

Figure 4.14: Intended/actual place of birth, by mother's age at delivery, North West Thames RHA area, 1988-2000

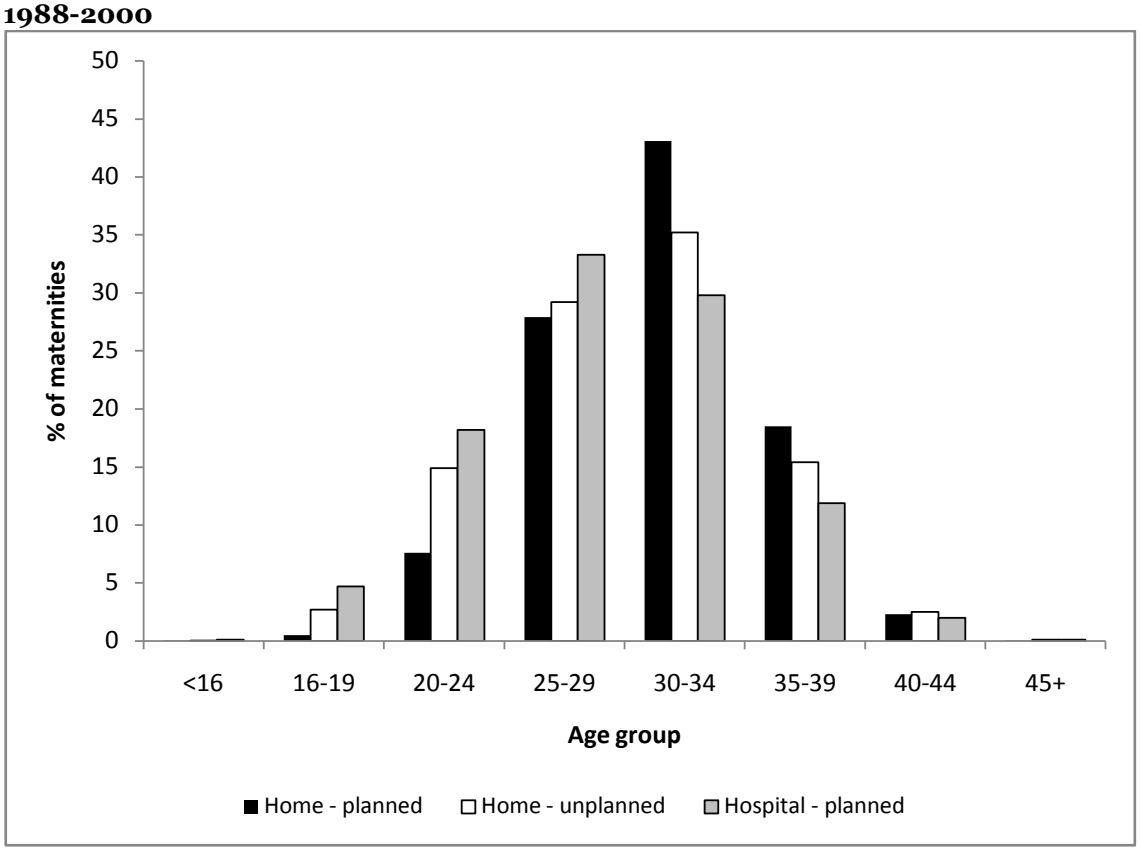


Source: SMMIS. P=0.000.

Note: just 4 under-16s gave birth at home without their intention regarding place of birth being recorded, so the size of the 'home – intention unknown' section in the '<16' bar is not as alarming as it might first appear.

A 2006 survey across England by Redshaw et al (2007) found that women having unplanned home births tended to be younger than women giving birth in hospital, and the GUS data showed a similar pattern (see below). The SMMIS data, however, exhibited a different pattern. Figure 4.15 shows that women in the SMMIS database who had unplanned home births tended to be younger than those having planned home births, but older than those having planned hospital births. This may be due to the age profile of women giving birth in the NW Thames area being atypical (Tromans et al, 2008), but it may also be due to SMMIS having less response bias than the two surveys.

Figure 4.15: Place of birth by mother's age at delivery, North West Thames RHA area, 1988-2000



Source: SMMIS. P = 0.000.

GUS data

In terms of the age profile of women having planned home births, the GUS data supported the SMMIS data, i.e. they tended to be older. Like Redshaw et al (2007), however, the GUS sample suggested that women having unplanned home births tended to be younger than women having hospital births.

4.4.2 Parity

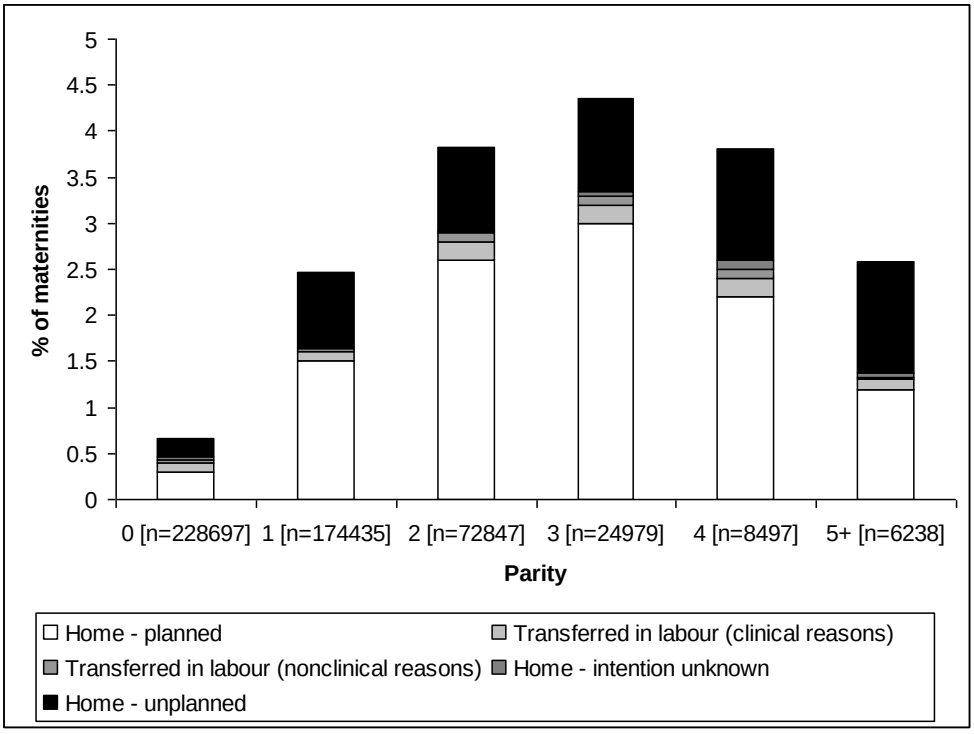
Birth registration data

Birth registration data only record a mother's parity if she is currently married to the father of the baby, and even among those women, only previous children born within wedlock are counted (see Table 3.1). The data do suggest that multiparae were more likely than primiparae to give birth at home (Nove et al, 2008), but given that in 2006, just 56.4% of maternities occurred within marriage (Office for National Statistics, 2008a), it would be dangerous to conclude too much from birth registration data about the relationship between parity and place of birth.

SMMIS data

Figure 4.16 confirms that home maternity, whether planned or unplanned, was rare among primiparae in the North West Thames RHA area. Among multiparae, the unplanned home maternity ratio was relatively static across the parity groups, but it did grow slightly in line with parity. The planned home maternity ratio, on the other hand, was higher for each subsequent parity group until parity 3 (i.e. 4th baby), then became smaller among women having their fifth or subsequent child.

Figure 4.16: Intended/actual place of birth by parity, North West Thames RHA area, 1988-2000



Source: SMMIS. P = 0.000.

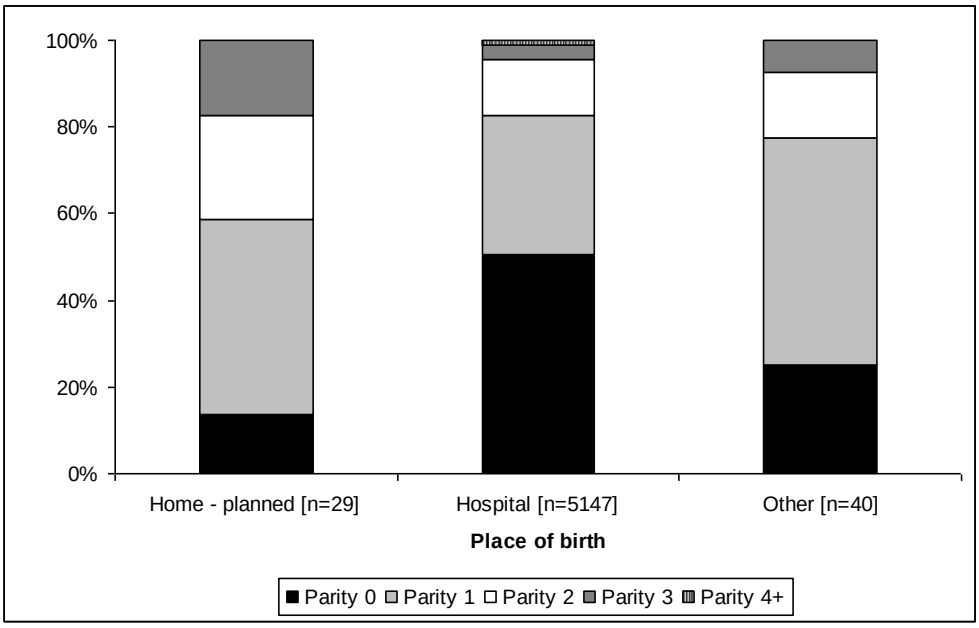
Age and parity were positively correlated (correlation coefficient = 0.32). Women of parity 4 or more are often labelled 'grand multiparae', although different studies use different definitions of the term. Traditionally, grand multiparae have been considered to be at greater risk of a number of different complications, although recent research using the SMMIS database (Bugg et al, 2002) concluded that grand multiparity *per se* did not entail higher risk, and current guidelines in the UK and the Netherlands do not consider grand multiparity to be a high risk factor in itself.

Among women who intended a home birth, primiparae were much more likely than multiparae to be transferred to hospital during labour (35% were, compared with 9% of multiparae). These figures are in line with current UK estimates by the Nursing and Midwifery Council (Magill-Cuerdin (2005) estimated that 30-40% of primiparae and 1-12% of multiparae who plan a home birth in the UK are transferred to hospital during labour).

GUS data

Figure 4.17 shows that, in Scotland also, primiparae tended not to have planned home births.

Figure 4.17: Mother's parity, by place of birth, Scotland, 2004-5



Source: GUS. P = 0.000

4.4.3 Reproductive history

4.4.3.1 Age at first birth

GUS data

Women having planned home births in Scotland tended to have started childbearing relatively late (40.0% were aged 30 or over when their first child was born, compared with 30.3% of women giving birth in hospital and just 7.5% of those in the 'other' category, p = 0.059).

This indicates that the tendency towards home birthing women being older was not simply a function of their higher parity, and therefore that age may have had an independent association with (intended) place of birth.

4.4.3.2 Number of previous miscarriages

SMMIS data

Women who had previously experienced one or two miscarriages were slightly more likely than women who had had none or more than two miscarriages to plan a home birth (1.6% of those who had had one or two had a planned home birth or were transferred to hospital in labour, compared with 1.3% of those who had had none or more than two; p=0.000).

4.4.3.3 Number of previous terminations

SMMIS data

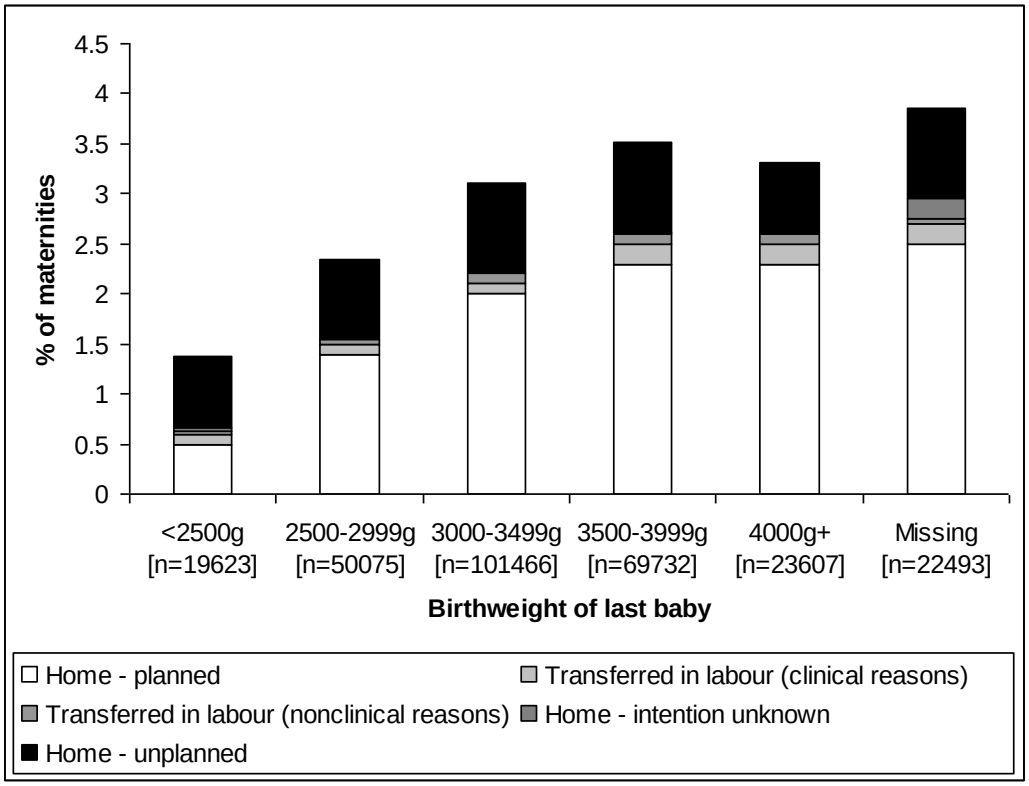
Women who had had one or more previous terminations were slightly less likely to plan a home birth (1.1% did, compared with 1.4% of those who had not had a termination; p=0.000).

4.4.3.4 Birthweight of last baby

SMMIS data

Figure 4.18 shows that multiparae whose last baby had low birthweight – i.e. less than 2,500g (5lb 7oz) - recorded a low home maternity ratio for their current pregnancy – both planned and unplanned. Among multiparae whose last baby was *not* of low birthweight, the planned home birth ratio was higher in each successive birthweight band, levelling off at 3,500g (7lb 10oz).

Figure 4.18: Intended/actual place of birth, by birthweight of last baby, North West Thames RHA area, 1988-2000



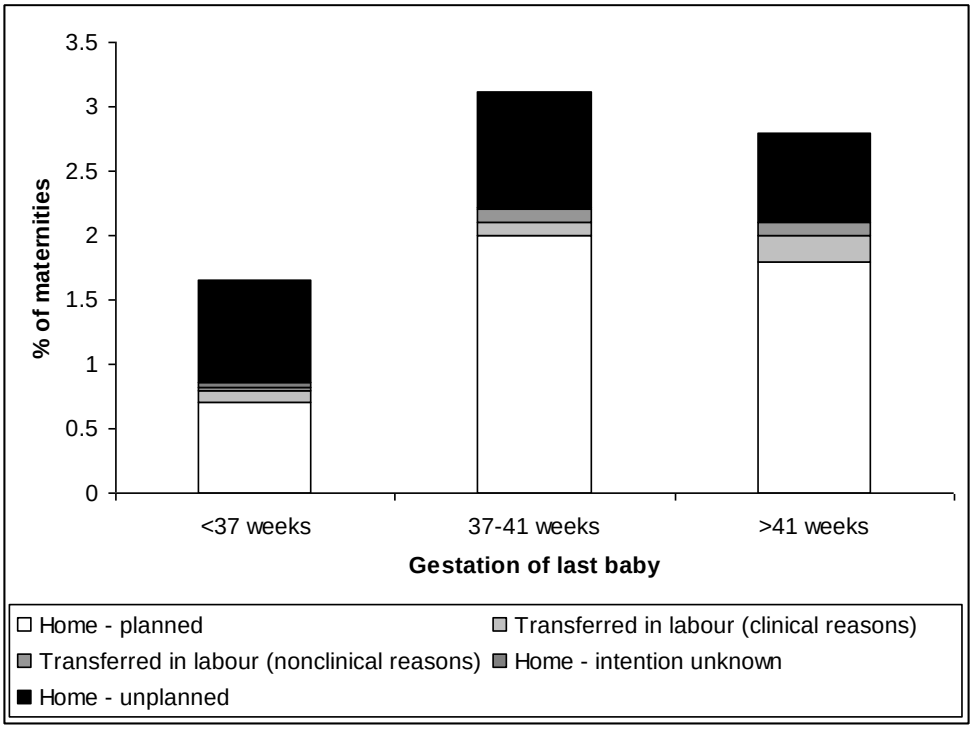
Source: SMMIS. Base: Multiparae only. P = 0.000.

4.4.3.5 Gestation of last baby

SMMIS data

Figure 4.19 shows that multiparae whose last pregnancy ended with a premature birth (less than 37 weeks' gestation) were unlikely to plan a home birth for their current pregnancy.

Figure 4.19: Intended/actual place of birth of current baby, by gestation of last baby, North West Thames RHA area, 1988-2000



Source: SMMIS. Base: Multiparae only. P = 0.000.

Among multiparae, the birthweight and gestation of the last baby were correlated at 0.542, indicating that it would not be appropriate to include both as explanatory variables in the final model.

4.4.4 Relationship status

Birth registration data

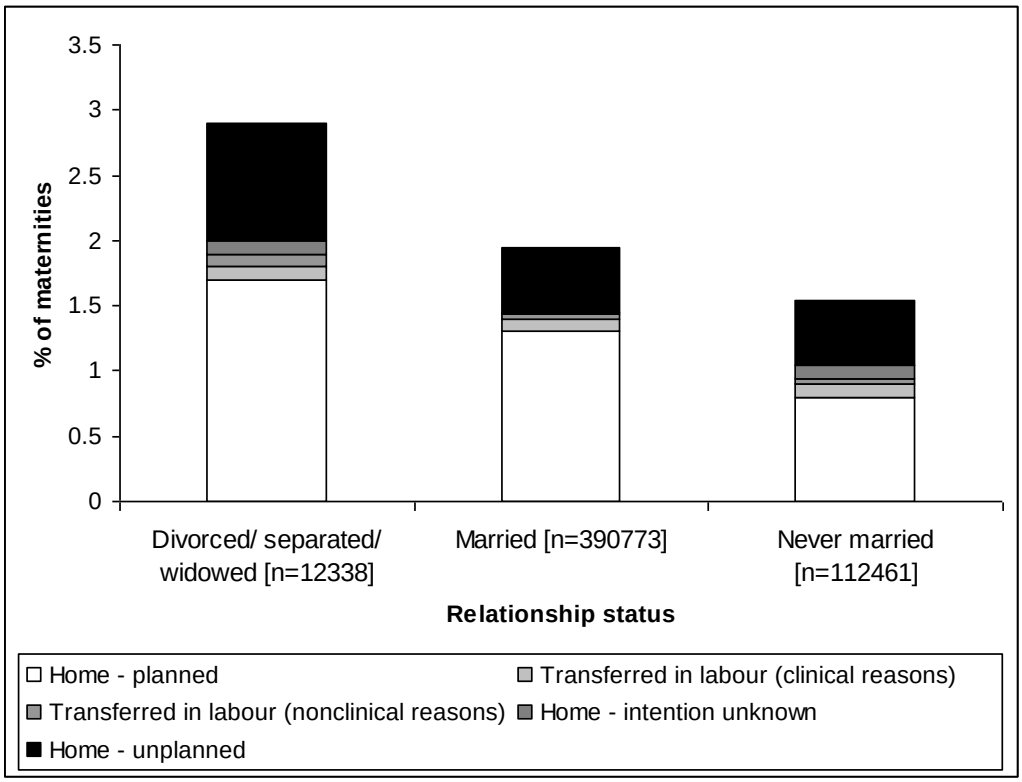
In England and Wales in 2006, the home maternity ratio was slightly higher among married women than among unmarried women (3.0% and 2.4% respectively).

SMMIS data

Figure 4.20 shows that in SMMIS, married women were more likely than women who had never been married to have a planned home birth, but *less* likely than women who used to be married to

have either a planned or unplanned home birth. If this pattern is replicated nationally, the birth registration figures may be masking an interesting variation.

Figure 4.20: Intended/actual place of birth, by mother's marital status, North West Thames RHA area, 1988-2000



Source: SMMIS. P = 0.000.

SMMIS also contained a field which recorded whether or not the woman was 'single and unsupported'. Just 0.8% of 'single, unsupported' women planned a home birth (0.6% had a planned home birth), compared with 1.5% of partnered women (1.3% had a planned home birth), p=0.000.

Marital status and 'single unsupported mother' were correlated at 0.45, indicating that it would not be appropriate to include both in the final models. Consideration was given to creating a composite 'marital/relationship status' variable, but previous research (Madi & Crow, 2003) indicated that support from a partner (not necessarily a husband) was an important factor in decisions about place of birth. For this reason, and to keep the model as simple as possible, 'single, unsupported mother' was selected for inclusion in the modelling process.

4.4.5 Educational qualifications (as an indicator of social class)

Quantitative analysis involving social class and maternity is complicated by the unsuitability of standard methods of classification of social class. Green et al (1998) pointed out that classification based a woman's current or most recent job is inappropriate for mothers, because their family commitments often lead to their taking relatively low-status employment. They also found partner's occupation to be a poor substitute because (a) it does not necessarily reflect the woman's own social class, and (b) it excludes women who do not have partners. They found that, for the purposes of examining issues pertaining to childbirth, a woman's age of leaving full-time education was the most appropriate measure of social class.

GUS data

Women giving birth at home in Scotland in 2004/5 tended to be better-qualified educationally than those giving birth in hospital. Nearly two-thirds (64%) of those having planned home births had a first degree, compared with 34% of those giving birth in hospital (p=0.002). A quarter (24%) of women having planned home births had a postgraduate degree, compared with 10% of those giving birth in hospital (p=0.081).

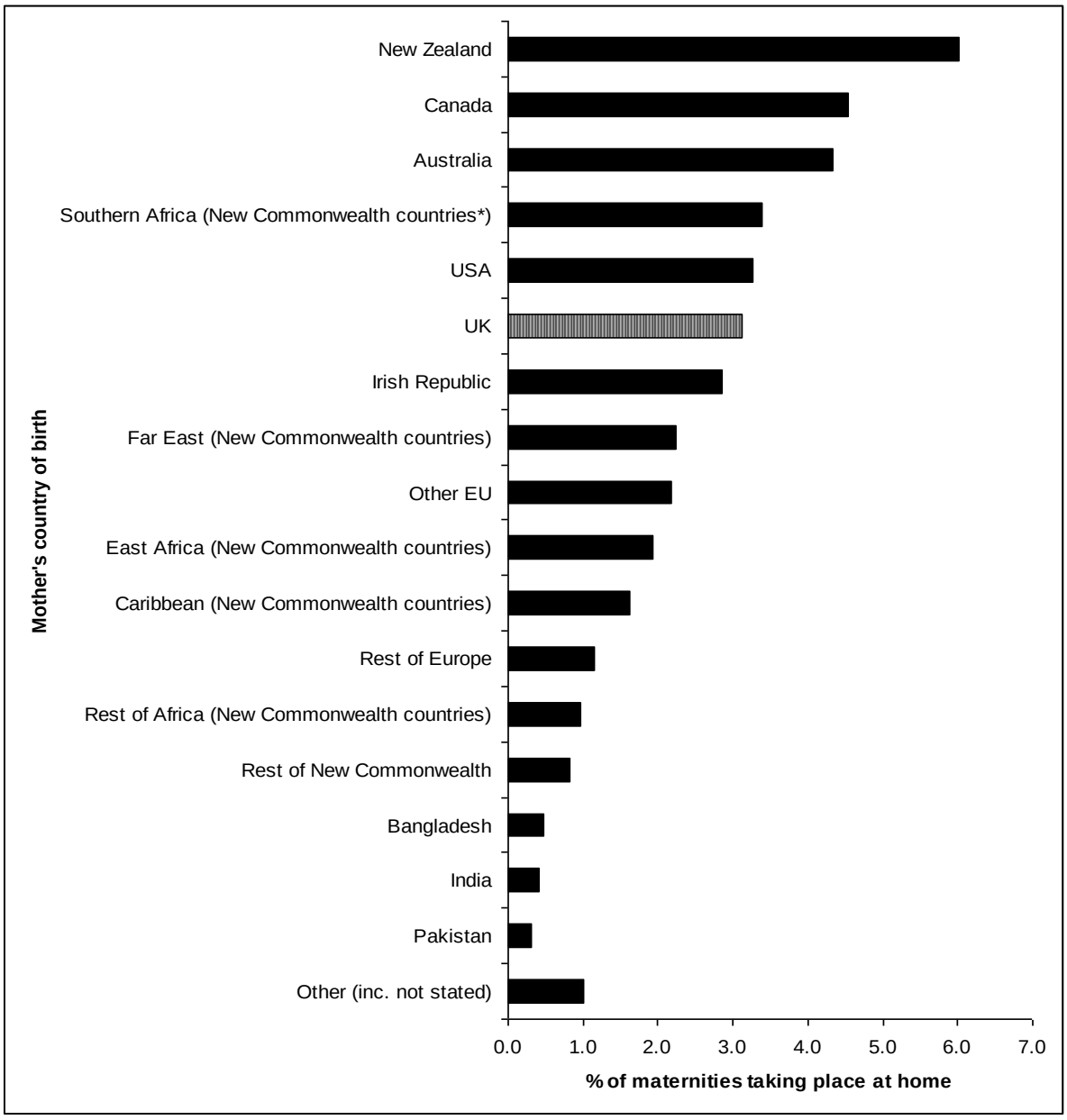
The SMMIS dataset did not contain a measure of the mother's social class, but it did contain the Carstairs deprivation index (Carstairs and Morris, 1991) of the mother's address. The GUS dataset indicated that, in Scotland, the Carstairs deprivation index was a reasonable proxy for social class (as measured by mother's educational qualifications), because women living in more deprived areas in Scotland were much less likely to have higher education qualifications (p=0.000).

4.4.6 Country of birth/ethnic group/language

Birth registration data: country of birth

Figure 4.21 shows that, in 2006 in England and Wales, women born in New Zealand, Canada or Australia were most likely to have a home birth (6.0%, 4.5% and 4.3% respectively), and those born in Pakistan, India or Bangladesh were least likely to do so (0.3%, 0.4% and 0.5% respectively).

Figure 4.21: Home maternity ratio, by mother's country of birth, E & W, 2006



Source: Nove et al (2008), derived from birth registration data
* Botswana, Lesotho, Namibia, South Africa, Bantu Homelands, Bophuthatswana, Transkei, Venda, Walvis Bay and Swaziland.

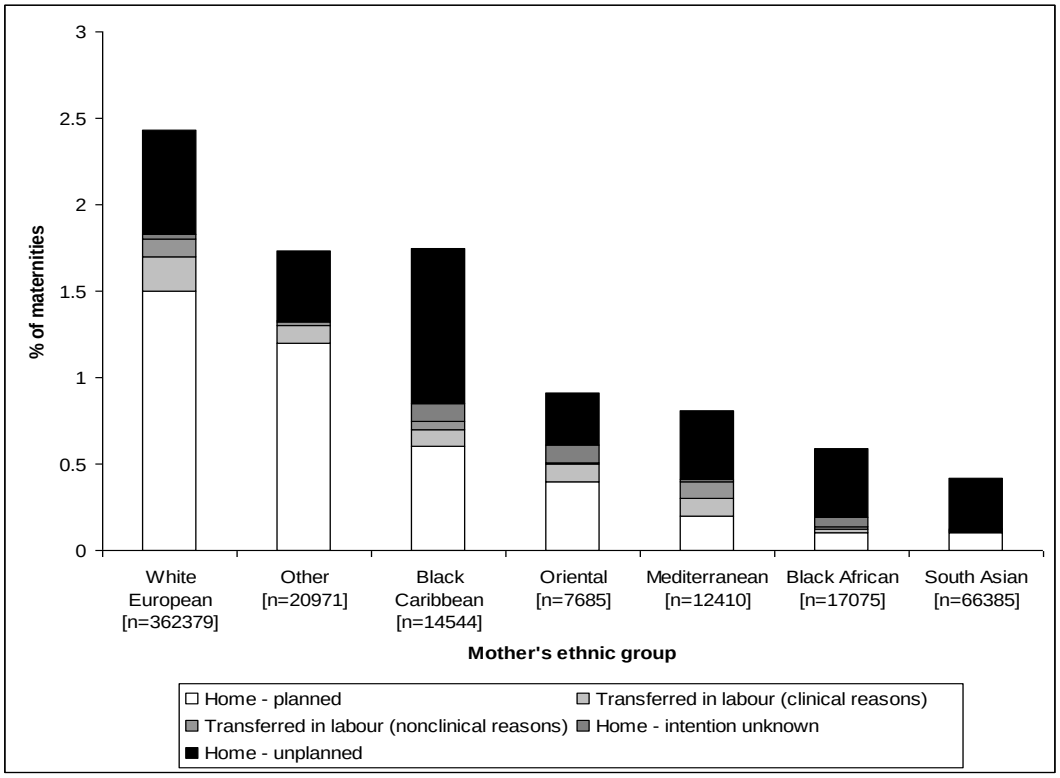
The home maternity ratio in New Zealand is estimated to be relatively high at about 7% (Home Birth Aotearoa, 2007), but the ratios in Canada and Australia are very low (Nove et al, 2008; Morison et al, 1998), which indicates that the pattern observed in England and Wales cannot be explained in terms of women following the norm of their country of birth.

SMMIS data: ethnic group/language

Just over a quarter (27.2%) of the records in the SMMIS dataset were for women from ethnic groups other than 'white European', but 92% of planned home maternities were to white European women. Figure 4.22 emphasises that white European women were most likely to plan a home birth, followed

by 'other' (the 'other' group was probably mainly white non-European). If the pattern shown in Figure 4.21 also applied in 1988-2000, it is not surprising that this group had a high HMR. Figure 4.22 also reveals a relatively high unplanned home maternity ratio among women of Black Caribbean origin (0.9%) and an extremely low planned home maternity ratio among women of South Asian or Black African origin (both 0.1%).

Figure 4.22: Intended/actual place of birth, by mother's ethnic group, North West Thames RHA area, 1988-2000



Source: SMMIS. P = 0.000.

Information on ethnic group was missing for 2.8% of the SMMIS records. Nearly two-thirds (63%) of the missing data were for the year 1995, and nearly all of the remaining missing data were from the years prior to 1995. A third (32%) of the records without ethnic group were from Bedford maternity unit.

In SMMIS, 2.2% of records (n=11,315) were for women who required an interpreter, of whom just 0.1% had a planned home birth. This may be because those needing interpreters were from ethnic groups with low planned HMRs. However, if the association between poor spoken English and place of birth remains after ethnic group is held constant, this may indicate that women who did not speak fluent English were less likely to have a choice about birth setting.

GUS data: country of birth

Women born in England were more likely than Scottish-born women to have a planned home birth in Scotland in 2004/5. Just 0.3% of women born in Scotland did so, compared with 2.3% of women born in England (p=0.000).

4.4.7 Mother's height

SMMIS data

Without a measure of actual pelvis size, it is necessary to rely on a proxy measure. Bull (1994) posited that height was a reasonable proxy, since "small women tend to have a small pelvis". Clearly, this will not be true for all women, so this analysis should be treated with a degree of caution. This said, it is clear from SMMIS that the taller the woman, the more likely she was to have a planned home birth. It is likely that this result was related to: social class (women living in more affluent areas tended to be taller) and ethnic group (South Asian women tended to be shorter). But it is also possible that, if women were being encouraged into hospital by a paternalistic medical system, smaller women may have come under more pressure to conform.

The intention to give birth at home was relatively common among women for whom height was not recorded. This may be due to home birthing women being less likely to attend a clinic, where height measuring equipment will have been more easily accessible. However, the main factor associated with missing height data was maternity unit; 70% of the records with missing height data came from five units (Hillingdon, Edgware, Central Middlesex, St Mary's and Luton & Dunstable).

4.4.8 Attitudes towards pregnancy, childbirth and childrearing

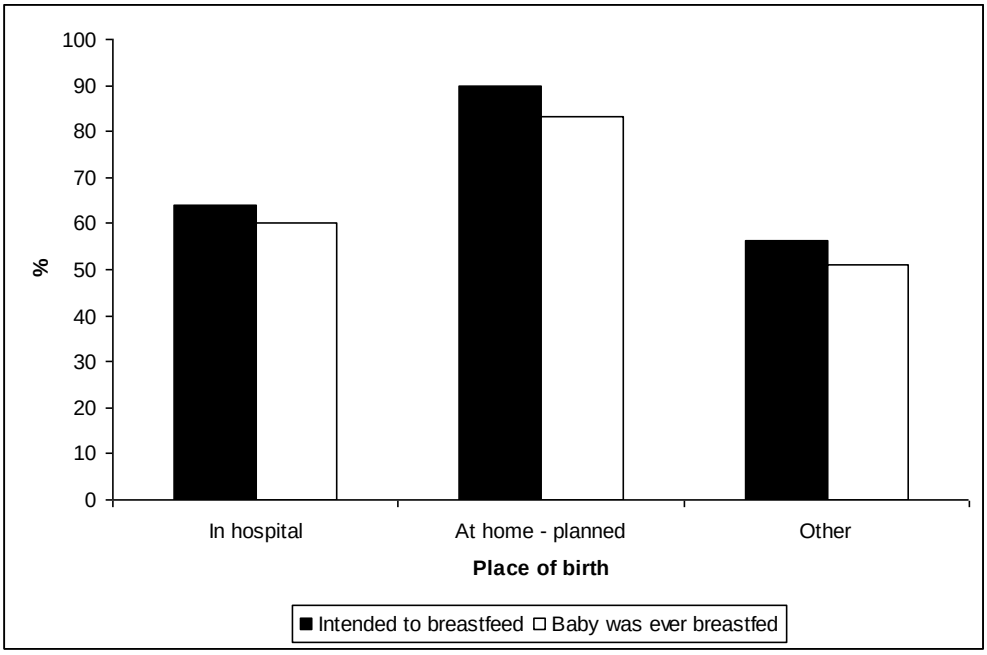
GUS data

Women who had planned home births in Scotland in 2004-5 were more likely to say that the pregnancy was planned (70.0%, compared with 59.1% of women who gave birth in hospital and 55.3% of women giving birth in other situations). The p-value for the chi-squared test, however, was high at 0.788. Women who had planned home births were less likely to say they attended antenatal classes (27.6%, compared with 46.0% of women giving birth in hospital, p=0.000). This is perhaps not surprising, given that women giving birth at home tended to have given birth before (see Section 4.4.2).

Figure 4.23 shows that women having planned home births in Scotland in 2004-5 tended to be more 'pro-breastfeeding', in both intention and practice[43], than women giving birth elsewhere.

[43] The questions were asked when the baby was nearly a year old, so will have been subject to both recall problems and *post hoc* rationalisation. The question about actual feeding instructed women to count themselves as having breastfed if the baby was ever put to the breast, even if it only received colostrum in the first few days, which probably explains the high reported levels of breastfeeding.

Figure 4.23: Breastfeeding intentions and incidence, by place of birth, Scotland, 2004-5



Source: GUS birth cohort. P = 0.123 (intention); p = 0.033 (actual).

There are a few indications from the GUS birth cohort to suggest that women having planned home births in Scotland in 2004-5 had relatively liberal attitudes to childrearing in comparison to those giving birth in hospital. They tended to be less tolerant of corporal punishment as a method of disciplining children than women giving birth in hospital (33.3% and 12.6% respectively disagreed strongly with the statement "It may not be a good thing to smack, but sometimes it is the only thing that will work"; p = 0.000). They were also more likely to have the attitude that baby care should be led by the child rather than the parent; 51.7% agreed that "it is more important to go with what the child wants than to stick to a firm routine for feeding or sleeping", compared with 35.2% of women giving birth in hospital (p = 0.154). Women having planned home births also tended to be more open to being taught parenting skills; 41.4% disagreed that "no-one can teach you how to be a good parent, you just have to learn for yourself", compared with 21.9% of women giving birth in hospital (p = 0.056).

4.4.9 Deprivation level of local area

SMMIS data

Women living in more affluent areas were more likely to state an intention to have a home birth. The unplanned HMR, on the other hand, varied little by Carstairs quintile (see Section 4.2.2 for a description of this measure). Unfortunately, this information was missing for 9.0% of the observations in the SMMIS database (n=46,229). Over a third (38.4%) of the observations with missing data on this variable were from the St Mary's and Chelsea & Westminster units, and 42.9%

were from the years 1988-90. Women having their first baby and black or Mediterranean women were slightly less likely to have their Carstairs quintile recorded. In terms of actual/intended place of birth, however, the profile of women with this information missing was very similar to the overall profile.

GUS data

In contrast to the situation in the SMMIS dataset, the GUS dataset revealed no significant difference between women having planned home births and those giving birth in hospital, in terms of the level of deprivation of their area of residence.

4.4.10 Housing type

GUS data

Women giving birth at home in Scotland in 2004-5 were more likely than women giving birth in hospital to live in a house or bungalow as opposed to a flat or maisonette (86.2% of home birthing women lived in a house/bungalow, compared with 69.1% of hospital birthing women, $p = 0.000$). This result may simply be a function of social class, but there is anecdotal evidence that women living in flats can be refused home birth, because of concerns about ease of access in case of emergency (e.g. Day-Stirk, 2005; Davies, 2004).

4.5 Statistical modelling: methods

Research question 1: Who plans a home birth in the UK, who changes intention during pregnancy, and who achieves a planned home birth?

The modelling was carried out using the SMMIS database. The conceptual framework for this analysis (see Figure 4.3) breaks the process of planning a home birth into three distinct stages: (1) intended place of birth in the early stages of pregnancy, (2) whether or not the intended place of birth changed over the course of pregnancy and (3) actual place of birth. To reflect this, the analysis was run as a series of models, as described in Table 4.9.

Table 4.9: Stages of modelling for 'who intends/has a home birth', and aim of each stage

Stage	Outcome variable	Group modelled	Aim
1	Intended place of birth at booking (home or hospital)	All pregnancies	Gain a better understanding of the type of woman who expresses an intention at booking to give birth at home.
2a	Whether or not intended place of birth changed from hospital at booking to home before labour commenced (yes or no)	All who intended a hospital birth at booking	Gain a better understanding of what factors are associated with a change in intended place of birth during pregnancy.
2b	Whether or not intended place of birth changed from home at booking to hospital before labour commenced (yes or no)	All who intended a home birth at booking	
3	Actual place of birth (home or hospital)	All who intended a home birth at the end of pregnancy	Gain an understanding of the characteristics associated with converting an intention to give birth at home into an actual home birth. The hypothesis was that, regardless of clinical factors, some types of women may be more determined to achieve their desired home birth and therefore non-clinical factors may also have an independent association with actual place of birth.

4.5.1 Outcome and explanatory variables included in model building process

Table 4.10 shows the outcome variables used in all four models described in this chapter.

Table 4.10: Outcome variables used for modelling who intends/has a home birth, and numbers of cases involved

Stage	Outcome variable	Numbers involved
1	Intended place of birth at booking	6,878 intended a home birth at booking
2	Intended place of birth at end of pregnancy (derived[44])	1,005 intended hospital birth at booking but changed to intending home birth during pregnancy 795 intended home birth at booking but changed to intending hospital birth during pregnancy
3	Actual place of birth	7,079 intended a home birth at end of pregnancy, of whom 6,154 went on to have one and 925 were transferred to hospital during labour

[44] Women were classed as having intended a home birth at the end of pregnancy if they: (i) intended a home birth at booking and gave birth at home, or (ii) intended a hospital birth at booking, gave birth at home, and the reason for the change was related to pregnancy rather than labour – see Table 4.2.

The exploratory analysis highlighted factors associated with an intention to give birth at home, and the modelling aimed to ascertain if the associations remained and to quantify their strength once other, related, factors were held constant. A full list and description of the explanatory variables can be found in Appendix E. Full details of the model-building process can be found in Appendix F.

It was expected that the achievement of a planned home birth would be largely determined by whether or not there were labour complications, but it was hypothesised that certain types of women might be more determined to see through a home birth and/or that some hospitals might have a greater tendency to transfer women to hospital without an obvious clinical need.

4.5.2 Reference categories

A reference category was selected for each categorical explanatory variable, against which the other categories of that variable could be compared when interpreting the model outputs. In most cases, the reference category was the group most likely to have a planned home birth. If this was not appropriate (e.g. the group was very small), the reference category was the largest group. Where appropriate, the reference category was the same for all four models. Table 4.11 in Section 4.6 describes reference pregnancies for these models.

4.6 Statistical modelling: results

In this section, the results from all four models are considered as a whole, with a view to aiding understanding of the decision-making pathway. This analysis has been published in the International Journal of Childbirth (Nove et al, 2011).

Most of the results are shown as predicted probabilities (see Section 3.3.6), which are calculated on the basis of reference pregnancies. The calculation assumes that the pregnancy in question has all the characteristics of a reference pregnancy except for the one explanatory variable under consideration, and therefore shows the effect of changing just that one explanatory variable on the predicted probability of experiencing the outcome. Table 4.11 summarises the characteristics of a reference pregnancy for each of the four models. Cells containing the letters 'NR' represent variables that did not feature in that particular model because they were not relevant, and cells containing the letters 'NS' represent variables that did not feature in that model because they were found not to have a significant association with the outcome once the other covariates were held constant.

Table 4.11: Reference categories for modelling who intends/has a home birth

Variable	Model 1: Intention at booking	Model 2a: Changing from hospital to home	Model 2b: Changing from home to hospital	Model 3: Achieving a planned home birth
Year of delivery	1997-98	1998	1998	
Hospital providing care	Hemel Hempstead	Hemel Hempstead	Hemel Hempstead	Hemel Hempstead
Pre-pregnancy risk status	Low	NS	Low	NR
High-risk factors developed during pregnancy?	NR	No	No	NR
High-risk factors evident at booking or developed during pregnancy?	NR	NR	NR	No
Complications in labour	NR	NR	NR	No
Duration of stage 1 of labour	NR	NR	NR	<3 hours
Birthweight (current baby)	NR	NR	2500+g	2500g-3999g
Number of ultrasound scans	NR	1 or 2	1	NS
Age at delivery	30-34	30+	30-34	NS
Parity	1	1	1+	1+
Previous miscarriage(s?	No	NS	NS	NS
Last baby low birthweight?	No	NS	No	NS
Single?	No	No	No	NS
Ethnic group	White European	White European	NS	White European
Interpreter needed?	NR	NR	NR	No
Previous terminations?	No	NS	NS	NS
Carstairs quintile	1 or 2	NS	NS	NS

4.6.1 Detailed results

In this section, the results of all four models are shown in four consecutive tables, followed by a detailed description and discussion of the results. All four models are discussed together, to aid understanding of the decision-making pathway as described in Section 4.1.

Table 4.12 shows the log odds, standard errors, odds ratios and 99% confidence intervals[45] for the odds ratios from the final 'intention at booking' model. The odds ratio is interpreted as the number of times by which the odds of a person in that category intending a home birth were greater/less

[45] The 99% confidence interval is used rather than the 95% confidence interval because, due to the large number of observations, the 95% CI was not judged to be sufficiently discriminating.

than the odds of someone in the reference category[46] doing so, other observed characteristics being equal. For example, the odds ratio of 0.2568 for high-risk pregnancies means that the odds of a woman with a high-risk pregnancy intending a home birth at booking were 0.2568 times those of a woman with a low-risk pregnancy doing so ('low-risk' being the reference category for pre-pregnancy risk status), assuming that the high-risk pregnancy in question was identical to the low-risk pregnancy in terms of the other variables in the model.

An odds ratio of less than 1 indicates a lower likelihood of intending a home birth at booking in comparison to the reference group, and an odds ratio of greater than 1 indicates a higher likelihood of intending a home birth at booking. When calculating odds ratios for interactions, the odds ratios from the relevant main effects must be multiplied by the interaction effect odds ratio.

Table 4.12: Results of 'intention at booking' model, based on all pregnancies (n=514,020)

	Log odds	Standard error	p-value of log odds	Odds ratio	99% confidence interval for OR	
Year of delivery main effect (reference = 1997-98)						
1988-1990	-1.6079	0.1272	***	0.1994	0.1454	0.2736
1991-1992	-0.9658	0.1138	***	0.2608	0.1865	0.3647
1993-1994	-0.5555	0.0983	***	0.3971	0.2947	0.5350
1995-1996	-0.2948	0.0921	***	0.7441	0.5740	0.9647
1999-2000	0.0426	0.0856	***	1.3910	1.0983	1.7617
Hospital providing care main effect (reference = Hemel Hempstead)						
Ashford	-1.3901	0.2446	***	0.2460	0.1306	0.4634
Bedford	-1.3246	0.1555	***	0.2796	0.1859	0.4207
Central Middlesex	-1.2918	0.3352	***	0.2830	0.1188	0.6737
Chelsea & Westminster	-1.2280	0.1449	***	0.1758	0.1145	0.2698
Ealing	-0.2598	0.2055	-	1.0998	0.6387	1.8938
Edgware	-1.5300	0.1851	***	0.0965	0.0528	0.1762
Hillingdon	-0.6356	0.1176	-	1.0298	0.7797	1.3602
Luton & Dunstable	0.3432	0.1005	***	0.4541	0.3236	0.6373
Northwick Park	-1.5044	0.1913	***	0.2456	0.1474	0.4092
St Mary's	-1.5394	0.1886	***	0.2184	0.1363	0.3501
Stevenage	-1.1721	0.1496	***	0.3969	0.2712	0.5807
Watford	-3.9746	0.3874	***	0.0210	0.0077	0.0568
Welwyn Garden City	-0.3135	0.1099	***	0.5205	0.3748	0.7228
West Middlesex	0.2829	0.1079	-	1.0617	0.7780	1.4489
Hospital * year interaction						
Ashford 88-90	-0.1314	0.3344	-	0.8801	0.3750	2.0656
Ashford 91-92	-0.1961	0.3127	-	1.1988	0.5294	2.7148
Ashford 93-94	-0.2318	0.2810	-	1.1452	0.5486	2.3904

[46] The reference category is shown separately for each variable in the table.

Table 4.12 (cont'd): Results of 'intention at booking' model, based on all pregnancies (n=514,020)

	Log odds	Standard error	p-value of log odds	Odds ratio	99% confidence interval for OR	
Bedford 88-90	0.4739	0.2782	-	1.5139	0.7445	3.0785
Bedford 91-92	0.0920	0.2528	-	1.5018	0.7688	2.9338
Bedford 93-94	-0.0446	0.2264	-	1.2969	0.7101	2.3686
Bedford 95-96	0.0758	0.2018	-	1.0130	0.5973	1.7182
Bedford 99-00	0.0210	0.1832	**	0.6746	0.4176	1.0897
Central Middlesex 88-90	1.7076	0.3718	***	5.3091	2.0486	13.7589
Central Middlesex 91-92	1.5988	0.3637	***	6.9200	2.6753	17.8996
Central Middlesex 93-94	1.5939	0.3514	***	6.8169	2.7225	17.0692
Chelsea & Westminster 88-90	1.3002	0.2042	***	6.0616	3.5014	10.4936
Chelsea & Westminster 91-92	1.9302	0.1856	***	16.5411	9.6778	28.2717
Chelsea & Westminster 93-94	1.2392	0.1802	***	8.2049	4.8683	13.8284
Chelsea & Westminster 95-96	0.3520	0.1886	***	2.3398	1.3785	3.9715
Chelsea & Westminster 99-00	-0.5400	0.1920	-	1.1822	0.7159	1.9523
Ealing 88-90	0.4599	0.2733	-	1.1010	0.5452	2.2232
Ealing 91-92	0.3125	0.2549	-	1.3807	0.6993	2.7261
Edgware 88-90	0.3748	0.2795	***	3.2372	1.4587	7.1841
Edgware 91-92	0.8335	0.2416	***	7.4427	3.5750	15.4948
Edgware 93-94	0.5664	0.2315	***	5.6409	2.7730	11.4746
Edgware 95-96	0.4693	0.2259	***	3.5451	1.7811	7.0560
Edgware 99-00	-0.8381	0.2634	*	1.5928	0.8037	3.1563
Hillingdon 88-90	-0.4199	0.2250	-	0.9626	0.6107	1.5171
Hillingdon 91-92	-0.5561	0.2083	*	1.3988	0.8961	2.1837
Hillingdon 93-94	-0.2247	0.1637	**	1.3848	0.9364	2.0480
Hillingdon 95-96	-0.0539	0.1481	-	0.9590	0.6755	1.3616
Hillingdon 99-00	-0.1832	0.1428	*	0.6889	0.4987	0.9516
Luton & Dunstable 88-90	-0.3345	0.1726	-	0.7597	0.4240	1.3612
Luton & Dunstable 91-92	-0.7083	0.1689	-	0.9634	0.5445	1.7046
Luton & Dunstable 93-94	-0.6982	0.1473	-	1.3284	0.8365	2.1095
Luton & Dunstable 95-96	-0.3308	0.1308	-	1.0914	0.7243	1.6444
Luton & Dunstable 99-00	-0.3726	0.1254	-	0.8274	0.5673	1.2068
Northwick Park 88-90	-0.1860	0.3513	-	0.7444	0.3024	1.8327
Northwick Park 91-92	-0.0814	0.3095	-	1.2011	0.5323	2.7101
Northwick Park 93-94	0.2294	0.2548	*	1.6225	0.8262	3.1863
Northwick Park 95-96	0.1220	0.2409	-	1.0092	0.5377	1.8940
Northwick Park 99-00	0.0710	0.2337	*	0.6417	0.3494	1.1786
St Mary's 88-90	1.5990	0.2468	***	4.8174	2.6182	8.8640
St Mary's 91-92	0.3207	0.2788	**	1.9497	0.9500	4.0017
St Mary's 93-94	0.2049	0.2509	**	1.7192	0.9009	3.2809
St Mary's 95-96	0.4295	0.2270	*	1.4904	0.8402	2.6437
St Mary's 99-00	-0.0114	0.2208	-	0.6968	0.3921	1.2382
Stevenage 88-90	0.0759	0.2529	-	0.8346	0.4429	1.5727
Stevenage 91-92	-0.0373	0.2400	-	1.0831	0.5785	2.0279
Stevenage 93-94	-0.1996	0.2178	-	0.9116	0.5159	1.6110
Stevenage 95-96	-0.2673	0.2099	**	0.5900	0.3450	1.0090
Stevenage 99-00	0.2185	0.1764	***	0.5537	0.3487	0.8791

Table 4.12 (cont'd): Results of 'intention at booking' model, based on all pregnancies (n=514,020)

	Log odds	Standard error	p-value of log odds	Odds ratio	99% confidence interval for OR	
Watford 88-90	1.9641	0.4248	***	6.3311	2.1262	18.8524
Watford 91-92	1.1183	0.4741	***	3.9493	1.1516	13.5443
Watford 93-94	1.0413	0.4394	***	3.6199	1.1544	11.3509
Watford 95-96	0.8587	0.4323	*	2.0884	0.6824	6.3915
Watford 99-00	0.0804	0.4799	-	0.6357	0.1841	2.1947
Welwyn Garden City 88-90	0.0159	0.1951	*	1.4143	0.8475	2.3602
Welwyn Garden City 91-92	0.1315	0.1689	***	2.3072	1.4253	3.7348
Welwyn Garden City 93-94	0.3540	0.1455	***	2.8533	1.8641	4.3675
Welwyn Garden City 95-96	0.1501	0.1416	***	1.6116	1.0796	2.4056
Welwyn Garden City 99-00	-0.3689	0.1444	-	0.9963	0.6801	1.4595
West Middlesex 88-90	-0.0912	0.1971	-	1.1309	0.6801	1.8805
West Middlesex 91-92	0.4093	0.1475	***	2.7042	1.6941	4.3166
West Middlesex 93-94	0.4067	0.1671	***	2.6837	1.7644	4.0822
West Middlesex 95-96	0.3455	0.1406	***	1.7439	1.1855	2.5652
West Middlesex 99-00	-0.2524	0.1359	-	0.8867	0.6186	1.2711
Parity main effect (reference = 1)						
0 (first baby)	-1.5148	0.1079	***	0.0974	0.0663	0.1430
2+ (3rd or subsequent baby)	0.9471	0.0709	***	1.8966	1.5404	2.3352
Hospital * parity interaction						
Ashford parity 0	0.3303	0.3988	**	2.4733	0.8591	7.1207
Ashford parity 2+	0.4754	0.2426	***	1.9270	1.0287	3.6095
Bedford parity 0	0.2608	0.2197	***	2.3073	1.2424	4.2850
Bedford parity 2+	0.0468	0.1427	-	1.2553	0.8654	1.8208
Central Middlesex parity 0	0.7684	0.2460	***	3.8333	1.9464	7.5497
Central Middlesex parity 2+	-0.6535	0.2137	**	0.6232	0.3593	1.0808
Chelsea & Westminster parity 0	0.9524	0.1447	***	4.6074	2.9421	7.2154
Chelsea & W'minster parity 2+	-0.4175	0.1361	*	0.7890	0.5537	1.1243
Ealing parity 0	-0.0605	0.3292	-	1.6733	0.6924	4.0442
Ealing parity 2+	-0.4249	0.2128	**	0.7832	0.4523	1.3564
Edgware parity 0	0.6482	0.2138	***	3.3990	1.8595	6.2131
Edgware parity 2+	-0.2258	0.1605	-	0.9558	0.6303	1.4495
Hillingdon parity 0	0.6099	0.1591	***	1.7777	1.1392	2.7740
Hillingdon parity 2+	0.1253	0.1114	*	1.1979	0.9396	1.5273
Luton & Dunstable parity 0	-0.5753	0.1728	***	3.2714	2.0219	5.2931
Luton & Dunstable parity 2+	-0.1806	0.0943	***	1.3579	1.0132	1.8198
Northwick Park parity 0	0.6437	0.2212	***	3.3838	1.8164	6.3034
Northwick Park parity 2+	-0.3857	0.1799	-	0.8145	0.5109	1.2986
St Mary's parity 0	0.9673	0.1815	***	4.6769	2.7574	7.9326
St Mary's parity 2+	-0.4856	0.1743	*	0.7371	0.4698	1.1567
Stevenage parity 0	0.1606	0.2115	***	2.0874	1.1443	3.8077
Stevenage parity 2+	-0.2088	0.1362	-	0.9722	0.6807	1.3886
Watford parity 0	1.0858	0.3438	***	5.2649	2.0950	13.2313
Watford parity 2+	0.3412	0.2760	*	1.6851	0.8251	3.4414

Table 4.12 (cont'd): Results of 'intention at booking' model, based on all pregnancies (n=514,020)

	Log odds	Standard error	p-value of log odds	Odds ratio	99% confidence interval for OR	
Welwyn Garden City parity 0	0.1015	0.1530	***	1.9676	1.2312	3.1444
Welwyn Garden City parity 2+	-0.0206	0.0992	-	1.1735	0.9017	1.5271
West Middlesex parity 0	0.3843	0.1422	***	2.6106	1.6745	4.0700
West Middlesex parity 2+	-0.2596	0.1004	-	0.9240	0.7096	1.2033
Ethnic group main effect (reference = white European)						
Black Caribbean	-0.9441	0.2049	***	0.3890	0.2295	0.6595
Oriental/Mediterranean/Black African/South Asian	-2.1892	0.1265	***	0.1120	0.0809	0.1552
Other	-0.4194	0.0986	***	0.6575	0.5101	0.8475
Missing	-0.1929	0.1269	-	0.8245	0.5947	1.1433
Ethnic group * parity interaction						
Black Caribbean parity 0	0.4047	0.3343	-	1.4989	0.6336	3.5457
Black Caribbean parity 2+	0.5764	0.2441	**	1.7795	0.9489	3.3373
Oriental/Mediterranean/Black African/South Asian parity 0	0.4333	0.2043	**	1.5424	0.9112	2.6109
Oriental/Mediterranean/Black African/South Asian parity 2+	-0.2288	0.1704	-	0.7955	0.5129	1.2338
Other parity 0	0.0656	0.1805	-	1.0678	0.6709	1.6997
Other parity 2+	-0.2062	0.1393	-	0.8137	0.5684	1.1649
Missing parity 0	0.4217	0.2057	**	1.5246	0.8974	2.5899
Missing parity 2+	-0.4437	0.1795	**	0.6416	0.4041	1.0188
Mother's age at delivery main effect (reference = 30-34)						
<20	-1.1559	0.2470	***	0.3499	0.1850	0.6616
20-24	-0.4831	0.0715	***	0.6857	0.5681	0.8275
25-29	-0.1058	0.0473	**	1.1116	0.9839	1.2557
35-39	-0.0595	0.0597	-	1.0474	0.8901	1.2325
40+	-0.0520	0.1562	-	1.0552	0.7030	1.5840
Age * parity interaction						
<20 parity 0	-0.7093	0.3450	-	0.6247	0.2563	1.5228
<20 parity 2+	-1.0262	1.0353	-	0.4067	0.0282	5.8598
20-24 parity 0	-0.4629	0.1311	*	0.7993	0.5668	1.1272
20-24 parity 2+	-0.1435	0.1110	-	0.9831	0.7308	1.3225
25-29 parity 0	-0.2389	0.0870	***	1.2698	1.0149	1.5889
25-29 parity 2+	-0.1264	0.0667	*	1.1348	0.9557	1.3474
35-39 parity 0	0.1646	0.1134	***	1.4971	1.1055	2.0275
35-39 parity 2+	-0.0789	0.0766	-	1.0487	0.8465	1.2992
40+ parity 0	-0.1157	0.3147	-	1.1311	0.5006	2.5555
40+ parity 2+	-0.1341	0.1852	-	0.9923	0.6113	1.6110
Single? (reference = no)						
Yes	-0.3719	0.0472	***	0.6894	0.6104	0.7786

Table 4.12 (cont'd): Results of 'intention at booking' model, based on all pregnancies (n=514,020)

	Log odds	Standard error	p-value of log odds	Odds ratio	99% confidence interval for OR	
Carstairs quintile (reference = 1/2)						
3/4	-0.2919	0.0293	***	1.3390	1.2417	1.4440
5	-0.4726	0.0556	***	0.8347	0.7253	0.9607
Missing	0.4173	0.0474	***	2.0325	1.7967	2.2992
Pre-pregnancy risk status (reference = low)						
High	-1.3594	0.0519	***	0.2568	0.2247	0.2936
Medium	-0.4605	0.0490	***	0.6310	0.5562	0.7159
Previous baby low birthweight (reference = no)						
Yes	-0.7422	0.0915	***	0.4760	0.3761	0.6026
Previous termination(s) (reference = none)						
Any	-0.2270	0.0390	***	0.7969	0.7207	0.8812
Previous miscarriage(s) (reference = none)						
Any	-0.1446	0.0301	***	0.8654	0.8008	0.9351
Constant	-2.2946	0.0730	***	n/a	n/a	n/a

*** p<0.01 / ** p<0.05 / * p<0.1

Table 4.13: Results of 'changing from hospital to home' model, based on all who intended a hospital birth at booking (n=506,487)

	Log odds	Standard error	p-value of log odds	Odds ratio	95% confidence interval for OR	
Year (reference = 1998)						
1988	-3.2565	0.4574	***	0.0385	0.0157	0.0944
1989	-3.3219	0.4577	***	0.0361	0.0147	0.0885
1990	-1.4039	0.1970	***	0.2456	0.1670	0.3614
1991	-0.8514	0.1621	***	0.4268	0.3106	0.5864
1992	-0.6429	0.1519	***	0.5258	0.3904	0.7081
1993	-0.5065	0.1469	***	0.6026	0.4518	0.8037
1994	-0.2568	0.1360	*	0.7736	0.5926	1.0098
1995	-0.6340	0.1626	***	0.5305	0.3857	0.7296
1996	-0.0309	0.1287	-	0.9696	0.7534	1.2477
1997	-0.1761	0.1352	-	0.8386	0.6434	1.0929
1999	0.0254	0.1297	-	1.0258	0.7955	1.3227
2000	-0.0708	0.1336	-	0.9317	0.7170	1.2106
Hospital (reference = Hemel Hempstead)						
Ashford	0.0615	0.2087	-	1.0634	0.7064	1.6008
Bedford	0.3899	0.1338	***	1.4768	1.1361	1.9197
Central Middlesex	-0.5220	0.3544	-	0.5933	0.2962	1.1884
Chelsea & Westminster	0.0671	0.1491	-	1.0694	0.7984	1.4323
Ealing	-0.5576	0.3525	-	0.5726	0.2869	1.1424
Edgware	-0.0510	0.1506	-	0.9503	0.7075	1.2765
Hillingdon	-0.1536	0.1464	-	0.8577	0.6437	1.1427
Luton & Dunstable	-0.9177	0.1782	***	0.3994	0.2817	0.5664
Northwick Park	-0.8145	0.1981	***	0.4429	0.3003	0.6530
St Mary's	-0.9809	0.2277	***	0.3750	0.2400	0.5859
Stevenage	0.5487	0.1258	***	1.7311	1.3527	2.2153
Watford	0.0506	0.1381	-	1.0520	0.8025	1.3790
Welwyn Garden City	-1.5144	0.2567	***	0.2199	0.1330	0.3637
West Middlesex	-0.3180	0.1851	*	0.7276	0.5062	1.0458
High risk pregnancy? (reference = no)						
Yes	-1.6911	0.0984	***	0.1843	0.1520	0.2235
No of ultrasound scans (reference = 1 or 2)						
0	1.0314	0.1757	***	2.8050	1.9877	3.9583
3+	-0.6065	0.0990	***	0.5453	0.4490	0.6621
Missing	-0.0066	0.2989	-	0.9935	0.5530	1.7848
Mother's age (reference = 30+)						
<20	-0.8775	0.3260	***	0.4158	0.2195	0.7878
20-24	-0.4180	0.1161	***	0.6583	0.5243	0.8266
25-29	-0.1413	0.0733	*	0.8682	0.7521	1.0023
Parity (reference = 1)						
0	-1.4020	0.1006	***	0.2461	0.2021	0.2997
2+	0.5507	0.0690	***	1.7345	1.5152	1.9854
Single? (reference = no)						
Yes	-0.3393	0.1249	***	0.7122	0.5575	0.9099
Mother's ethnic group (reference = White European)						
Black Caribbean	-0.3640	0.2430	-	0.6949	0.4316	1.1189
Oriental/Mediterranean/Black African/South Asian	-2.1815	0.2018	***	0.1129	0.0760	0.1676
Other	-0.3621	0.1750	**	0.6962	0.4941	0.9811
Missing	-0.1268	0.2291	-	0.8809	0.5622	1.3802
Constant	-4.4470	0.1400	***	n/a	n/a	n/a

*** p<0.01 / ** p<0.05 / * p<0.1

Table 4.14: Results of 'changing from home to hospital' model, based on all who intended a home birth at booking (n=6,865)

	Log odds	Standard error	p-value of log odds	Odds ratio	95% confidence interval for OR	
Year (reference = 1998)						
1988	-0.6366	0.3587	*	0.5291	0.2619	1.0688
1989	-0.4527	0.2873	-	0.6359	0.3621	1.1167
1990	-0.6882	0.2805	**	0.5025	0.2899	0.8708
1991	-0.5530	0.2402	**	0.5752	0.3593	0.9210
1992	-0.6203	0.2257	***	0.5378	0.3455	0.8370
1993	-0.8296	0.2246	***	0.4362	0.2809	0.6775
1994	-0.9162	0.2095	***	0.4000	0.2653	0.6032
1995	-0.2066	0.1942	-	0.8133	0.5558	1.1901
1996	-0.0488	0.1883	-	0.9523	0.6585	1.3773
1997	-0.2438	0.1827	-	0.7836	0.5478	1.1210
1999	0.2063	0.1721	-	1.2291	0.8772	1.7222
2000	0.1319	0.1885	-	1.1410	0.7885	1.6512
Hospital main effect (reference = Hemel Hempstead)						
Ashford	1.1746	0.3455	***	3.2367	1.6446	6.3702
Bedford	-0.3672	0.3411	-	0.6927	0.3550	1.3516
Central Middlesex	0.3652	0.4572	-	1.4408	0.5881	3.5298
Chelsea & Westminster	1.2696	0.2071	***	3.5596	2.3720	5.3416
Ealing	-0.0060	0.6174	-	0.9940	0.2964	3.3333
Edgware	0.6276	0.3245	*	1.8732	0.9916	3.5385
Hillingdon	0.1883	0.2205	-	1.2072	0.7836	1.8599
Luton & Dunstable	-0.8985	0.2550	***	0.4072	0.2470	0.6712
Northwick Park	0.4791	0.3369	-	1.6146	0.8343	3.1249
St Mary's	0.1570	0.3244	-	1.1701	0.6195	2.2098
Stevenage	0.2944	0.2795	-	1.3424	0.7762	2.3214
Watford	-1.0598	1.0202	-	0.3465	0.0469	2.5595
Welwyn Garden City	0.1502	0.2164	-	1.1621	0.7603	1.7762
West Middlesex	-0.3135	0.2345	-	0.7309	0.4616	1.1572
High-risk factor(s) developed during pregnancy? (main effect) (reference = no)						
Yes				21.848		
	3.0841	0.2129	***	6	14.3951	33.1614
Hospital * developed risk factors during pregnancy interaction						
Ashford * high risk	-1.9923	0.9225	**	0.1364	0.0224	0.8317
Bedford * high risk	-0.4188	0.5384	-	0.6578	0.2290	1.8899
Central Middlesex * high risk	-0.3417	0.6711	-	0.7105	0.1907	2.6477
Chelsea & Westminster * high risk	-1.5974	0.3377	***	0.2024	0.1044	0.3924
Ealing * high risk	-0.2909	0.8453	-	0.7476	0.1426	3.9188
Edgware * high risk	-1.1881	0.5171	**	0.3048	0.1106	0.8399
Hillingdon * high risk	-0.5534	0.3435	-	0.5750	0.2933	1.1274
Luton & Dunstable * high risk	-0.0926	0.3802	-	0.9116	0.4327	1.9204
Northwick Park * high risk	-1.4802	0.5423	***	0.2276	0.0786	0.6588
St Mary's * high risk	-0.9181	0.4883	*	0.3993	0.1533	1.0398
Stevenage * high risk	-0.5193	0.4324	-	0.5950	0.2549	1.3885
Watford * high risk	1.4494	1.3524	-	4.2607	0.3008	60.3417
Welwyn Garden City * high risk	0.1126	0.3427	-	1.1192	0.5717	2.1908
West Middlesex * high risk	-0.3393	0.3338	-	0.7123	0.3703	1.3702

Table 4.14 (cont'd): Results of 'changing from home to hospital' model, based on all who intended a home birth at booking (n=6,865)

	Log odds	Standard error	p-value of log odds	Odds ratio	95% confidence interval for OR	
Pre-pregnancy risk status (reference = low)						
High	0.1081	0.1660	-	1.1142	0.8048	1.5425
Medium	0.5862	0.1551	***	1.7972	1.3260	2.4359
No of ultrasound scans (reference = 1)						
0	-0.6208	0.2419	**	0.5375	0.3345	0.8636
2	0.3148	0.1095	***	1.3700	1.1055	1.6978
3+	0.8426	0.1235	***	2.3225	1.8233	2.9584
Missing	-0.3160	0.3350	-	0.7291	0.3781	1.4059
Current baby low birthweight? (reference = no)						
Yes	1.4021	0.2230	***	4.0636	2.6248	6.2909
Previous baby low birthweight? (reference = no)						
Yes	0.7847	0.2664	***	2.1917	1.3002	3.6946
Mother's age (reference = 30-34)						
<20	0.5491	0.5200	-	1.7317	0.6250	4.7980
20-24	0.4893	0.1623	***	1.6312	1.1868	2.2420
25-29	0.1330	0.1095	-	1.1423	0.9216	1.4158
35-39	-0.2173	0.1281	*	0.8047	0.6261	1.0343
40+	-0.3400	0.2883	-	0.7118	0.4045	1.2525
Primipara? (reference = no)						
Yes	0.3287	0.1154	***	1.3891	1.1080	1.7417
Single? (reference = no)						
Yes	0.4067	0.1536	***	1.5018	1.1113	2.0294
Constant	-3.1482	0.2004	***	n/a	n/a	n/a

*** p<0.01 / ** p<0.05 / * p<0.1

Table 4.15: Results of 'who achieves a planned home birth?' model, based on all who intended a home birth at the end of pregnancy (n=7,037)

	Log odds	Standard error	p-value of log odds	Odds ratio	95% confidence interval for OR	
Hospital main effect (reference = Hemel Hempstead)						
Ashford	-0.4693	0.4306	-	0.6254	0.2689	1.4545
Bedford	0.1998	0.2989	-	1.2212	0.6798	2.1938
Central Middlesex	-0.9063	0.3228	***	0.4040	0.2146	0.7606
Chelsea & Westminster	-1.1712	0.1995	***	0.3100	0.2097	0.4583
Ealing	-0.4443	0.3983	-	0.6413	0.2938	1.3998
Edgware	-0.0376	0.3087	-	0.9631	0.5260	1.7637
Hillingdon	-0.5681	0.2141	***	0.5666	0.3724	0.8620
Luton & Dunstable	0.2668	0.2272	-	1.3057	0.8365	2.0382
Northwick Park	-0.1902	0.3348	-	0.8268	0.4290	1.5935
St Mary's	-0.8043	0.2579	***	0.4474	0.2699	0.7417
Stevenage	-0.1104	0.2561	-	0.8955	0.5420	1.4794
Watford	1.2456	0.6089	**	3.4750	1.0536	11.4613
Welwyn Garden City	-0.1297	0.2246	-	0.8784	0.5656	1.3642
West Middlesex	-0.8022	0.1844	***	0.4483	0.3124	0.6435
Complications in labour? (main effect) (reference = no)						
Yes	-2.2035	0.2359	***	0.1104	0.0695	0.1753
Hospital * complications in labour interaction						
Ashford * complications	1.2406	0.6829	*	3.4577	0.9068	13.1845
Bedford * complications	0.4621	0.4546	-	1.5874	0.6512	3.8695
Central Middlesex * complications	0.7795	0.5661	-	2.1804	0.7190	6.6124
Chelsea & Westminster * complications	0.8466	0.3459	**	2.3317	1.1837	4.5932
Ealing * complications	0.7189	0.6601	-	2.0522	0.5627	7.4839
Edgware * complications	0.5793	0.4938	-	1.7848	0.6781	4.6977
Hillingdon * complications	0.7322	0.3492	**	2.0797	1.0489	4.1234
Luton & Dunstable * complications	0.3223	0.3602	-	1.3803	0.6814	2.7962
Northwick Park * complications	0.1630	0.5643	-	1.1770	0.3894	3.5574
St Mary's * complications	0.6738	0.4496	-	1.9616	0.8126	4.7353
Stevenage * complications	0.9959	0.4469	**	2.7072	1.1275	6.4998
Watford * complications	-0.1676	0.7865	-	0.8457	0.1810	3.9511
Welwyn Garden City * complications	0.4508	0.3555	-	1.5695	0.7819	3.1504
West Middlesex * complications	1.1711	0.3194	***	3.2256	1.7248	6.0326
High risk at end of pregnancy (reference = no)						
Yes	-1.2039	0.0998	***	0.3000	0.2467	0.3648
Duration of stage 1 of labour (reference = <3 hours)						
3 - <6 hours	-0.0802	0.1194	-	0.9229	0.7304	1.1662
6 - <9 hours	-0.1250	0.1405	-	0.8825	0.6700	1.1623
9+ hours	-1.1183	0.1281	***	0.3268	0.2543	0.4201
Missing	-0.2507	0.2312	-	0.7783	0.4946	1.2245
Birthweight (reference = 2500g-3999g)						
<2500g	-1.8107	0.2610	***	0.1635	0.0981	0.2728
4000g+	0.2321	0.1128	**	1.2613	1.0112	1.5732

Table 4.15 (cont'd): Results of 'who achieves a planned home birth?' model, based on all who intended a home birth at the end of pregnancy (n=7,037)

	Log odds	Standard error	p-value of log odds	Odds ratio	95% confidence interval for OR	
Parity (reference = multipara)						
Primipara	-0.9448	0.1039	***	0.3888	0.3171	0.4766
Mother's ethnic group (reference = White European)						
Black Caribbean	-0.1708	0.3150	-	0.8430	0.4547	1.5630
Oriental/Mediterranean/Black African/South Asian	-0.5204	0.2187	**	0.5943	0.3871	0.9123
Other	0.1686	0.2272	-	1.1836	0.7583	1.8474
Missing	0.2689	0.2898	-	1.3085	0.7415	2.3092
Interpreter required? (reference = no)						
Yes	-1.4478	0.5618	**	0.2351	0.0782	0.7071
Constant	3.4390	0.1678	***	n/a	n/a	n/a

*** p<0.01 / ** p<0.05 / * p<0.1

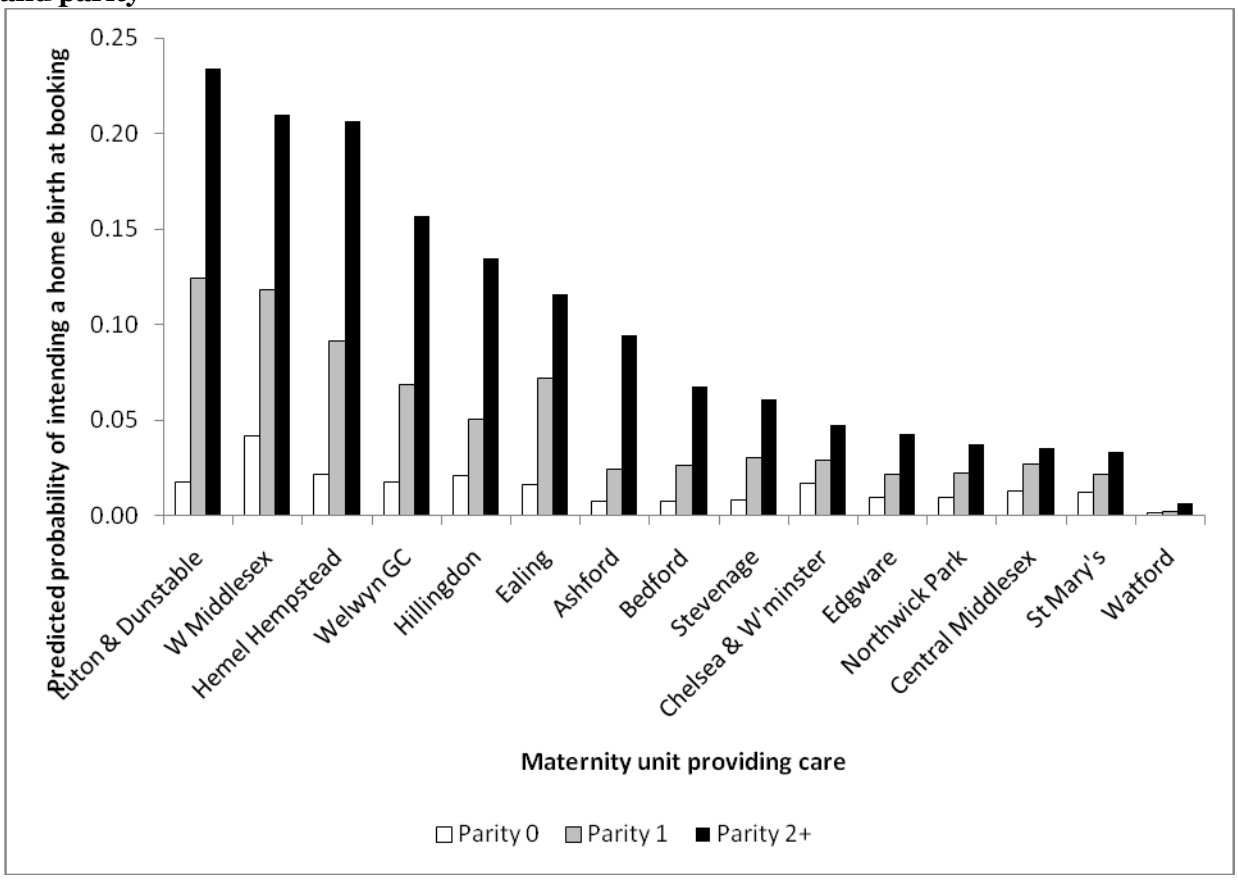
In the following discussion, results are shown as predicted probabilities. As noted in Section 3.3.6, care should be exercised when interpreting predicted probabilities for covariates involved in interaction terms. The predicted probability calculation assumes that all other covariates are held at their reference value.

Hospital / parity

In the 'intention at booking' and 'changing from hospital to home' models, the main effect for parity explained more of the variance than the other covariates, and the second highest proportion of the variance in the 'achieving a planned home birth' model. Parity was less important in the 'changing from home to hospital' model, but still featured in it. Hospital was also important in all four models.

Figure 4.24, which shows how the interaction between hospital and parity was associated with intention at booking, indicates that the predicted probability of intending a home birth at booking increased in line with parity no matter which hospital was providing care, but that the size of the difference between higher-parity and lower-parity women varied by hospital. It should be noted that the predicted probabilities shown in Figure 2.24 are for the reference years of 1997-98. Because hospital also interacts with year (see Figure 4.34), the predicted probabilities for other years will be different, but the interaction effect between hospital and parity is the same for all years.

Figure 4.24: Predicted probability of intending a home birth at booking, by hospital and parity



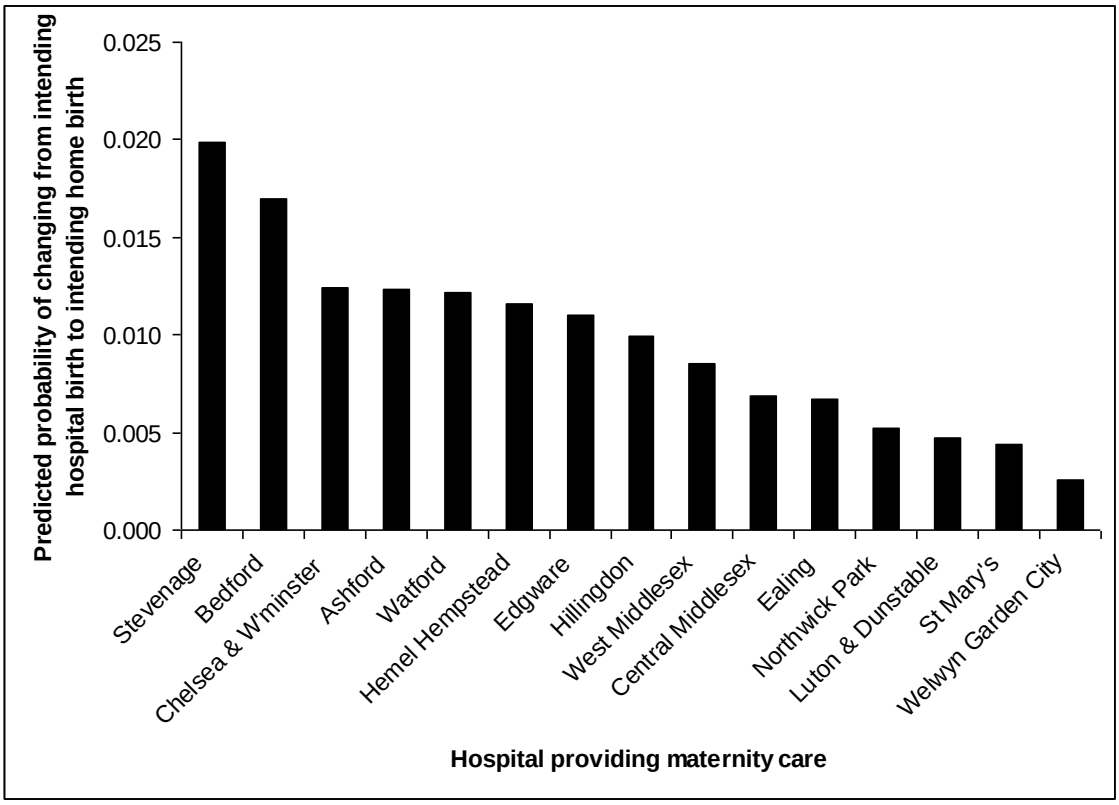
No matter which hospital was providing maternity care, women having their first baby tended not to intend a home birth at booking, although at the West Middlesex the predicted probability for parity 0 women was higher than the predicted probability for parity 2+ women receiving care from: Northwick Park, Central Middlesex, St Mary's or Watford if other observed covariates were held at their reference values.

For women having their second or subsequent baby, all other observed covariates being equal, the predicted probability of intending a home birth at booking was highest among those receiving care from Luton & Dunstable, West Middlesex or Hemel Hempstead. At the Watford unit, predicted probabilities were low, regardless of parity.

The two 'changing intention' models found that primiparae (first-time mothers) were highly unlikely to change intention from hospital to home (odds ratio of 0.25 in comparison to women having their second baby), and more likely than multiparae to change intention from home to hospital (odds ratio of 1.39). The 'who achieves a planned home birth?' model found that primiparae who intended a home birth at the end of pregnancy were less likely than multiparae to give birth at home, even when risk status and duration of labour were held constant. All other observed covariates being equal, the odds of a primipara who intended a home birth at the end of pregnancy achieving one were 0.39 those of a multipara doing so. Therefore, not only were primiparae unlikely to express an intention to give birth at home at the outset, those who did express this intention were less likely than multiparae to carry it through to the end of pregnancy, and to convert it into a planned home birth.

Figure 4.25 shows that, even after factors such as risk status and parity were taken into account, the predicted probability of a woman changing her intention from hospital to home varied according to hospital. Women at Stevenage and Bedford were most likely to change, and those at Welwyn Garden City were least likely to do so.

Figure 4.25: Predicted probability of changing from intending a hospital birth to intending a home birth, by hospital providing maternity care



Similarly, Figure 4.26 shows that the predicted probability of a woman changing her intention from home to hospital varied according to which hospital was providing her care. Women who intended a home birth at booking and did not develop high-risk factors were most likely to change their intention if they were receiving care from the Chelsea & Westminster or Ashford units. Those who did develop high-risk factors were most likely to change their intention if they were receiving care from the Watford or Welwyn Garden City units.

Figure 4.26: Predicted probability of changing from intending a home birth to intending a hospital birth, by hospital providing maternity care and whether or not high-risk factors developed during pregnancy

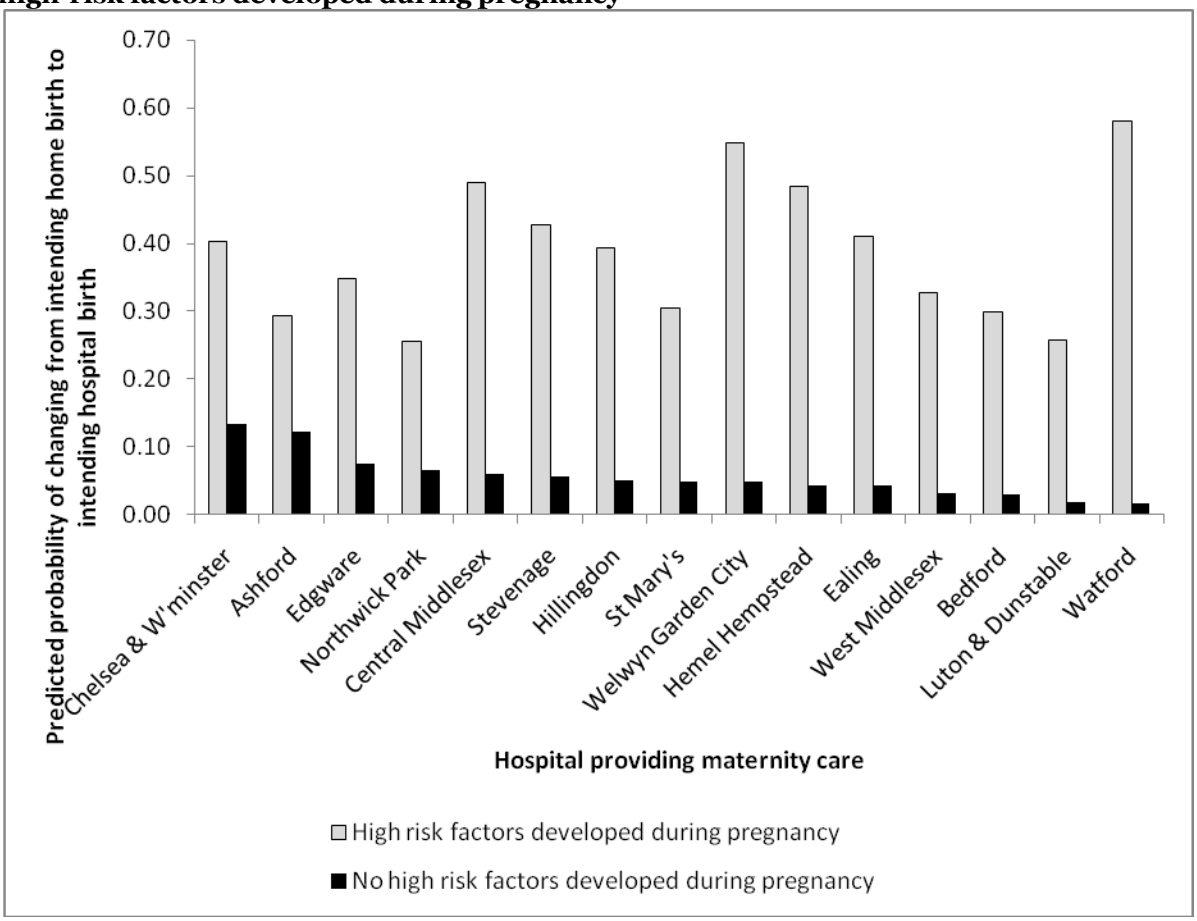
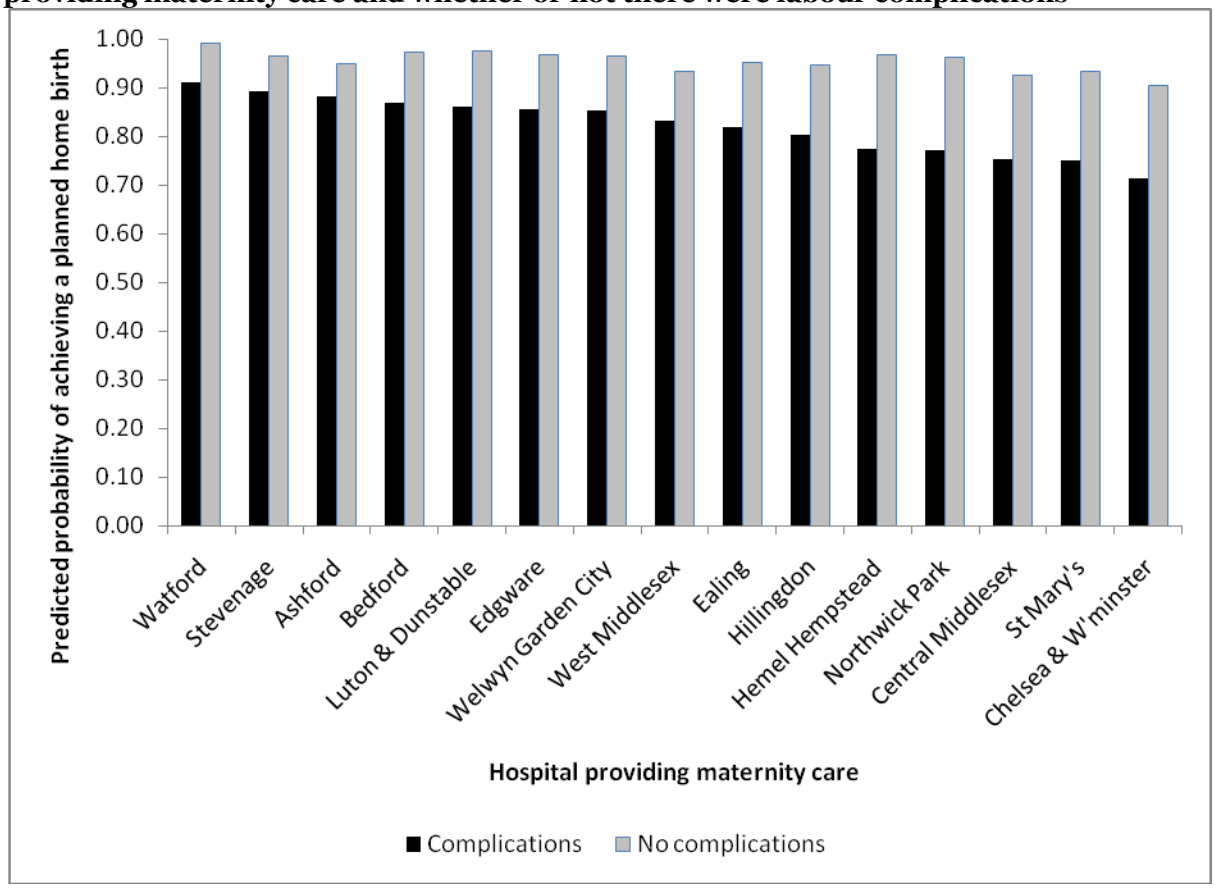


Figure 4.27 shows that women who intended a home birth at the end of pregnancy were likely to achieve a planned home birth regardless of which hospital was providing their care, and regardless of whether or not they experienced complications in labour. However, there was still variation by hospital. Despite being the least likely to express this intention at booking (see Figure 4.24), women under the care of Watford hospital were most likely to achieve a planned home birth whether or not they developed complications in labour. Women under the care of the Chelsea & Westminster unit were least likely to achieve a planned home birth, again whether or not they developed complications. Hemel Hempstead stands out because women under its care were among the most

likely to achieve a planned home birth if there were no complications, but among the least likely to do so if there *were* complications.

Figure 4.27: Predicted probability of achieving a planned home birth, by hospital providing maternity care and whether or not there were labour complications

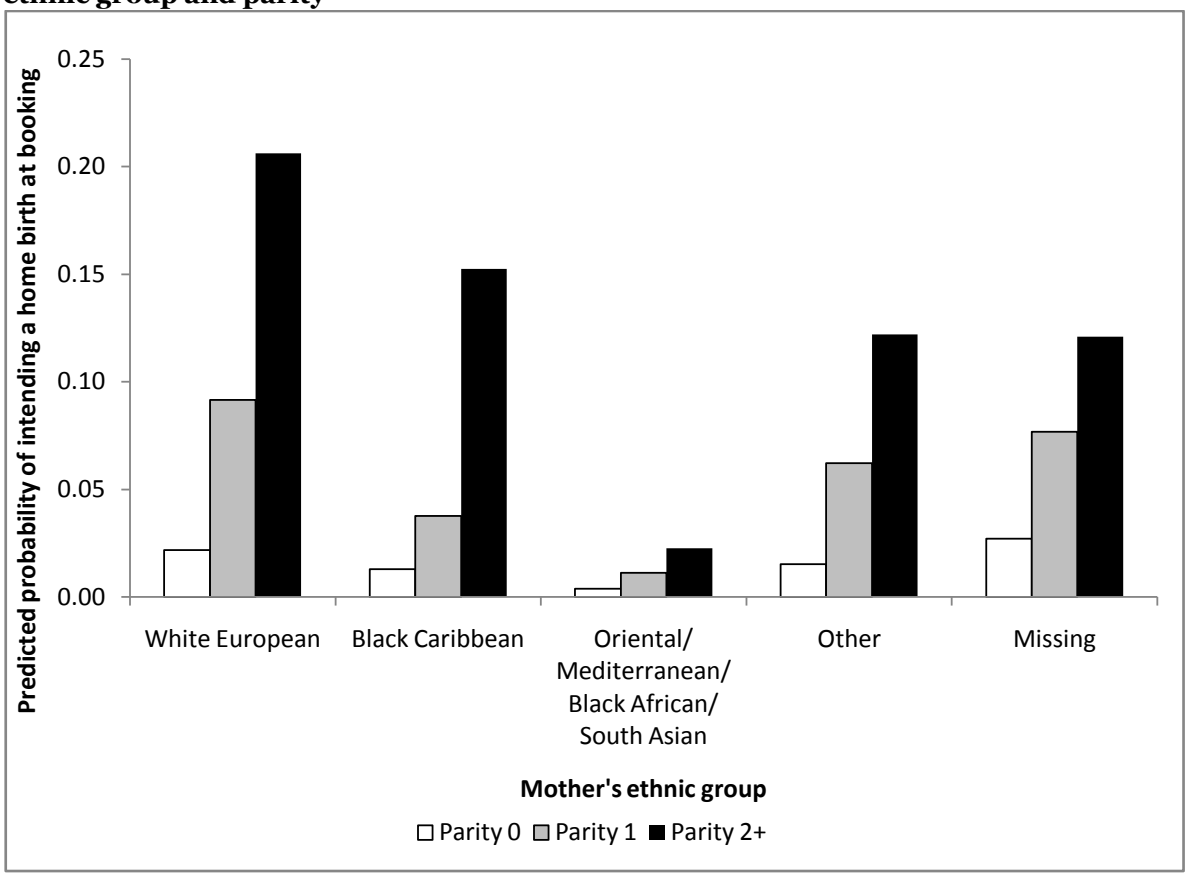


Ethnic group / parity

Ethnic group was the third explanatory variable to be added to the 'intended place of birth at booking' model, and the association remained strong even after the addition of other explanatory variables. Ethnic group was also significant in the 'changing from hospital to home' and 'achieving a planned home birth' models, but not in the 'changing from home to hospital' model.

Figure 4.28 shows that, all other observed covariates being equal, women having their first baby tended not to intend a home birth, and that the difference between higher- and lower-parity women was greatest among women in the White European and Black Caribbean groups, and smallest among Oriental/Mediterranean/Black African/South Asian women.

Figure 4.28: Predicted probability of intending a home birth at booking, by mother's ethnic group and parity



The odds of a Oriental/Mediterranean/Black African/South Asian woman changing her intention from hospital to home between the booking appointment and the start of labour were 0.11 those of a White European woman doing so, and the odds of an Oriental/Mediterranean/Black African/South Asian woman who intended a home birth at the end of pregnancy going on to have one were 0.59 those of a White European woman. Therefore, not only were Oriental/Mediterranean/ Black African/South Asian women unlikely to express an intention to give birth at home at the outset, those who did express this intention were less likely than White European women to carry it through to the end of pregnancy, and to convert it into a planned home birth.

English language skills

All other observed covariates being equal, among those who intended a home birth at the end of pregnancy, the odds of a woman who needed an interpreter giving birth at home were 0.24 those of a woman who did not need an interpreter, even when ethnic group was held constant.

Age / parity

At the bivariate level, the association between intention at booking and mother's age was among the strongest. Once parity was held constant, age became less important (see Table F.1 in Appendix F), indicating that some of the variation by age was due to older women tending to be higher parity.

Age was also a predictor of changing intention after the booking appointment, but not of achieving a planned home birth.

Figure 4.29 shows that, all other things being equal, women having their first baby were unlikely to intend a home birth at booking regardless of their age, and that the predicted probability of intending a home birth at booking was lowest among women aged under 20 and highest among women aged 30+. The difference between higher- and lower-parity women was greatest in the over-30 age groups. The difference between the older and younger mothers was most marked among those having their third or subsequent baby. All other observed covariates being equal, women aged 35+ were not significantly different from those age 30-34 in terms of their propensity to intend a home birth at booking. This indicates that the relatively low planned HMR among women aged 40+ (see Figure 4.14) was probably due to their being more likely to be high-risk than to their age *per se*.

Figure 4.29: Predicted probability of intending a home birth at booking, by mother's age and parity

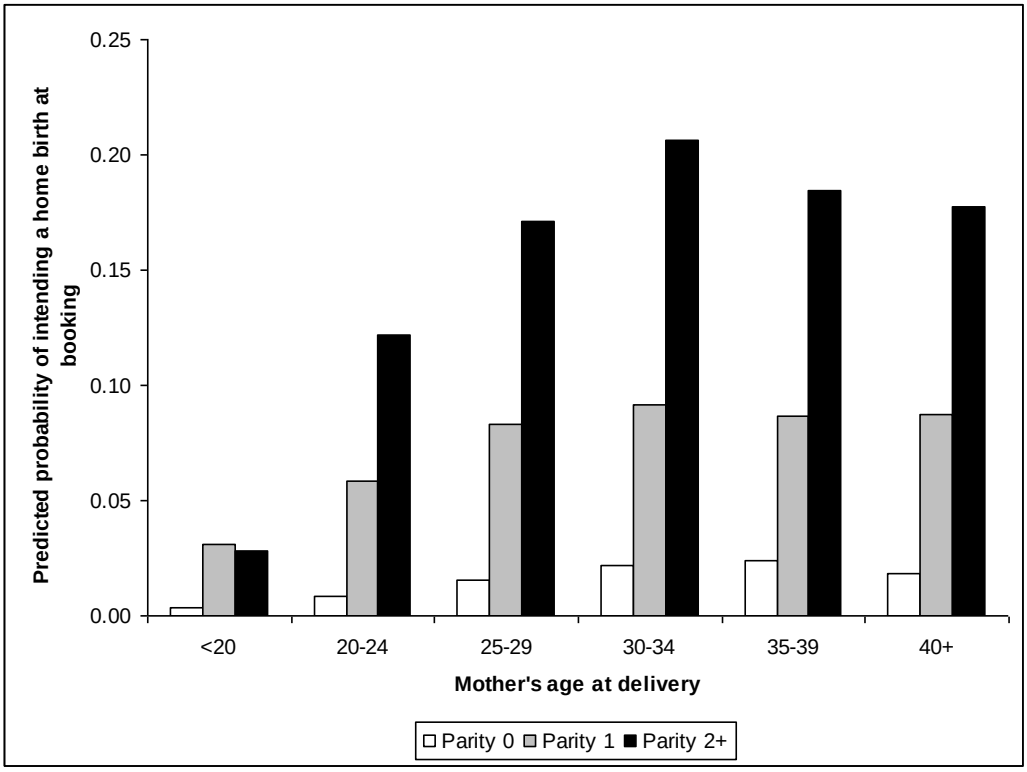
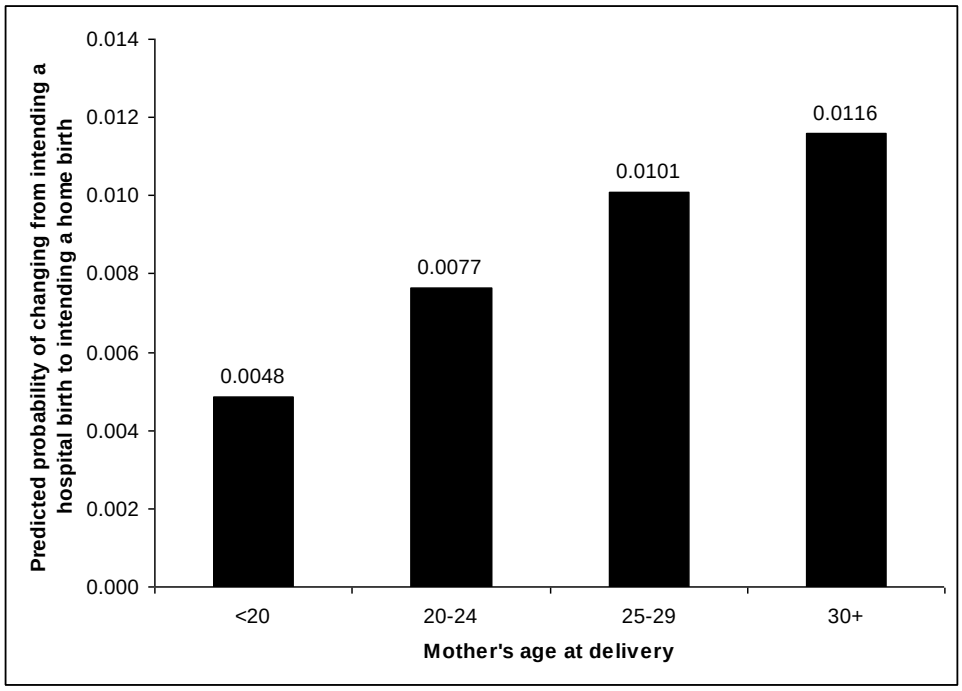


Figure 4.30 shows that, the older the mother, the more likely she was to change her intention from hospital to home between the booking appointment and commencement of labour. Correspondingly, the 'changing from home to hospital' model found that, the older the mother, the *less* likely she was to change her intention from home to hospital.

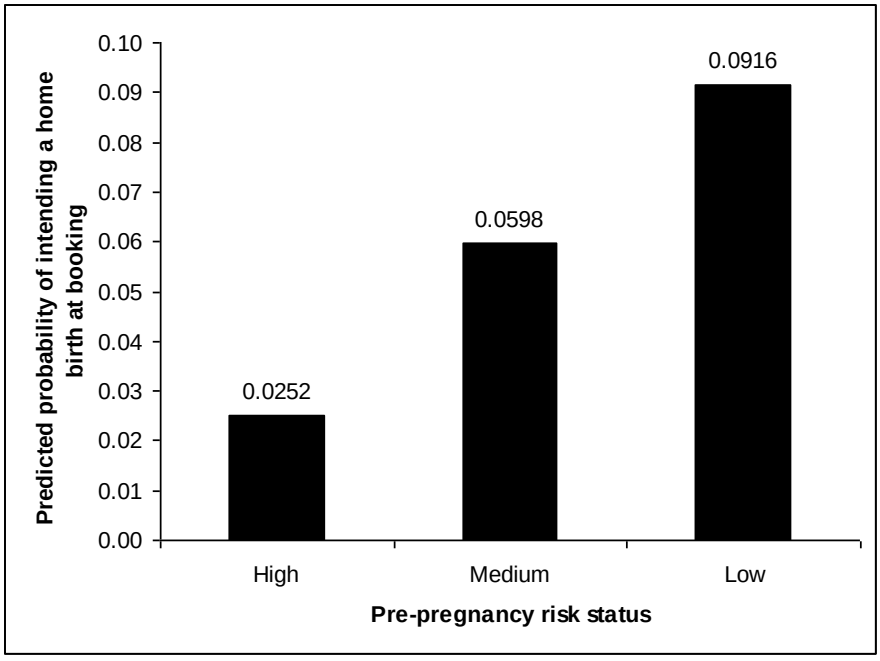
Figure 4.30: Predicted probability of changing from intending a hospital birth to intending a home birth, by mother's age



Risk status

Figure 4.31 shows that the predicted probability of a woman with a low pre-pregnancy risk status[47] intending a home birth at booking was 3.6 times higher than that of an identical woman with a high pre-pregnancy risk status.

Figure 4.31: Predicted probability of intending a home birth at booking, by pre-pregnancy risk status



[47] Based on factors that would usually have been evident at booking (see Section 4.3.1.1)

Risk status was also a predictor of changing the intended place of birth during the course of pregnancy. The development of high-risk factors during pregnancy was by far the most important predictor of changing intention from home to hospital (main effect odds ratio: 21.85). Similarly, taking into account both conditions that would usually have been evident before pregnancy and those that would usually have developed during pregnancy, the odds of a woman with a high-risk pregnancy changing her intention from hospital to home were just 0.18 those of a woman with a low- or medium-risk pregnancy doing so.

The 'changing from home to hospital' model also found that, among those who intended a home birth at booking, women who would have been classed as 'medium-risk' at booking were more likely than those who would have been classed as 'low-risk' at booking to change their intention from home to hospital (odds ratio 1.80). Strangely, however, those who would have been classed as 'high-risk' at booking were no more likely than those who would have been classed as 'low-risk' at booking to change from home to hospital.

Among those who intended a home birth at the end of pregnancy, the odds of a woman with a high overall antenatal risk status going on to give birth at home were 0.30 those of an otherwise identical woman who did not have a high overall antenatal risk status. Being high-risk before labour commenced, therefore, was a predictor of being transferred to hospital in labour, even if there were no complications during labour.

As expected, the strongest predictor of whether or not a woman who intended a home birth at the end of pregnancy went on to have one was the development of complications in labour. Figure 4.27 shows that, among those who intended a home birth at the end of pregnancy, women who experienced complications in labour were less likely than those who did not to achieve a planned home birth.

Number of ultrasound scans during pregnancy

Figures 4.32 and 4.33 show that, even when factors such as parity, hospital and risk status were taken into account, the number of ultrasound scans administered during pregnancy was associated with changing the intended place of birth. The more scans received, the less likely the woman was to change her intention from hospital to home, and the more likely she was to change her intention from home to hospital. If this is a causal relationship, it could operate in either direction.

Figure 4.32: Predicted probability of changing from intending a hospital birth to intending a home birth, by number of ultrasound scans during pregnancy

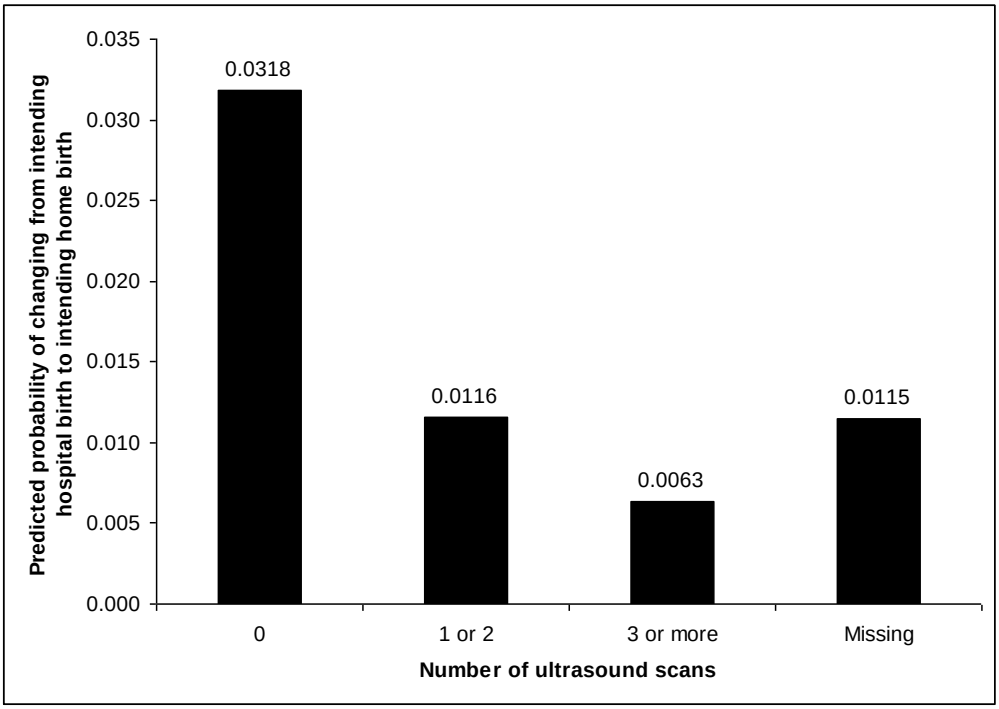
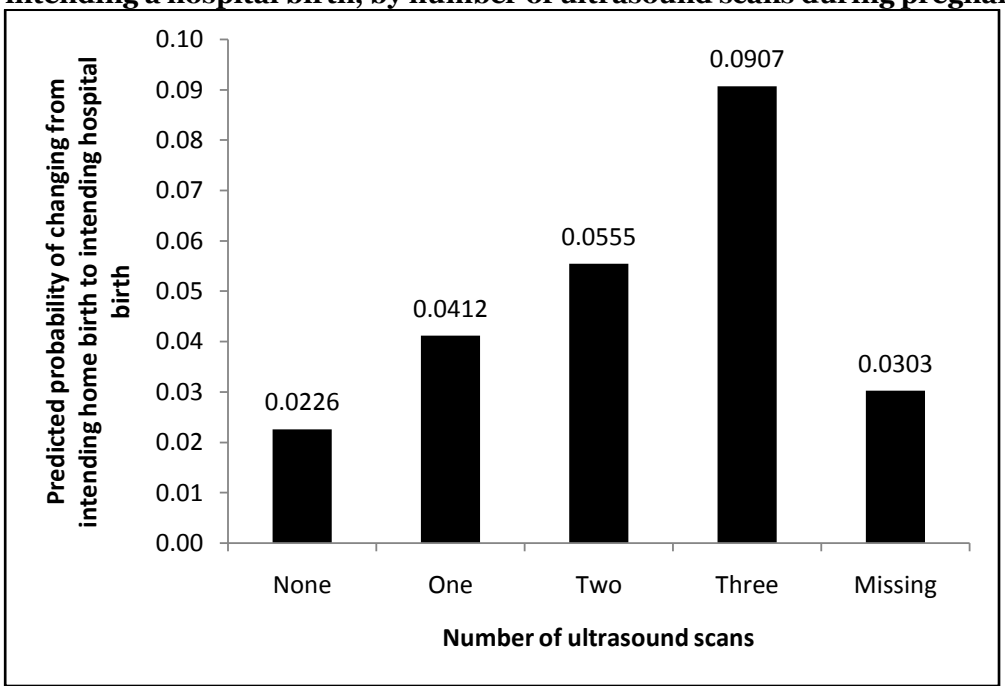


Figure 4.33: Predicted probability of changing from intending a home birth to intending a hospital birth, by number of ultrasound scans during pregnancy



Duration of labour

Among those who had intended a home birth at the end of labour, labour length was a strong predictor of a woman's likelihood of going on to give birth at home. The odds of a woman whose first stage of labour lasted 9 hours or more doing so were 0.33 those of a woman whose first stage lasted less than 3 hours, regardless of risk status and other factors. As noted in Section 4.3.1.2, the

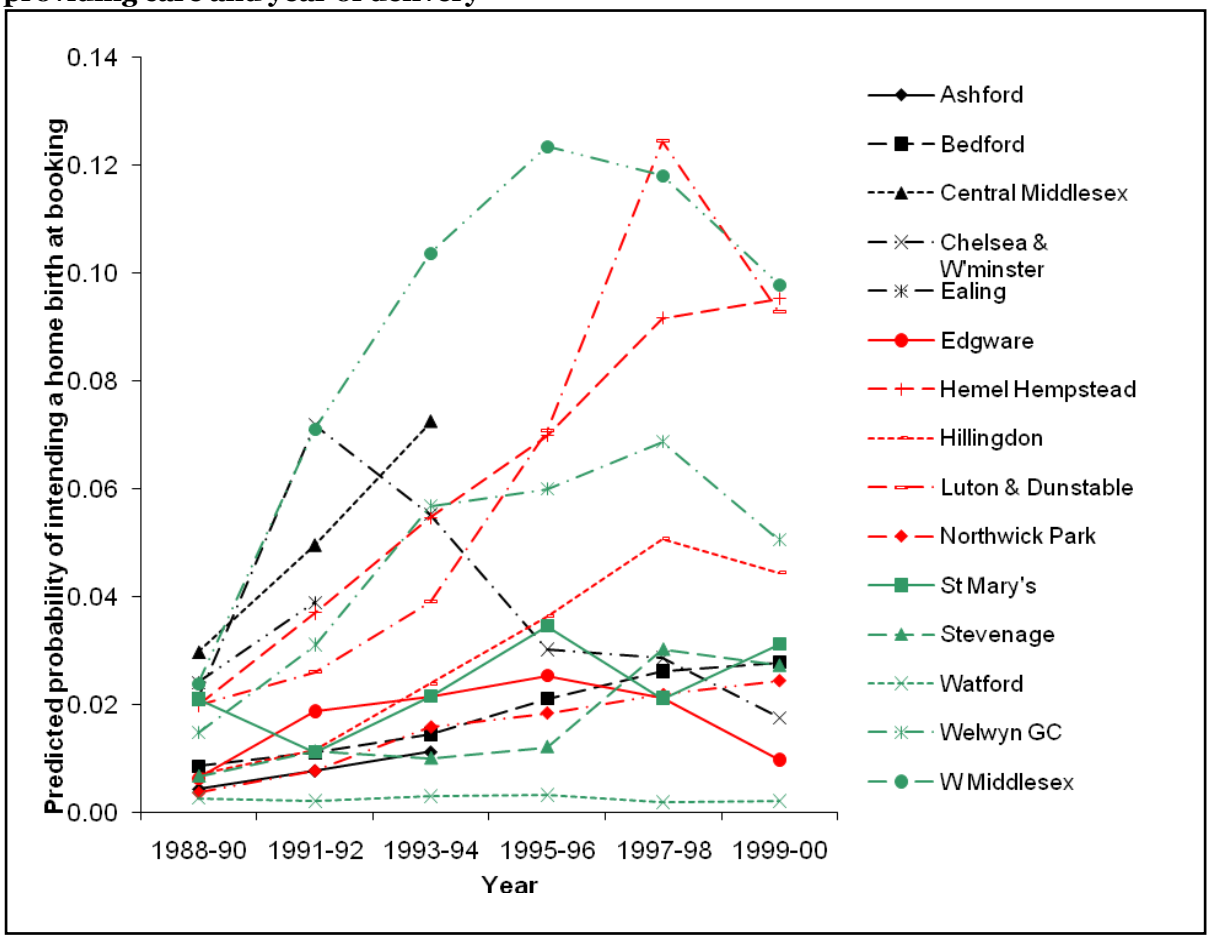
NICE guideline states that transfer to hospital should be considered if there is "delay" in the first or second stages of labour. Because delay in labour was held constant via the 'labour complications' variable, these results indicate either that attending midwives were using labour length *per se* as an indicator of heightened risk, or that women having long labours were more likely to request a transfer to hospital.

Hospital / year

As noted above, hospital had a very strong association with intention at booking, and year was the fourth explanatory variable to be added to the model. Out of all the interactions tested, the interaction between hospital and year made far and away the largest improvement to the fit of the additive 'intention at booking' model (see Table F.1 in Appendix F).

Figure 4.34 shows that, all other observed covariates being equal, the predicted probability of intending a home birth at booking varied considerably depending on hospital and year of delivery. Hemel Hempstead, Stevenage, Bedford, Northwick Park and Luton & Dunstable showed increases over time. St Mary's and Watford showed very little change over the 13-year period. Six hospitals showed a relatively sharp drop between 1997-1998 and 1999-2000. Chelsea & Westminster was unusual in that its predicted probability fell sharply after 1991-2.

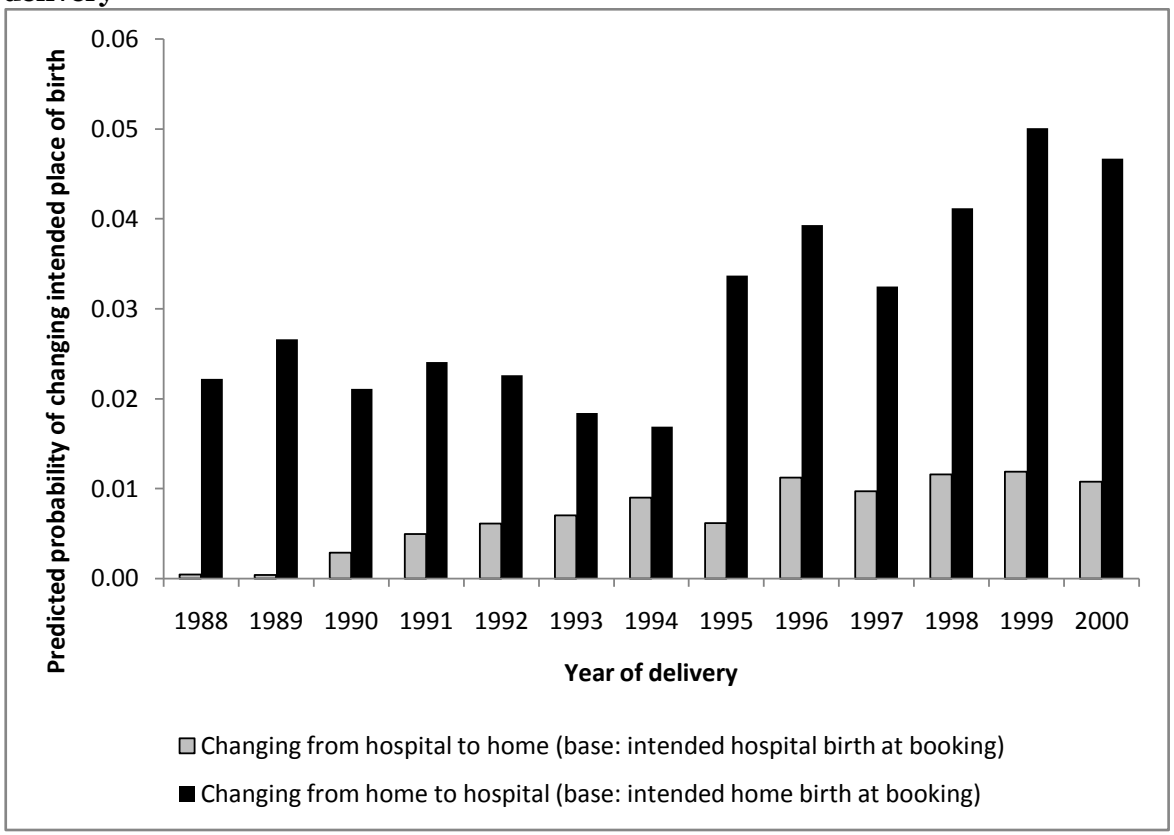
Figure 4.34: Predicted probability of intending a home birth at booking, by hospital providing care and year of delivery



These predicted probabilities broadly reflected the patterns evident in the unadjusted data, indicating that, even when the casemix of an individual hospital was taken into account, much of the variation by hospital and year remained. However, the predicted probabilities for West Middlesex and Luton & Dunstable were higher than the observed percentages relative to the other hospitals, suggesting that, had these two hospitals had a more 'home birth prone' clientele, their observed HMR would have been higher. Conversely, the predicted probabilities for Watford, Stevenage and Bedford were lower than might have been expected from the observed percentages, suggesting that these three hospitals may have been relatively discouraging of home birth.

Figure 4.35 shows that, in the later years of the SMMIS database, it was more likely that women would change their intended place of birth after booking, especially from home to hospital. This would have slightly counteracted the greater tendency to intend a home birth at booking in these later years (see Figure 4.6).

Figure 4.35: Predicted probability of changing intended place of birth, by year of delivery

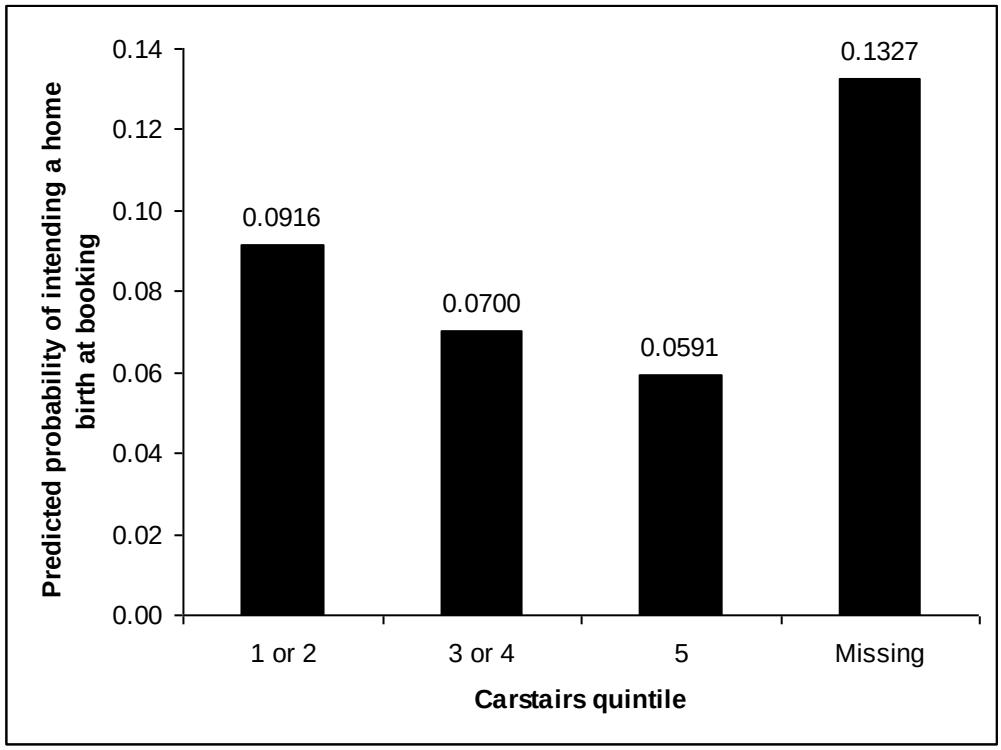


Area deprivation

Figure 4.36 shows that, all other observed covariates being equal, the predicted probability of intending a home birth at booking was 1.6 times higher among women living in areas classed as within the 40% least deprived than among women living in areas classed as the 20% most deprived, according to the Carstairs deprivation index. As indicated by the descriptive analysis (see Section

4.4.9), the predicted probability of intending a home birth at booking among those whose Carstairs classification was missing was very high. This was unexpected, because a large proportion of the records with missing Carstairs classification were from 1988-90 (a period when relatively few women intended a home birth) and from St Mary's and Chelsea & Westminster (hospitals with relatively low percentages of women intending a home birth, and relatively high levels of deprivation).

Figure 4.36: Predicted probability of intending a home birth at booking, by Carstairs quintile



Carstairs quintile was not a predictor of changing intention during pregnancy, nor of achieving a planned home birth, once other explanatory variables were held constant, indicating that the variation by deprivation level occurred before pregnancy or during its early stages, rather than as the pregnancy progressed.

Previous low birthweight baby

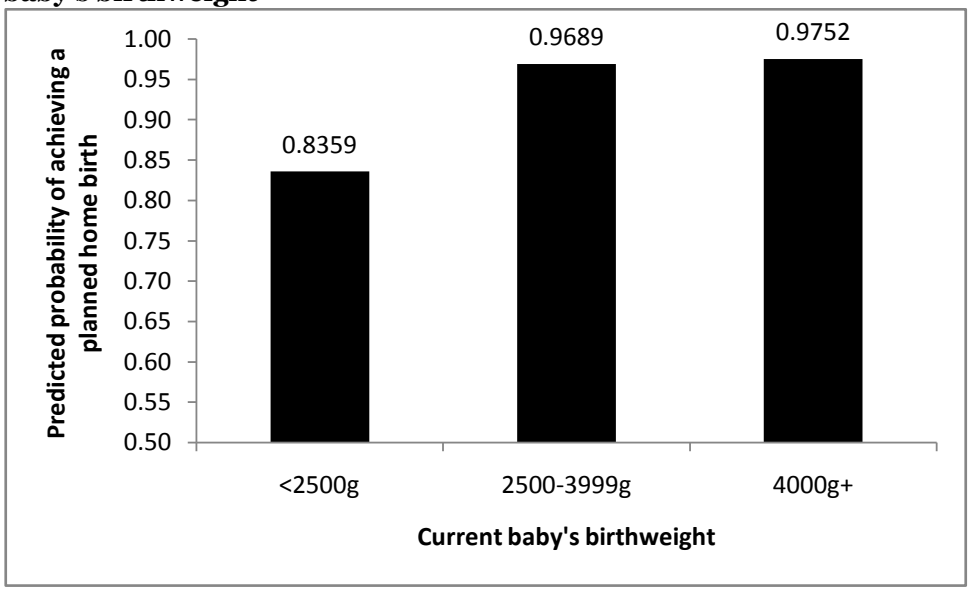
The odds of a woman whose last baby was of low birthweight (<2500g) intending a home birth at booking were 0.48 those of a woman who did not fit this description. Furthermore, among those who intended a home birth at booking, the odds of a woman whose last baby was of low birthweight changing her intention to hospital were 2.19 those of a woman who did not fit this description doing so. Therefore, not only were women who had had low-birthweight babies less likely to intend a home birth at booking, those who did were less likely to carry this intention through to the end of pregnancy, regardless of their risk status and other factors.

Current baby's birthweight

The 'changing from home to hospital' model showed that, among those who intended a home birth at booking, women who went on to have a low birthweight baby (<2500g) were more likely than those who went on to have a baby weighing 2500g or more to change their intended place of birth during pregnancy (odds ratio 4.06), regardless of risk status and other factors.

Figure 4.37 shows that, among those who intended a home birth at the end of pregnancy, those who went on to give birth to a low birthweight baby were much less likely to achieve a planned home birth than those whose babies were not of low birthweight, regardless of other factors such as risk status, labour duration or ethnic group. Figure 4.37 also shows that, all other things being equal, women carrying a baby weighing more than 4000g (8lb 11oz) were most likely to achieve a planned home birth, which is perhaps surprising given the anecdotal evidence (e.g. Davies, 2004) that women who are 'large for dates' can be discouraged from giving birth at home.

Figure 4.37: Predicted probability of achieving a planned home birth, by current baby's birthweight



Although there was a positive correlation between last baby's birthweight and current baby's birthweight (correlation coefficient 0.44), there was very little correlation between the last baby being low birthweight baby and the current one being low birthweight (0.11). For this reason, it was judged to be appropriate to keep both variables in the models.

Relationship status

Being single was a predictor both of intending a hospital birth at booking and of changing intention to a hospital birth during pregnancy. Those who were classed as 'single and unsupported' were less likely than partnered women to intend a home birth at booking (odds ratio 0.69). Among those who intended a hospital birth at booking, the odds of a single woman changing her intention to a home

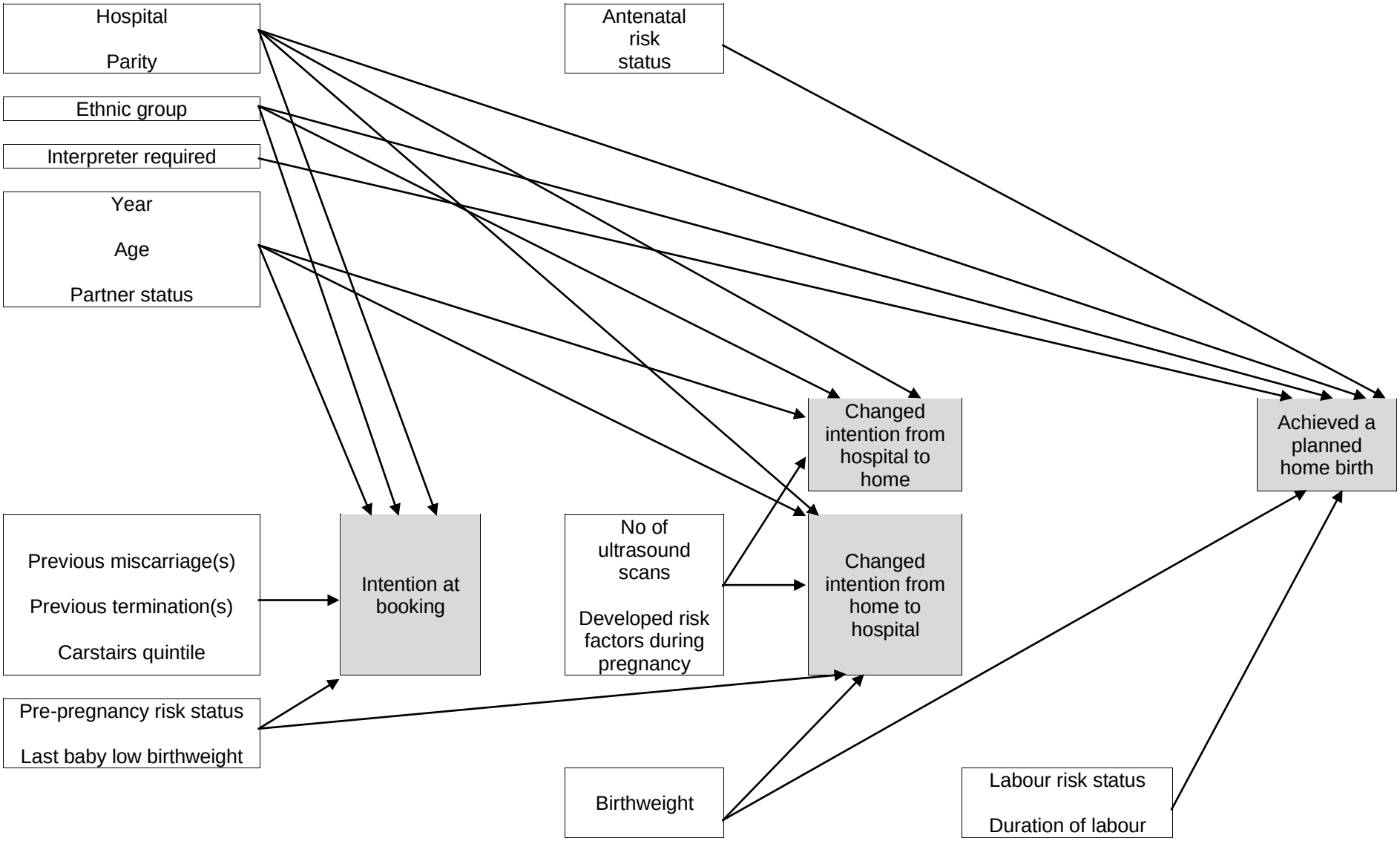
birth during pregnancy were 0.71 those of a partnered woman doing so. Correspondingly, among those who intended a home birth at booking, the odds of a single woman changing her intention to hospital birth during pregnancy were 1.50 those of a partnered woman doing so.

Previous termination(s) & miscarriages
All other things being equal, women who had had one or more previous pregnancies terminated were slightly less likely to intend a home birth at booking (odds ratio 0.80), as were women who had had one or more previous miscarriages (odds ratio 0.87). After booking, however, previous terminations/miscarriages did not predict a change in intended place of birth, nor achieving a planned home birth.

4.6.2 Summary

Figure 4.38 summarises the explanatory variables which had an independent association with each of the four response variables, which are represented by the shaded boxes. This diagram should be read from left to right, as it presents each variable in chronological order (e.g. the variables on the far left are those which will usually have been established in advance of the booking appointment). To simplify the diagram, explanatory variables which had an independent association with the same set of response variables appear in the same box.

Figure 4.38: Explanatory variables associated with each outcome variable in the modelling of 'who intends/has a home birth'



4.7 Discussion & conclusions

The main messages from this analysis relate to the question of *choice* of place of birth. That women should have an informed choice about where to give birth has been Government policy in England and Wales since 1993 (see Section 2.2). If women in the North West Thames RHA area in 1988-2000 were being given a real choice and unbiased advice about place of birth, external factors such as hospital and year would not be associated with intended and actual place of birth once socio-demographic and obstetric factors were held constant. However, at every stage in the process, external factors had an independent association with intended and actual place of birth.

Two explanatory variables stood out due to having an independent association with the outcome at every stage of the process: the woman's parity and the hospital providing her maternity care. Whatever their age, area deprivation level, risk status or ethnic group, women having their first baby tended not to express an intention at booking to give birth at home. Furthermore, those who did were more likely than multiparae to be transferred to hospital-based care during either pregnancy or labour, *whether or not they developed pregnancy or labour complications*. This would suggest that first-time mothers and their care-givers tended to lack confidence in their ability to give birth without medical assistance. This raises questions over the implicit and explicit messages about risk that women receive from maternity services and other sources before conception, during pregnancy and during labour, and also over the confidence and skills of midwives attending women labouring at home.

Regardless of the risk status of the pregnancy and the socio-demographic profile of the pregnant woman, her likelihood of intending and having a home birth varied according to which hospital was providing her maternity care. This is strong evidence to indicate that some hospitals were more 'pro home birth' than others and/or that some midwifery teams were more confident/competent at handling home births than others, and that these factors influenced decisions about place of birth. Given this, it is difficult to argue that there was equality of access to choice at this point in time and in this region. If this remains true in the present day, one policy response would be to encourage women who are interested in home birth to book with a 'home-birth-friendly' hospital, even if it is not her nearest one. In reality, however, it is unlikely that a woman will be comfortable with having to receive care from a hospital which is not within reasonable travelling distance. Furthermore, hospitals tend not to offer a home birth service to women who are 'out of area' (Options UK, 2009), so a woman attempting to book with a more distant hospital is likely to find that this option is denied her. Therefore, if the delivery of the choice agenda is to be achieved, it will be important to ensure that all hospitals follow the same protocol in terms of encouraging and accepting women who show an interest in home birth.

This raises a more fundamental question about the way the maternity care system is structured. Because all midwives operate out of hospitals rather than as relatively autonomous primary care practitioners, they are likely to be strongly influenced by the culture of the hospital at which they are based. It is notable that, in parts of the UK with relatively high home birth rates, midwives tend to have a more autonomous role (Sandall et al, 2001a; Leyshon, 2004). The 2008 Healthcare Commission report on maternity services in England contained the telling statistics that 28% of hospital doctors involved in maternity care and 58% of midwives felt that they did not have shared goals. Because it is not in the interests of obstetricians to offer women more choice in relation to place of birth, the choice agenda will be delivered only if midwives take a leading role in making it happen; indeed Rogers et al (2005) and Lavender & Chapple (2004) expressed the view that strong leadership from the midwifery profession was a necessary prerequisite for such change. Midwives' relatively lowly position within the professional hierarchy in most parts of the UK is therefore almost certainly a barrier to current Government policy being implemented (Kirkham & Stapleton, 2004).

Some have argued that midwives themselves would resist a change to the existing structure; Sandall et al (2001b) noted that a midwife who is committed to delivering the choice agenda could easily end up neglecting her own personal and family commitments. There is evidence of this among Dutch midwives (Bakker et al, 1996) and among 'caseload' midwives in the UK (Sandall et al, 2001a). Some (e.g. Stephens, 2005) have suggested that the answer may lie in creating two categories of midwife: one working primarily in the community and on home births, and the other primarily in hospital. Sandall (1995) expressed concern that this risked creating a two-tier midwifery profession, under which those able to commit to full-time, flexible working would have higher status and better rewards than those unable to do so. She saw this is more worrying for midwifery than for other professions, because those unable to commit to full-time work are more likely to have given birth themselves, which (arguably) allows them to bring their own experience to bear on their work, and to be more empathetic towards the women in their care. Robinson (2009) and Lavender & Chapple (2004) expressed the opinion that a two-tier system already exists informally (labour ward midwives versus community midwives) and that labour ward midwives have higher status than community midwives. Lavender & Chapple also found that midwives were receptive to changing work practices if they perceived that the change would impact positively on the service they provide to women. If so, it would be possible to bring about a change in the structure of maternity services without alienating a large number of key staff.

The SMMIS analysis found that some socio-demographic groups were more 'home-birth-prone' than others, even when factors such as risk status, hospital and obstetric history were held constant. Older, middle-class, partnered, white and/or English-speaking women were all more likely to intend a home birth at booking. This could be due to other groups being less likely to want home birth, but it could be because they were less likely to be offered the option. Several researchers and

commentators have suggested that lack of opportunity is behind these differences rather than lack of desire for home birth among younger, working-class, single women and ethnic minorities:

- In their review of the maternity services in England in 2007, the Healthcare Commission (2008) found that younger women, women from minority ethnic groups and women without a partner were less likely to feel that they were given a choice about place of birth.
- Nolan (2002) suggested that the power imbalance between medical professionals and pregnant women is even more marked when the pregnant woman is from a 'lower' social class. She also cited Green et al (1998) to support her argument that the needs and desires of middle class women in the UK are not very different to those of other women, and quoted the 1990 National Association of Health Authorities and Trusts (NAHAT) report as evidence that UK women's ethnicity is irrelevant to their desires in relation to childbirth.
- Day-Stirk (2005) described a case study of a woman living in poverty being overjoyed that her midwife supported her desire for a home birth – she had expected to have her request refused because she was unused to being 'allowed' to have a choice.

The SMMIS analysis showed that, not only were younger, single women less likely to intend a home birth at booking, those who did were more likely than older, partnered women to transfer to hospital-based care during pregnancy, regardless of the existence or otherwise of clinical complications. This may be due to younger, single women having less confidence in their ability to give birth without technical assistance, but it may be an indication that they came under more pressure to conform to the medical model of maternity care and/or were less able to resist such pressure.

It is also notable from the SMMIS analysis that white, English-speaking women who intended a home birth were less likely to be transferred to hospital during labour, regardless of their risk status. This suggests that cultural and/or communication issues may have been a barrier to women from some ethnic minority groups achieving their desire for a home birth. In multicultural areas, therefore, it is important that midwives attending home births understand and are comfortable working with women from different cultures, and that adequate interpretation arrangements are in place when attending a non-English speaking woman in labour.

The SMMIS analysis also found that a woman's obstetric history was associated with her intended place of birth at booking. Women who had had previous miscarriage(s), termination(s) and/or a low birthweight baby were less likely to intend a home birth at booking, regardless of risk status, hospital and socio-demographic profile. Among those who intended a home birth at booking, having previously given birth to a low birthweight baby was also associated with a greater likelihood of transferring to hospital-based care during pregnancy. This may be due to women with less-than-ideal obstetric histories being more nervous about their ability to deliver successfully at home. On the other hand, Davies (2004) reported that maternity service providers sometimes gave spurious

reasons for refusing women the option of a home birth, so it is possible that aspects of women's obstetric history were being used to deny them the option of a home birth.

The fact that such a small proportion of women in the SMMIS database changed their intended place of birth after the booking appointment suggests that women were (or felt they were) being expected to decide on their place of birth at or before the booking appointment, and not given much opportunity to revisit this decision as the pregnancy progressed. In 2008, NICE recommended that the booking appointment should take place before 10 weeks' gestation, and the Healthcare Commission (HC) recommended that at this appointment there should be a discussion of "the risks and benefits of different birth settings". Neither NICE nor the HC recommended that the place of birth should be decided at this appointment. Rogers et al (2005) found that women did not generally want to have to make this choice so early. It is notable that, in areas with high home birth rates, the decision about place of birth is left until late in pregnancy, and sometimes not made until labour is under way (Rogers et al, 2005; Leap, 1996; Leyshon, 2004; Sandall et al, 2001a; Ogden et al, 1997). This would suggest that the NICE guidance should specify that, although the pros and cons of different places of birth can be discussed at the booking appointment, the final decision need not be made until much later in pregnancy.

The finding that the number of ultrasound scans a woman has during her pregnancy had an independent association with a decision to change her intended place of birth regardless of the risk status of the pregnancy suggests that the receipt of medical attention during pregnancy *per se* may influence decisions about place of birth. Care should be exercised in making causal inferences here, because it is possible that those who have more scans are more likely to be forewarned about complications such as malpresentation and low birthweight and it may be this forewarning which leads to a greater preference for hospital birth, rather than the receipt of the scans *per se*. However, this may not be the whole story. Tew (1998) claimed that reliance on medical technology could lead to women having more trust in the opinions of their care providers than in what their own bodies tell them, and therefore losing confidence in their ability to give birth without intervention, leading to an expressed preference for hospital birth. Lauritzen & Sachs (2001) made a similar point, suggesting that regular checks of healthy people can lead to dependence on medical reassurance, and that "the individual has to live with a constant reassessment of her/his identity as a healthy or normal person, and thus with a constant uncertainty." The results of this analysis lend support to these viewpoints, and suggest that maternity service providers should think very carefully about the psychological implications of ultrasound scans and other technological checks during pregnancy, and only offer them if there is a clear clinical need.

Chamberlain et al (1997) reported that the main reason given by midwives for transfer from home to hospital during labour in the UK in 1994 was 'prolonged labour'. The SMMIS analysis reported here confirms that the duration of the first stage of labour had an independent association with a woman's likelihood of being transferred from home to hospital during labour, regardless of whether

or not complications developed in labour. Murphy-Lawless (1998) expressed concern that within obstetric science, deviation from the average and pathology were often – erroneously - seen as the same thing, and the results of this analysis raise questions over whether midwives are too quick to label a relatively long labour as cause for concern in and of itself. On the other hand, some or all of these transfers may have been at the woman's request (e.g. if she wanted epidural pain relief).

Again, this brings into question midwives' confidence in their ability to deliver a positive outcome to a home birth. Stephens (2005) argued that the midwifery skills required for home birth are not the same as those for hospital birth. A side-effect of the rarity of home birth in the UK is that most midwives have little or no experience of attending them, and therefore may not feel confident to do so. The 2007 Healthcare Commission review of maternity services in England (Healthcare Commission, 2008) found that midwives tended to be less confident working in the home setting than in the hospital setting. Lavender & Chapple (2004) reported that some midwives were nervous about working in low-technology settings; the technological 'back-up' (as opposed to their own skills) gave them their professional confidence. Furthermore, in 2005 the Nursing and Midwifery Council reported that: "current levels of skills and knowledge may be insufficient to support a home birth service" and that "the level of skill in midwives for detecting and dealing with complications and assessing risk was possibly much higher [before the 1970s] than today's predominantly hospital trained midwife" (Magill-Cuerdin, 2005). Lavender & Chapple (2004) suggested that midwifery training puts insufficient emphasis on the care of low-risk women in low-technology settings, and that newly-qualified midwives tend to be placed in high-technology settings first, which normalises this model of care for them. This suggests that, if the choice agenda is to be delivered effectively and uniformly, there should be a re-think of the way in which midwives are trained and their early career placements.

4.8 Chapter 4 key points

This chapter makes a novel contribution to existing knowledge in two main ways. Firstly, it uses quantitative rather than qualitative analysis to describe the types of women who plan a home birth. Very little quantitative analysis has been done on this subject in the past, and none has been published in the UK since Chamberlain et al in 1997. Of the quantitative analysis that has been done using UK data, none has ever attempted to use a multivariate method to control for confounding. Secondly, the analyses in this chapter use a pathway as a framework for understanding the types of women who plan and have a home birth, in recognition of the fact that decisions about place of birth can be made over a period of time, particularly if circumstances change during the pregnancy. The use of a pathway as a framework was possible because the database used for the modelling permitted 'intended place of birth at the end of pregnancy' to be derived (see Section 4.1). This meant that those who originally intended a home birth but changed their minds during pregnancy were classed as having intended a hospital birth, and those who

originally intended a hospital birth but changed their intention were classed as having intended a home birth. This is a truer reflection of their intentions, but most previous research has been unable to achieve this. Depending on intention at booking to define planned home births would have resulted in the 'planned home birth' group containing women who did not, in the end, plan to have a home birth. The extent to which this is a problem has never been quantitatively estimated until now.

The key messages of this chapter are as follows:

- Key variables robustly predict a woman's intended place of birth at booking, her propensity to change intention during pregnancy, and her chances of achieving a planned home birth.
- Most of these key predictors have also been identified by previous research in the UK and other countries, e.g. parity (first-time mothers tend not to plan a home birth), age (those who intend a home birth tend to be older), pregnancy risk status (higher-risk women tend not to plan a home birth) and ethnic group (certain minority ethnic groups tend not to plan a home birth).
- Additionally, the hospital which provides maternity care predicts: intended place of birth, a change in intention during pregnancy, and the achievement of a planned home birth. This holds true even when variations in a hospital's casemix are held constant. Whilst we cannot infer from this analysis that the policies and practices of individuals hospitals influence women's choices, the possibility that they do cannot be discounted.

5 Methodological approach taken to answering the research questions on the safety of home birth

This chapter explains and justifies the approach taken in the analyses reported in Chapters 6 and 7, which compare the maternal and infant outcomes of those who intended a home birth against those who intended a hospital birth. This will help contribute to the debate about whether planning a home birth is safe for all, some or no women.

As discussed in Section 2.4, study of the comparative safety of different birth settings is dogged with problems of definition, measurement and interpretation. Because the study of home birth is such an emotive and controversial subject, it is extremely important for any new study to avoid as many of these problems as possible, or else its findings will be ignored or decried by any party whose interests are not served by the study's findings. Some of the more common problems with previous studies include: being unable satisfactorily to identify either planned home births or pregnancies that experienced labour complications, not being able adequately to control for selection effects, and including cases which should ideally have been excluded in order to allow a fair comparison (e.g. lethal congenital abnormalities – see Section 5.3.2). In the analyses reported in this thesis, great care was taken: (1) to select appropriate outcome variables so that comparative safety of both mother and baby could be assessed in a way that is able to influence clinical practice, (2) to identify and exclude pregnancies which hinder the answering of the research questions, (3) to ensure that women classed as intending a home birth did actually intend a home birth at the point at which they went into labour, (4) to ensure that labour complications were defined in the same way for those who planned a home birth and those who planned a hospital birth and (5) to control for the fact that women who intended a home birth were a selected group who tended to be at lower risk of negative pregnancy outcomes. This chapter describes how these aims were achieved in practice.

5.1 Data sources and eligibility criteria

The analyses in Chapters 5-7 are based solely on the St Mary's Maternity Information System (SMMIS) database. As detailed in Section 3.1.4, a total of 515,777 SMMIS records ended in a live birth or stillbirth in the North West Thames region in the years 1988-2000 inclusive, and were therefore eligible for consideration

Records for which it was not possible to determine the woman's intended place of birth at the end of pregnancy were deleted (n=1,994), because for these women it was not possible to establish whether the place of birth was planned or unplanned[48]. This left 513,783 records for further analysis.

Backing up the findings of previous research (see Section 2.4.2), the initial exploratory analysis found that the outcomes of *unplanned* home births tended to be worse than for planned home births and hospital births. Their inclusion in the analysis, therefore, would have artificially inflated the incidence of these negative outcomes among the group of women who intended a hospital birth. The aim of this analysis was to work out whether planning a home birth is safe in comparison to planning a hospital birth for all, some or no women. The inclusion of unplanned home births in the modelling would not help to answer this question, so they were excluded after the initial exploratory analysis. Although women having unplanned home births were comparable to those who transferred from home to hospital in labour in that they did not give birth where they originally intended to do so, the two situations are fundamentally different. In most cases, transferring from home to hospital generally involves a considered decision made by the labouring woman, her birth partner and her care provider, to give birth in hospital – there is a change of mind during labour about the intended place of birth. Unplanned home births, however, do not usually involve a change of mind; they are simply a response to a given set of circumstances. For this reason, unplanned home births (n=2,771) were included in the initial exploratory analysis only, and deleted before the main analysis commenced.

[48] This resulted in the exclusion of a relatively high proportion of records from the St Mary's and Chelsea and Westminster units (0.7% in each case, compared with 0.4% overall). Unknown intention was also relatively common among mothers aged under 25 (0.6%) and those from the Black African, Black Caribbean and Mediterranean ethnic groups (0.7%).

5.2 Answering the research questions without ambiguity by specifying covariates and comparison groups appropriately

5.2.1 Appropriate comparison groups with respect to place of birth

Most previous studies concluded that, for low-risk women giving birth in developed countries, the infant outcomes for planned home birth are at least as good as for planned hospital birth. However, to a greater or lesser extent, these studies all suffered from fundamental problems in their design (see Section 2.4.2), there was more of a focus on infant outcomes than on maternal outcomes, and only one study (Symon et al, 2009)came to any considered conclusion about whether planned home birth is safe for high-risk pregnancies.

As noted in Section 2.4.2, there is debate over whether comparisons of different birth settings should be based on intended place of birth or actual place of birth. Women who intended a home birth but gave birth in hospital do tend to 'muddy the waters', but to exclude them would mean that the planned home birth group would largely be composed of straightforward cases, so there would be a bias against hospital birth. Ideally, SMMIS would have contained a record of exactly when the transfer to hospital took place, but as it did not, it is very difficult to draw firm conclusions about the safety of home birth in cases transferred from home to hospital in labour, because negative outcomes may have been attributable to suboptimal care received in hospital rather than the fact that a home birth was attempted. Nevertheless, intrapartum transfers *were* included within this analysis, because a significant proportion of them will have involved labour complications, and the potential for unforeseen complications is the main argument against home birth. To assess the strength of this argument, it is important to know how the outcomes of planned home births with complications compared with planned hospital births with complications. A recent UK study (Mori et al, 2008) suggested that those who attempted a home birth but transferred to hospital were at increased risk of perinatal mortality. This study was heavily criticised (see Section 2.4.2), but it raised an important question: are the overall statistics on the safety of planned home birth masking sub-groups for whom home birth is especially risky?

It is therefore important to consider the question about the relative safety of home birth from two perspectives: (1) whether or not there is a difference between those who plan a home birth and those who plan a hospital birth in terms of their likelihood of experiencing labour complications and negative pregnancy outcomes, and (2) among those who *do* experience complications, whether the outcomes are different for those who attempted/had a home birth in comparison to those who had planned hospital births. A reliable answer to the second question is dependent on the ability to identify women who experienced labour complications that required specialist medical care or equipment, regardless of their intended or actual place of birth.

5.2.2 Appropriate comparison groups with respect to labour complications

In this analysis, women who experienced labour complications are identified using NICE guidance (National Collaborating Centre for Women's and Children's Health (NCCWCH), 2007) on conditions that indicate women who attempt a home birth should consider transfer to hospital. This classification was applied both to those intending a home birth and those intending a hospital birth to ensure a fair comparison between the two birth settings. Table 5.1 reproduces the content of the guidance.

Table 5.1: NICE guidance on "indications for intrapartum transfer" from home to hospital

The following risks and benefits should be assessed when considering transfer to an obstetric unit, bearing in mind the likelihood of birth during the transfer:

- indications for electronic foetal monitoring (EFM) including abnormalities of the foetal heart rate (FHR) on intermittent auscultation
- delay in the first or second stages of labour
- obstetric emergency – antepartum haemorrhage, cord presentation/prolapse, postpartum haemorrhage, maternal collapse or a need for advanced neonatal resuscitation
- maternal pyrexia in labour (38.0°C once or 37.5°C on two occasions 2 hours apart)
- either raised diastolic blood pressure (over 90 mmHg) or raised systolic blood pressure (over 140 mmHg) on two consecutive readings taken 30 minutes apart
- retained placenta
- malpresentation or breech presentation diagnosed for the first time at the onset of labour, taking into account imminence of birth
- maternal request for epidural pain relief
- third- or fourth-degree tear or other complicated perineal trauma requiring suturing
- significant meconium-stained liquor
- uncertainty about the presence of a foetal heartbeat

Source: NCCWCH (2007)

One condition in Table 5.1 (maternal request for epidural pain relief), whilst a sound reason for transferring to hospital in labour, is not in itself a clinical complication. For this reason, it was excluded from the definition of complications used in this analysis.

Although this part of the NICE guidance is entitled "indications for intrapartum transfer" it is clear that it is designed to cover both intrapartum indications and postpartum indications for transfer to hospital. For this analysis, the aim of using this guidance was to help identify cases with labour complications, so two of the conditions in Table 5.1 were excluded on this basis: a need for advanced neonatal resuscitation and complicated perineal trauma requiring suturing[49]. Labour complications were defined as any of the remaining conditions in Table 5.1. Using SMMIS data, it

[49] In this study, these conditions were considered under the heading of pregnancy outcomes (see Section 5.3.3 and Appendix H), so they were not disregarded as indicators of safety.

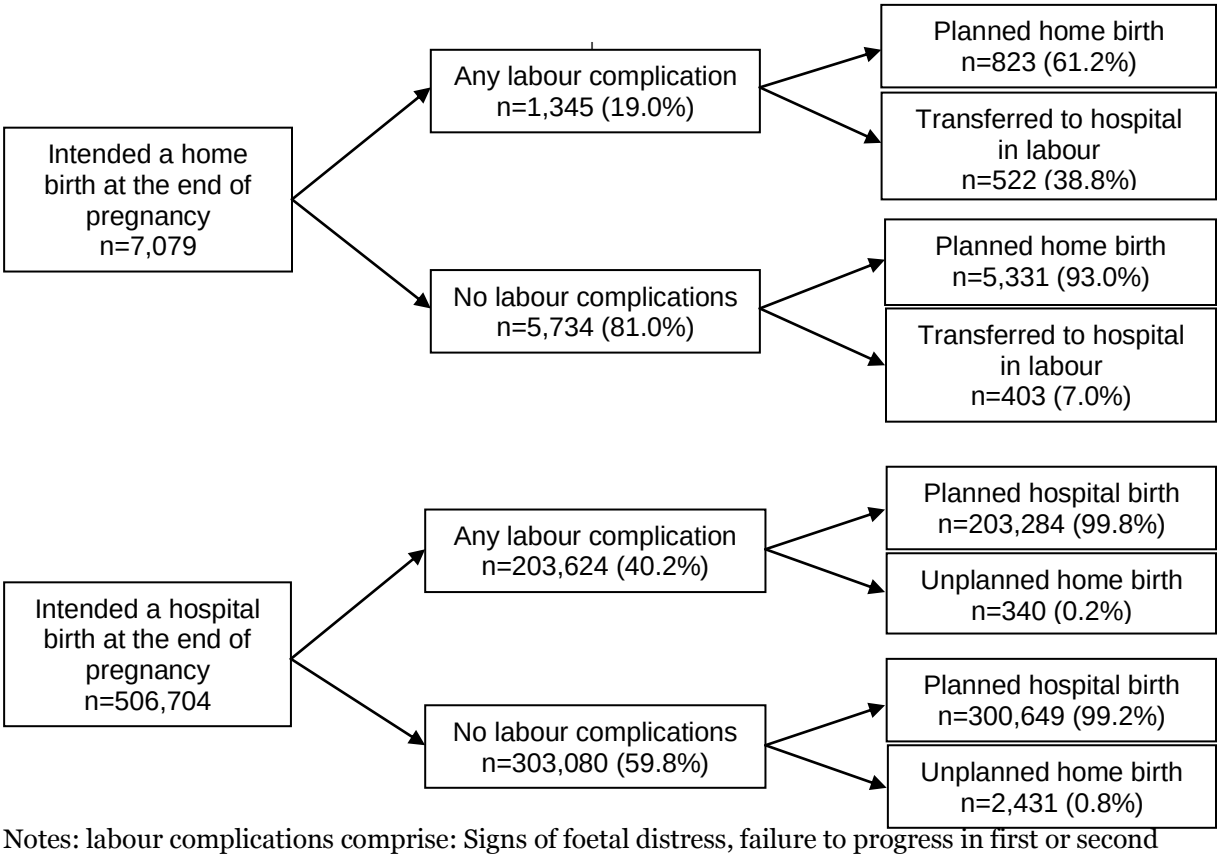
was possible to operationalise all of these labour complications except maternal collapse, as detailed in Table 5.2.

Table 5.2: Operationalisation of conditions classed as labour complications

Condition	How operationalised	No (%) of cases in SMMIS
Indications for electronic foetal monitoring (EFM), including abnormalities of foetal heart rate Uncertainty about the presence of a foetal heartbeat Significant meconium-stained liquor	Recorded as having "abnormal" EFM reading OR meconium-stained liquor in the relevant SMMIS fields, OR 'mother's delivery ICD codes' included ICD-9 codes starting with 656.3 / ICD-10 codes starting with O68 ("signs of foetal distress")	155,139 (30.20%)
Delay in first stage of labour	Mother's delivery ICD codes included ICD-9 code 662.0 / ICD-10 code O63.0 ("failure to progress in first stage")	16,148 (3.14%)
Delay in second stage of labour	Mother's delivery ICD codes included ICD-9 code 662.2 / ICD-10 code O63.1 ("failure to progress in second stage")	42,503 (8.27%)
Obstetric emergency:		
Intrapartum haemorrhage	Mother's delivery ICD codes included ICD-9 codes 641.1, 641.3, 641.8, 641.9 ("antepartum haemorrhage") / ICD-10 codes starting with O67 ("excessive bleeding during labour")	7 (<0.1%)
Cord presentation/prolapse	Recorded as having cord prolapse in the relevant SMMIS field, OR mother's delivery ICD codes included ICD-9 code 663.0 / ICD-10 code O69.0 ("labour and delivery complicated by prolapse of cord")	987 (0.19%)
Obstructed labour (including shoulder dystocia)	Mother's delivery ICD codes included ICD-9 codes starting with 660 / ICD-10 codes starting with O64, O65 or O66 ("obstructed labour")	1,492 (0.29%)
Major postpartum haemorrhage	SMMIS recorded that mother lost at least 1000ml of blood	9,475 (1.84%)
Ruptured uterus	Mother's delivery ICD codes included ICD-9 code 665.1 / ICD-10 code O71.1 ("rupture of uterus during labour")	68 (0.01%)
Maternal pyrexia	Recorded as having pyrexia in the relevant SMMIS field, OR mother's delivery ICD codes included ICD-9 code 659.2 ("maternal pyrexia during labour")	7,169 (1.40%)
Hypertension	Mother's delivery ICD codes included ICD-9 code 642.0-642.3 / ICD-10 codes starting with O13 ("gestational hypertension")	628 (0.12%)
Retained placenta	SMMIS recorded that the placenta was removed manually	10,013 (1.95%)
Malpresentation/breech presentation	Recorded as having undiagnosed malpresentation in the relevant SMMIS field, OR mother's delivery ICD codes included ICD-9 code 660.0 / ICD-10 codes starting with O32 ("malpresentation of foetus")	1,664 (0.32%)
Any labour complication		204,969 (38.89%)

Having defined labour complications, Figure 5.1 illustrates the different paths a woman may take through labour and birth, and the numbers taking in path in the SMMIS database.

Figure 5.1: Different paths through labour and birth



Notes: labour complications comprise: Signs of foetal distress, failure to progress in first or second stage of labour, obstetric emergency, pyrexia, pregnancy-induced hypertension during labour, retained placenta and abnormal presentation diagnosed during labour.

Most (61.2%) of those who intended a home birth and experienced labour complications did not transfer to hospital. Furthermore, 43.6% of those who transferred to hospital after an attempt at a planned home birth did not experience labour complications as defined by NICE. This indicates that it would be inappropriate to use 'transfer to hospital during labour' as the definition of having had complications in labour (as was done by Mori et al in 2008), and raises the question: why did women without labour complications transfer to hospital in labour? Analysis of the SMMIS database provides some clues. Those who transferred from home to hospital in labour in the absence of complications: (1) tended to have longer labours, (2) were more likely to be primiparae and (3) were more likely to have high-risk pregnancies. Perhaps surprisingly, just 14% had epidural/spinal pain relief in labour, indicating either that the desire for an epidural was a significant factor in the decision to transfer to hospital care in only a minority of cases, or that epidurals were not provided for all women who wanted them. It is notable that transfers with no labour complications were much more prevalent in some hospitals than in others.

5.2.3 Operationalising pregnancy risk status as an explanatory variable

Section 4.3.1.1 describes how a NICE clinical guideline was used to classify SMMIS pregnancies as 'high-', 'medium-' or 'low-risk' based on whether or not the pregnant woman had any conditions which are judged to be associated with a higher risk of negative pregnancy outcomes. As noted in Sections 6.5.1 and 7.5.1, the analyses in this thesis found that being 'high-risk' was indeed associated with negative pregnancy outcomes. However, these analyses also found that, had the statistical modelling treated 'pregnancy risk status' as a single composite variable with three levels (high, medium, low), the comparison between those planning a home birth and those planning a hospital birth would not have been a fair one. This is because women with 'high-risk' pregnancies who were planning a home birth tended to have different 'high-risk' conditions than women with 'high-risk' pregnancies who were planning a hospital birth (see Section 6.5.1). This suggests that, within the category 'high-risk', there may be a hierarchy of conditions, some of which present more of a risk than others. The analysis shown in Table 7.1 supports this theory. This being the case, if pregnancy risk status had been treated as a single variable, 'high-risk' home births would probably have been at lower risk of negative pregnancy outcomes than 'high-risk' hospital births. Controlling for risk status as a single variable would thus have introduced a bias against hospital births, because only some of the variation by risk status would have been held constant in the model. To guard against this bias, in the models presented in Chapters 6 and 7, pregnancy risk status was operationalised by including each individual 'high-' or 'medium-risk' condition in the NICE guidance as a separate covariate, with a few exceptions as described in Section 6.7.3.

5.2.4 Research questions addressed in Chapters 6 & 7

It is clear from Figure 5.1 that the incidence of labour complications was lower among those who intended a home birth at the end of pregnancy than among those who intended a hospital birth. This was to be expected, given that those intending a home birth tended to be low-risk multiparae (see Chapter 4), but using statistical modelling we can assess the extent to which it holds true regardless of these related factors. The first research question addressed by this analysis is therefore: '**Were those who attempted a home birth less likely to experience labour complications once other observed characteristics are held constant?**'

Proponents of hospital birth tend to argue that, if anything goes wrong during or shortly after labour, it is better to give birth in hospital so that emergency care can be provided without delay. Given that there is currently no reliable method for predicting which pregnancies will experience labour complications, this is a strong argument against home birth. It is, however, a largely theoretical argument, due to the lack of empirical evidence that mothers and babies tend to do better after complications if the birth was a planned hospital birth rather than an attempted or actual planned home birth. The second research question addressed by this analysis is therefore: '**If**

there were complications, were those who attempted a home birth more likely than those who had a planned hospital birth to have negative pregnancy outcomes?'

5.3 Defining safety; outcomes considered and/or used in this analysis

As noted in Section 2.4.2, there is no consensus about the definition of the word 'safety' in the context of comparing birth settings. The discipline of obstetrics has tended to consider it solely from the perspective of avoiding mortality, whereas in the context of recent low levels of maternal and infant mortality in developed countries, women themselves have tended to take a broader view of safety, involving the longer-term physical and emotional health of both mother and baby. In more recent years, therefore, there have been calls for comparisons of birth settings to take outcomes other than mortality into account (in addition to mortality itself).

Previous research and commentary has identified a number of pregnancy outcomes either for which incidence varies by place of birth, or which can be considered as important measures of safety. Because of the large number of outcomes that do or may vary according to place of birth, it was not possible to build models to examine all of them in the time and space available for this thesis (but bivariate analysis shows that many of them did vary according to intended/actual place of birth, as can be seen in Appendix H). For this reason, consideration was given to using composite outcome measures. Other studies which have used composite outcome measures (e.g. National Perinatal Epidemiology Unit, 2007b; Hutton et al, 2009) have tended to do so mainly because of the numbers of pregnancies resulting in individual negative outcomes being small, and therefore investigations involving them lacking statistical power. However, in SMMIS there were numerous outcomes that were experienced by a large number of women and their babies, so it was judged appropriate to consider individual outcomes rather than composite ones. Consultation with two obstetricians (one from the University of Southampton and one from Imperial College London) also indicated that the obstetric profession would view analysis using composite outcomes with suspicion, as it would be impossible to use the research to influence clinical practice.

5.3.1 Maternal outcomes

There were only ten maternal deaths in the SMMIS database (of which nine followed planned hospital births and one followed an unplanned home birth), so it was not possible to construct a model with maternal death as an outcome and place of birth as an explanatory variable. Instead, maternal outcomes that have the potential to lead to death were considered. The Healthcare Commission (2008) identified three indicators as "potential markers relating to the risk of maternal mortality": postpartum haemorrhage, eclampsia and admission of the mother to an Intensive Care Unit (ICU). Of these, postpartum haemorrhage was the only one suitable for modelling, because

there were only 30 cases of eclampsia in the SMMIS database, and SMMIS did not record whether or not the mother was admitted to an ICU.

There are a number of definitions of postpartum haemorrhage (PPH). According to the Royal College of Obstetricians and Gynaecologists (RCOG) (2009), although an estimated blood loss of at least 500ml counts as a PPH, only when the blood loss exceeds 1000ml should a case be considered an "emergency". For this reason, the definition of PPH adopted for this analysis was the loss of at least 1000ml of blood. Using this definition, 9,475 SMMIS cases experienced PPH.

In addition to PPH, several of the conditions listed as labour complications can be considered as negative maternal outcomes, e.g. obstructed labour and retained placenta. Such complications and the interventions which often result from them can lead to physical morbidity and/or the woman feeling as though she has had a negative birth experience. Models of labour complications can therefore also be considered as models of negative maternal outcomes. Section 6.1 describes which complications were selected as outcome variables.

5.3.2 Infant outcomes: perinatal mortality

As a measure of mortality, all cases ending in stillbirth or death within 7 days of a live birth were identified (n= 3,361). In addition to unplanned home births and cases for which the intended place of birth was not known, analysis of perinatal death as an outcome excluded cases ending in death for which this outcome (a) would have been determined before the onset of labour and (b) would have occurred regardless of place of birth or quality of intrapartum care. This was because it would be impossible for such outcomes to be associated with place of birth, and including them would almost certainly have artificially made the outcomes seem worse for hospital births in comparison to home births, because these outcomes were more common among high-risk pregnancies, which made up a larger proportion of hospital births than of home births (see Section 4.3.1.1). These cases fell into four groups: (1) lethal congenital anomalies (n=83), (2) antepartum stillbirths (i.e. the foetus died before the onset of labour (n=2,071)), (3) birthweight below 500g (n=333) and (4) birth before 22 weeks' gestation (n=47).

A number of congenital anomalies were identified as being 'lethal', i.e. they result in death either before or shortly after birth, as described in Table 5.3. Nearly all of these cases were recorded as having ended in stillbirth or death within 28 days of live birth.

Table 5.3: Lethal congenital anomalies, associated ICD codes, and incidence in SMMIS database

Anomaly	Reference	ICD-9 code	ICD-10 code	No of cases
Anencephaly	Julian-Reynier et al (1994)	740.0	Q00.0	24
Bilateral kidney agenesis	Julian-Reynier et al (1994)	753.00	Q60.1	11
Ectopia cordis*	Amato et al (1995)	746.8	Q24.8	3
Tracheal agenesis*	Lander et al (2004)	748.33	Q32.4	0
Triploidy	Arvidsson et al (1986)	758.58	Q92.7	1
Trisomy 18 (Edwards syndrome)	Hannah et al (2000)	758.2	Q91.0-3	44
Total				**83**

* These conditions do not have a unique ICD code; they are subsumed within a list of related conditions, for which the ICD-codes are shown in the above table, but not all of which are fatal. For these conditions, therefore, only cases with the relevant ICD code and which ended in stillbirth or neonatal death were counted.

The exclusion of babies born with these conditions will not have captured all babies who died or were stillborn due to congenital abnormalities. Some will have died or been stillborn due to abnormalities that are not always fatal, and it is possible that in some or all of these cases, death would have been inevitable regardless of place of birth or quality of care. It is therefore important to include congenital abnormalities as a covariate in the models, to control for this issue. As explained in Section 7.7.3, the model with perinatal mortality as the outcome used 'congenital abnormality diagnosed in pregnancy?' as an explanatory variable rather than 'actual congenital abnormality', because the two were correlated and the former was felt to be the more useful from the point of view of helping pregnant women make decisions about place of birth. The models with labour complications as outcomes included both variables in the model-building process, but 'actual congenital abnormality' was significantly associated with only one of the six outcomes once other covariates were held constant.

In SMMIS, stillbirths were classified as 'antepartum', 'intrapartum' or 'indeterminate'. Intrapartum stillbirths were those in which the foetus died during labour, and therefore could conceivably have been prevented with appropriate and timely intervention. Indeterminate stillbirths were those for which it was not established whether the foetus died before or during labour. There were 197 indeterminate stillbirths which, in the context of low levels of perinatal mortality, had the potential to affect the conclusions drawn by the analysis. Therefore, analysis of infant mortality was run both with and without indeterminate stillbirths, to assess the sensitivity of the results to their inclusion or exclusion. A large proportion of the indeterminate stillbirths were unplanned home births (see Figure 7.1) which were excluded from the safety analyses, so it was not expected that indeterminate stillbirths would have a major effect on the results.

Low birthweight babies and preterm births make a significant contribution to infant mortality (Bull et al, 2003; Moser et al, 2007). When making comparisons between the perinatal mortality rates of NHS trusts, the Centre for Maternal and Child Enquiries (CMACE) excludes babies born weighing less than 500g and those born before 22 weeks of gestation (CEMACE, 2009). In SMMIS, the vast majority of such cases ended in infant death, so the decision was taken to use the same approach for this analysis, to ensure a fair comparison between birth settings.

After the exclusion of lethal congenital anomalies, antepartum stillbirths, birthweight below 500g and gestation below 22 weeks, there were 1,622 cases of intrapartum stillbirth or neonatal death, i.e. 0.32% of the 511,441 eligible SMMIS records. Of these 1,622 cases, 1,382 were perinatal deaths and 1,131 were neonatal deaths. If the indeterminate stillbirths were also excluded, there were 1,441 cases (0.28% of the 511,260 eligible records), of which 1,201 were perinatal deaths and 1,131 were neonatal deaths.

There are arguments both for and against the use of perinatal and neonatal mortality to compare the safety of different birth settings. It could be argued that contributory factors which are relevant to labour/delivery are likely to lead to perinatal rather than neonatal death and therefore that the use of neonatal mortality as an outcome variable risks 'muddying the waters'. On the other hand, advances in perinatal care mean that babies suffering severe morbidity who would once have died within the first week are being kept alive for longer, so neonatal mortality will take these cases into account more effectively than perinatal mortality. It is traditional for studies which compare the infant mortality rates of home and hospital births to use perinatal death as the outcome measure (Gyte et al, 2010), so for consistency with previous studies, the analysis presented here uses this measure. However, Wax et al (2010) suggested that the neonatal mortality rate was significantly higher among home births than among hospital births, so future research should consider including neonatal death as an outcome measure as well as perinatal death (there were 519 cases of neonatal death that were not included in the figures on perinatal death).

6 Is planned home birth in the UK safe for mothers?

This chapter compares women who intended a home birth (whether or not they went on to have one) with women who intended and had a hospital birth in terms of their likelihood of experiencing labour complications, once other observed factors are held constant. This will help contribute to the debate about whether planning a home birth is safe for all, some or no women. This study, like all observational studies of home birth, almost certainly suffers from selection effects; we cannot be sure that variations by place of birth were due to place of birth *per* se or to other things that are related to it. However, the analysis in Chapter 4 helps us to understand at least some of these selection effects, and permits us to take these into account when comparing pregnancy outcomes.

This chapter begins with a summary of the observed variations in incidence of labour complications according to intended place of birth (Section 6.1), and notes that such complications are much less common among those who intended a home birth. This is to be expected, given that those who intend a home birth tend to have low-risk pregnancies and to have given birth before (see Chapter 4). The statistical modelling described later in this chapter aims to work out the extent to which the lower incidence of labour complications among those intending a home birth holds true once other observed characteristics are held constant. Section 6.1 also notes that the SMMIS database did not permit the modelling of all types of labour complications due to some having a very low incidence among those who planned a home birth. Section 6.2 references a number of previous studies which have identified or postulated a link between labour complications and other factors. From this review of literature, conceptual and analytical frameworks were drawn up with a view to controlling for as many confounders as possible.

Sections 6.3 to 6.6 detail the descriptive analysis of factors that are or may be associated with the labour complications, and show that the vast majority of the identified covariates are associated with labour complications at the bivariate level. As noted in Section 3.3.1, the descriptive analysis is shown in some detail, to aid understanding of the complex relationships between the large number of explanatory variables included in the statistical modelling. Without this understanding, it would be difficult to judge whether the statistical models are appropriate tools for answering the research questions.

The selection of appropriate explanatory variables was supported by a literature search and considerable deliberation, particularly when it came to the inclusion of 'high-risk' pregnancy conditions, and these decisions are explained and justified in Section 6.7, as are the methods used to build the statistical models and the difficult decisions which had to be made regarding the inclusion of interaction terms. Section 6.8 presents the results of the modelling, and Section 6.9 summarises and discusses these results in terms of their implications for UK maternity care policy and practice.

6.1 Bivariate associations between intended/actual place of birth and labour complications

All the labour complications in Table 5.2 were considered as individual outcomes. For most of them, elective Caesarean sections (CSs) were excluded from the analysis, because women having elective CSs do not go into labour and therefore cannot have these complications. However, of the 30,323 cases of elective CS, 3,098 (10.2%) were recorded as having experienced labour complications, mainly PPH (n=1,305), foetal distress (n=1,042) and retained placenta (n=485). Manual removal of the placenta[50] is an integral part of a CS, so it was unnecessary for elective CS cases to have been coded as having had a retained placenta. PPH and foetal distress, on the other hand, can occur during elective CS (Stones et al, 1993; Hannah et al, 2000), so for these complications, elective CSs were included in the main analysis. To check the sensitivity of the results to their inclusion, the models for foetal distress and PPH were also run with elective CSs excluded (see Sections 6.8.1 and 6.8.4).

In the unadjusted data, incidence of labour complications was higher among women who intended a hospital birth at the end of pregnancy than among those who intended a home birth (see Figure 5.1). This held true for all of the individual labour complications except delay in the first stage of labour, intrapartum haemorrhage and ruptured uterus, as shown in Table 6.1.

Table 6.1: Incidence of individual labour complications, by intended place of birth at end of pregnancy

Complication	Intended place of birth				X^2 test p-value
	Hospital		Home		
	N	%	N	%	
Signs of foetal distress*	154,231	30.44	908	12.83	0.000
Failure to progress in stage 1 of labour	15,880	3.33	268	3.79	0.035
Failure to progress in stage 2 of labour	42,287	8.88	199	2.81	0.000
Intrapartum haemorrhage	7	<0.01	0	0.00	0.747
Cord presentation / prolapse	980	0.21	4	0.06	0.006
Obstructed labour	1,400	0.29	12	0.17	0.054
Postpartum haemorrhage*	9,435	1.86	40	0.57	0.000
Ruptured uterus	65	0.01	0	0.00	0.326
Pyrexia in labour	7,113	1.49	27	0.38	0.000
Hypertension in labour	610	0.13	1	0.01	0.007
Retained placenta	9,938	1.97	75	1.06	0.000
Previously undiagnosed malpresentation	1,391	0.29	13	0.18	0.093
Any labour complication	**200,596**	**42.11**	**1,344**	**18.99**	**0.000**

Notes: Base includes elective CSs except for complications marked *. Hospital figures exclude unplanned home births.

[50] Manual removal of the placenta was used as the definition of retained placenta – see Table 5.2.

Although in one sense foetal distress is an infant outcome – it happens to the foetus rather than to the mother – it is considered here under the heading of 'labour complications' because it is not *per se* a negative outcome for the baby. It can predict negative infant outcomes (see Chapter 7), but only in a minority of cases does foetal distress end in a negative infant outcome. From the mother's perspective, however, foetal distress can lead to interventions and loss of control over her labour.

It is possible that irregularities in the foetal heartbeat were more likely to be recorded among hospital births because continuous foetal heart monitoring is not carried out at home but is relatively common in hospital. Therefore, the higher incidence of 'signs of foetal distress' among those intending a hospital birth may be at least partly due to this complication being more likely to be noticed, rather than more likely to occur.

Some complications were unsuitable for modelling as outcomes, mainly because there were not enough cases in the home birth group: intrapartum haemorrhage, cord presentation/prolapse, obstructed labour, ruptured uterus and hypertension. 'Previously undiagnosed malpresentation' was unsuitable because this situation is necessarily determined before the onset of labour and cannot be influenced by intended place of birth.

6.2 Conceptual and analytical frameworks

A number of factors are or may be associated with one or more of the pregnancy outcomes of interest, or with place of birth and therefore should be considered as potential covariates. They are summarised in Table 6.2, with the potential covariates arranged into four categories, and references to previous work which found or suggested a link between these factors and pregnancy outcomes or place of birth.

Table 6.2: Factors that may be associated with pregnancy outcomes, or may confound comparison between home and hospital births

Category	Concept(s)	Reference(s)
External factors	When delivery took place	Pasupathy et al (2010); Macfarlane & Mugford (2000); this thesis
	Hospital providing care	Healthcare Commission (2007b); this thesis
	Distance from home to hospital	Pitchforth et al (2007)
Mother's characteristics	Parity	Ford et al (1991); Pang et al (2002); de Jonge et al (2009); Campbell et al (1984); this thesis
	Mother's age	CEMACE (2009); de Jonge et al (2009); Waterstone et al (2001); this thesis
	Relationship status	This thesis
	Social class	Janssen et al (2002); de Jonge et al (2009)
	Social deprivation	CEMACE (2009); this thesis
	Culture/ethnicity/language	CEMACE (2009); de Jonge et al (2009); Waterstone et al (2001); this thesis
	Pelvis size	Bull (1994)
	Previous obstetric history	Chamberlain et al (1997); this thesis
	Health behaviours (e.g. smoking)	CEMACE (2009); Jaddoe et al (2008); Waterstone et al (2001)
Characteristics of pregnancy/ baby	Amount of medical attention received in pregnancy	Tew (1998); this thesis
	Pregnancy risk status	Symon et al (2009); Waterstone et al (2001); this thesis
	Maturity/size of foetus	Healthcare Commission (2008); Pang et al (2002); Campbell & Macfarlane (1994); CEMACE (2009); Campbell et al (1984)
	Sex of baby	Stevenson et al (2000)
	Congenital malformations / lethal anomalies	CEMACE (2009); Campbell & Macfarlane (1994); Hutton et al (2009)
Characteristics of labour/delivery	Birth attendant	Hatem et al (2008); Turnbull et al (1996); Janssen et al (2002)
	Mode of delivery	Hannah et al (2000); Matthews et al (2003); Waterstone et al (2001)
	Duration of labour	This thesis
	Type of pain relief used in labour	Chamberlain et al (1997); Ackermann-Liebrich et al (1996); Janssen et al (2002)
	Induction/augmentation of labour	Healthcare Commission (2008); Glantz (2010); Waterstone et al (2001)
	Intended/actual place of birth	Numerous (see Section 2.4.2)

The SMMIS database contained measures of most of the factors in Table 6.2, but not all. Table 6.3 shows the SMMIS variable(s) considered to represent each factor, and how the information was recorded or derived for each variable. Not all of these variables were used in the statistical modelling, and the reasons for this are explained in the relevant parts of Sections 6.3 – 6.6).

Table 6.3: SMMIS variables considered for use as covariates in models of labour complications

	Variable(s)	How recorded/derived
External factors		
When delivery took place	Year of delivery	Inputted directly
	Month of delivery	Inputted directly
	Infant's time of birth	Inputted directly
Hospital providing care	Hospital providing care	Inputted directly
Distance from home to hospital	Not recorded in SMMIS	Could not be derived from postcode as this was not provided for confidentiality reasons
Mother's characteristics		
Parity	Parity	Inputted directly as numeric variable
Age	Age at delivery	Inputted directly as numeric variable
Relationship status	Marital status	Inputted directly as: married/never married/divorced/separated/widowed
	'Single unsupported mother'	Inputted directly as yes or no
Social class	Not recorded in SMMIS	-
NHS or private patient	"Patient category"	Inputted directly as 'normal' (i.e. NHS care and accommodation), 'private', 'amenity' (NHS care but paying extra for private room) or 'overseas visitor'
Deprivation level	Carstairs quintile	Derived from mother's postcode
Culture/ethnicity/language	Ethnic group	Inputted directly as: white European, black African, black Caribbean, South Asian, Oriental, Mediterranean or other
	Whether interpreter needed	Inputted directly as yes or no
Pelvis size	Height	Inputted directly as numeric variable
Previous obstetric history	Number of previous miscarriages	Inputted directly as numeric variable
	Number of previous terminations	Inputted directly as numeric variable
	Birthweight of last baby	Inputted directly in grams
	Gestation of last baby	Inputted directly in weeks
Health behaviours	Smoking habits	Inputted directly as 'light' (1-9 per day), 'moderate' (10-19 per day) or 'heavy' (20+ per day)
	Weeks of gestation at booking	Inputted directly in weeks

Table 6.3 (cont'd): SMMIS variables considered for use as covariates in models of labour complications

Characteristics of pregnancy/baby		
Risk status	Pregnancy risk status	Derived (see Section 4.3.1)
Amount of medical attention received	Number of ultrasound scans	Inputted directly as numeric variable
	Number of antenatal clinic visits	Inputted directly as numeric variable
	Number of antenatal admissions	Inputted directly as numeric variable
	Amniocentesis performed	Inputted directly as: 'not done', 'done' or 'unsuccessful'
	Chorionic villus biopsy performed	Ditto
	Foetal manipulation before delivery	Inputted directly
Maturity/size	Birthweight	Inputted directly in grams
	Head circumference	Inputted directly in centimetres
	Weeks of gestation	Inputted directly in weeks[51]
Sex of baby	Sex	Inputted directly as: 'male', 'female' or 'indeterminate'
Baby's ethnic group	Infant's ethnic group	Inputted directly using same categories as mother's ethnic group
Congenital anomalies	Congenital abnormalities	Derived (see Section 6.5.5)
Characteristics of labour/delivery		
Birth attendant	"Person conducting delivery"	Inputted directly as: 'midwife', 'agency midwife', 'hospital doctor', 'GP', 'community midwife', 'other' or 'unattended in labour'
Duration of labour	Duration of first stage of labour	Inputted directly: hours and minutes
	Duration of second stage of labour	Inputted directly: hours and minutes
	Duration of third stage of labour	Inputted directly: hours and minutes
Mode of delivery	Method of delivery	Inputted directly
Type of pain relief used in labour	Pain relief used in labour	Inputted directly as: 'inhalational', 'pethidine', 'epidural', 'general anaesthetic', 'spinal', 'combined spinal & epidural', 'TENS', 'local infiltration', 'pudendal block', 'none', 'other', or combination of above
Induction/augmentation of labour	Whether labour induced	Labour onset coded as 'induced'
	Whether labour augmented	Inputted directly as 'yes' or 'no'
Intended/actual place of birth	Intention at end of pregnancy	Derived (see Section 4.1)
	Actual place of birth	Inputted directly as: 'hospital', 'in transit', 'home' or 'other'

[51] The method of calculating weeks of gestation in SMMIS has been found to vary between hospitals (Balchin et al, 2004), so it is important to include hospital as a covariate in any model involving length of gestation.

Although the analysis described in this chapter mentions a wide range of predictors of labour complications, the only predictor that is discussed in detail in Section 6.8 is intended place of birth. This is because the cases and covariates included in this analysis were selected with the specific aim of making a fair comparison between those intending a home birth and those intending a hospital birth. This resulted in the deletion of certain cases, e.g. unplanned home births (see Section 5.1), and the exclusion of certain key covariates, e.g. mode of delivery (see Section 6.6). Had the aim been to identify general predictors of the outcomes, such cases and covariates would have been included, which would have affected the coefficients for some or all of the remaining covariates.

6.3 Descriptive analysis: external factors associated with labour complications and/or place of birth

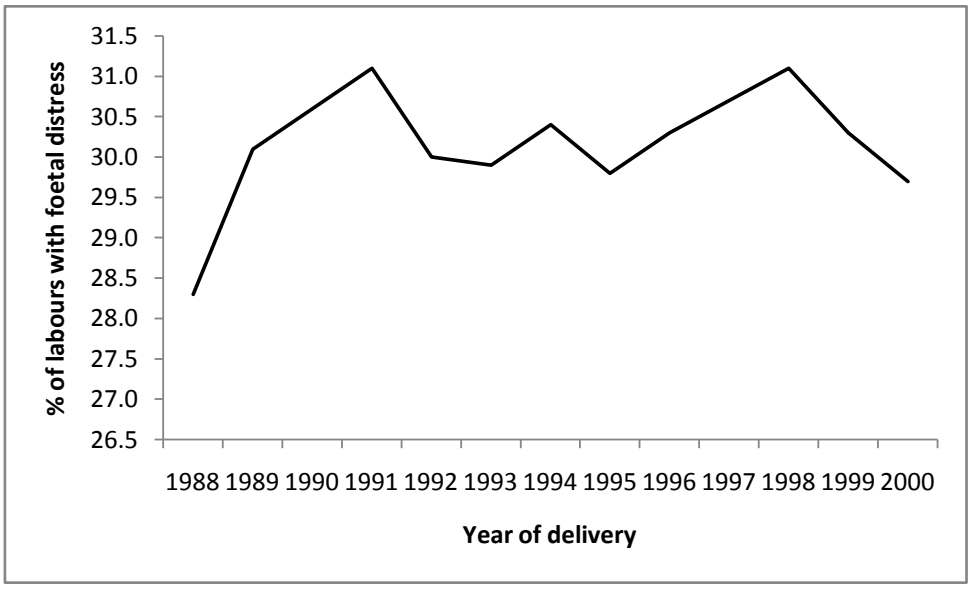
From this point onwards, all analyses exclude unplanned home births (see Section 5.1). Analyses of labour complications are based only on the six complications which were judged to be suitable for modelling (see Section 6.1): foetal distress, delay in first stage of labour, delay in second stage of labour, postpartum haemorrhage (PPH), pyrexia and retained placenta. Elective Caesareans were included in the descriptive analyses of foetal distress and PPH as outcomes, but excluded from the descriptive analyses of other labour complications as outcomes (see Section 6.1). Where the descriptive analysis suggested an interaction between a covariate and intended place of birth, it is described below. If there is no such discussion, it can be assumed that the descriptive analysis did not detect an interaction effect.

6.3.1 When delivery took place

Year

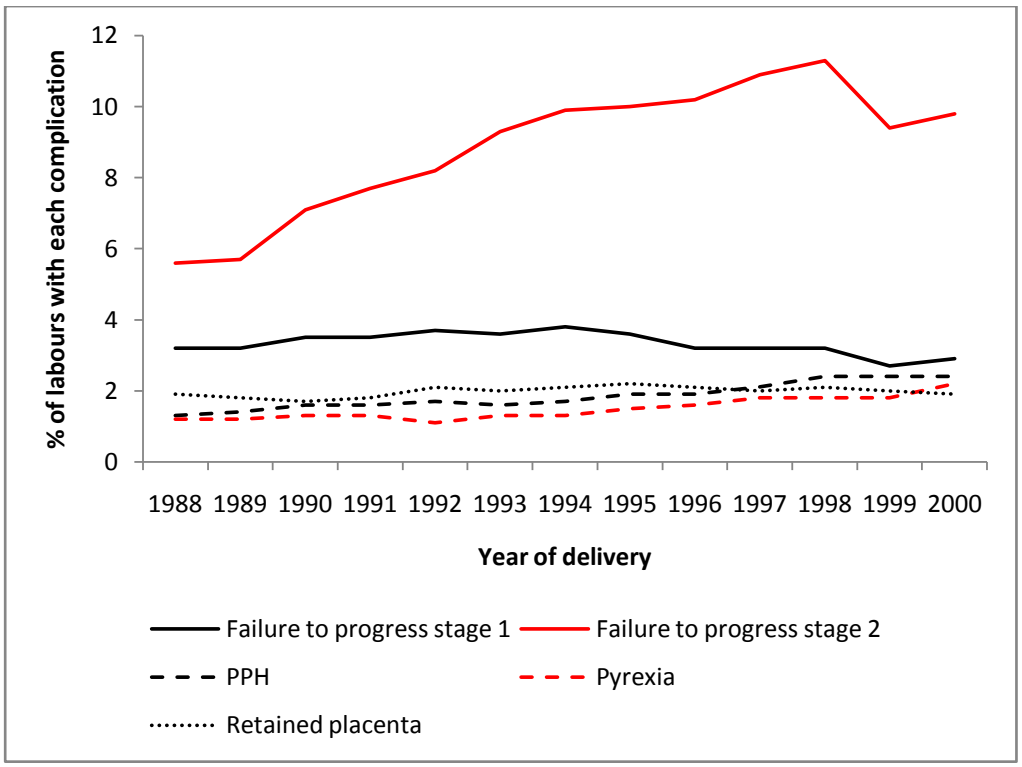
Figures 6.1 and 6.2 show that incidence of all six labour complications varied over time (p=0.000 in each case). Foetal distress is shown separately in Figure 6.1 because incidence of this complication was so much higher than the others; incidence fluctuated over the 13-year period, peaking in 1991 and 1998.

Figure 6.1: Incidence of foetal distress in labour, by year



The general trend for the remaining labour complications was for incidence to grow over time, but this was not the case for 'failure to progress in stage 1' (which had a downward trend overall) nor for retained placenta (which fluctuated slightly but had the same incidence in 2000 as in 1988). The most marked variation was for 'failure to progress in stage 2', incidence of which grew relatively steeply between 1988 and 1998, then dropped quite sharply.

Figure 6.2: Incidence of other labour complications, by year



Month

Incidence of three labour complications varied significantly by month of delivery: foetal distress (p=0.010), failure to progress in stage 2 (p=0.000) and pyrexia (p=0.000). Babies born in January and August were most likely to be distressed in labour (30.8%), and those born in September were least likely to be (29.7%). Incidence of failure to progress in stage 2 was highest in the months July to November inclusive, and incidence of pyrexia was slightly higher in the second half of the year than in the first.

Time of day

Figure 6.3 shows that babies born between 6am and 12 noon were least likely to be distressed in labour, and those born between 4pm and midnight were most likely to be (p=0.000). Because labour length varies, we cannot tell from the time of delivery whether the labour largely took place during the day or during the night. However, in the absence of this information, it is reasonable to assume that most women who gave birth in the morning did most of their labouring overnight, and that most of those who gave birth in the evening did most of their labouring during the day. On this basis, it appears that those labouring during the night were less likely than those labouring during the day to experience foetal distress. If so, this may be related to procedures such as inductions, which were associated with labour complications (see Section 6.6.5) and probably were more likely to take place during the day.

Figure 6.3: Incidence of foetal distress in labour, by time of birth

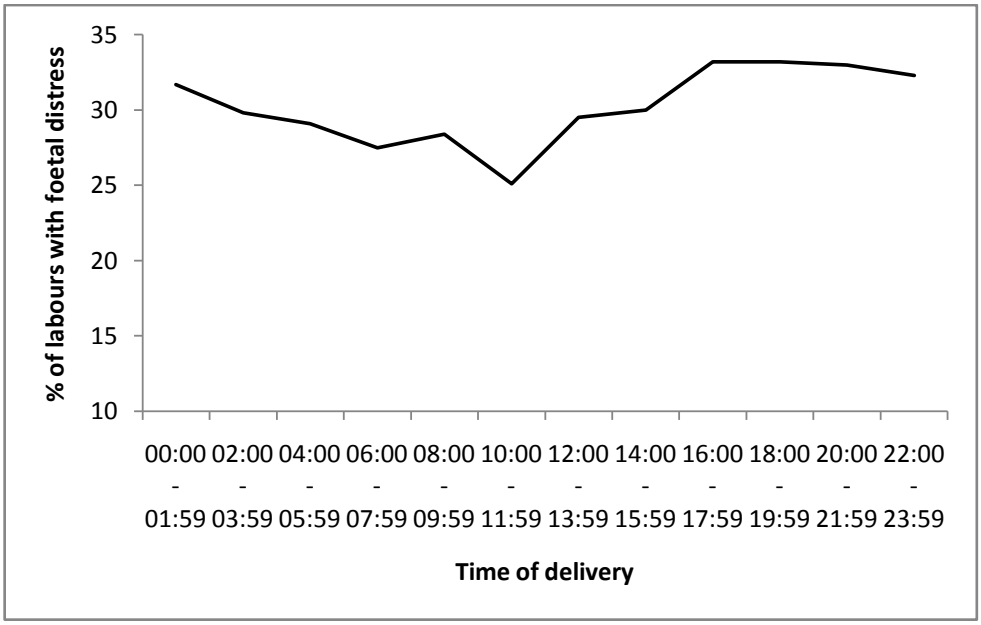
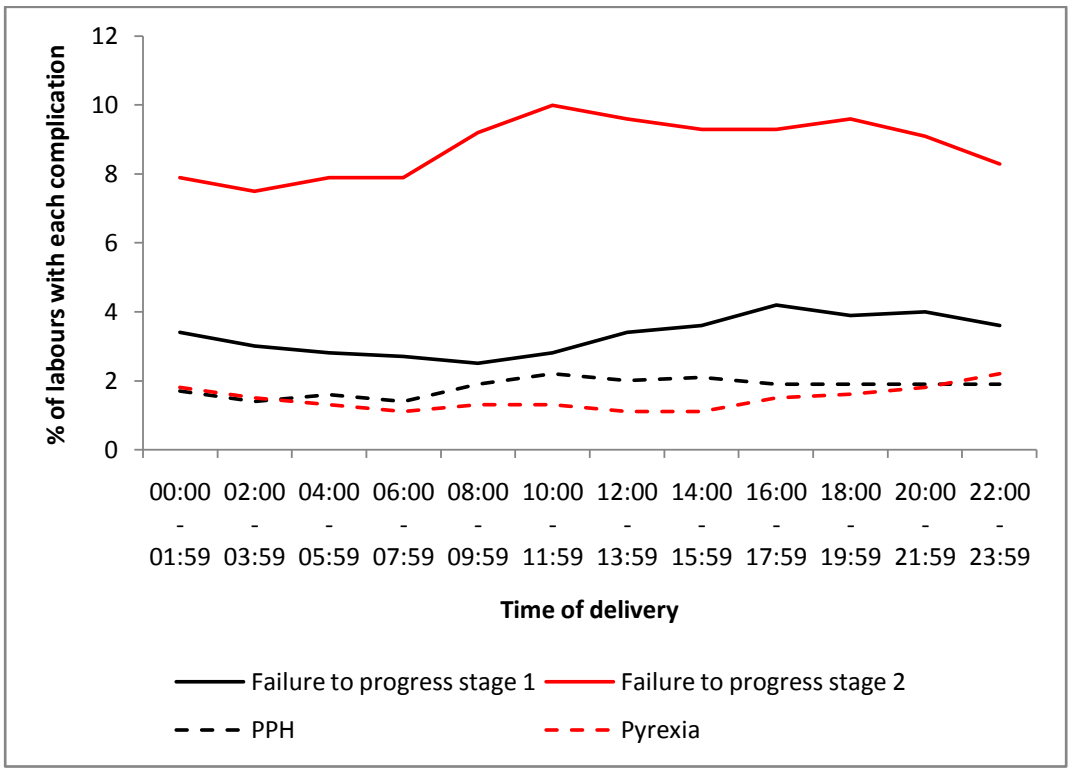


Figure 6.4 shows that incidence of the remaining labour complications varied significantly (p=0.000) according to time of day for all except retained placenta (p=0.164). Incidence of failure to progress in stage 1 was highest among those delivering between 2pm and 10pm, and incidence of failure to progress in stage 2 was highest among those delivering between 8am and 10pm. PPH was most common among those delivering between 10am and 4pm and pyrexia among those delivering between 10pm and 2am.

Figure 6.4: Incidence of other labour complications, by time of birth



6.3.2 Hospital providing care

It should be noted that there is evidence to suggest that the recording of pregnancy outcomes was incomplete in SMMIS (see Section 8.3), so it is possible that the same was true of labour complications. If so, high incidences of labour complications in a particular hospital may be due to that hospital being more diligent about recording outcomes rather than to those outcomes being more prevalent there. Nevertheless, if there are variations by hospital, it will be important for models to control for hospital to avoid erroneous conclusions being drawn.

Table 6.4 shows that incidence of all six labour complications varied significantly according to the hospital providing maternity care (p=0.000 in each case). For each complication, the hospitals with the highest reported rates are shown in red type, and the hospitals with the lowest reported rates are shown in green. For example, the reported percentage with foetal distress was highest among

women giving birth under the care of the Northwick Park unit, and lowest among those giving birth with the Hillingdon or Welwyn Garden City units.

Table 6.4: Incidence of labour complications, by hospital providing care

Hospital providing care		Labour complication					
		Foetal distress	Failure to progress stage 1	Failure to progress stage 2	PPH	Pyrexia	Retained placenta
Ashford	%	28.2	3.2	6.8	1.5	1.2	2.3
Bedford	%	29.8	5.7	10.3	1.2	1.0	1.9
Central Middlesex	%	28.9	2.9	5.4	1.5	1.4	1.5
Chelsea & W'minster	%	30.2	3.5	10.4	2.4	2.5	2.8
Ealing	%	28.3	2.5	8.2	1.7	2.1	1.8
Edgware	%	29.6	4.3	6.4	1.9	1.2	1.7
Hemel Hempstead	%	27.7	3.1	7.8	1.4	1.2	1.9
Hillingdon	%	25.8	2.9	9.4	1.8	1.5	1.9
Luton & Dunstable	%	33.1	5.1	8.3	2.3	1.0	1.9
Northwick Park	%	41.6	2.5	9.2	2.4	1.8	1.7
St Mary's	%	29.6	3.6	11.4	2.1	2.5	2.0
Stevenage	%	28.8	1.7	5.3	1.5	0.7	1.8
Watford	%	30.9	2.0	9.5	1.6	1.2	2.2
Welwyn Garden City	%	25.8	2.9	11.5	1.7	1.2	2.1
West Middlesex	%	27.6	3.2	8.9	1.9	1.9	2.0

6.4 Descriptive analysis: mother's characteristics associated with labour complications and/or place of birth

6.4.1 Parity

Figure 6.5 shows that incidence of foetal distress, failure to progress in stage 2 and pyrexia was at its highest among women having their first baby (p=0.000 for all three complications). In the case of foetal distress and pyrexia, the relationship with parity was u-shaped. In the case of failure to progress in stage 2, the higher the parity, the lower the incidence.

Figure 6.5: Incidence of foetal distress, failure to progress in stage 2 and pyrexia, by mother's parity

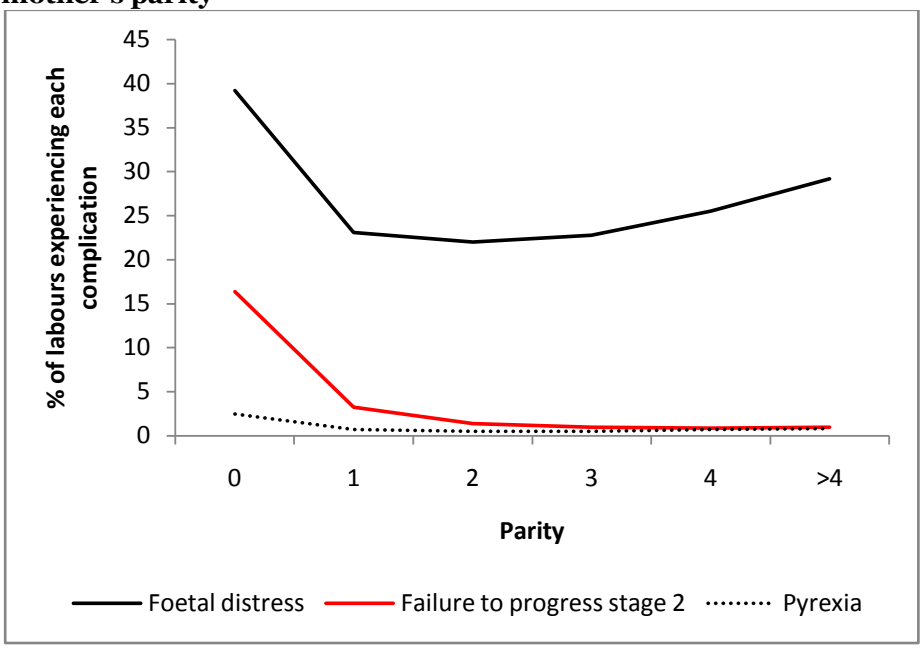
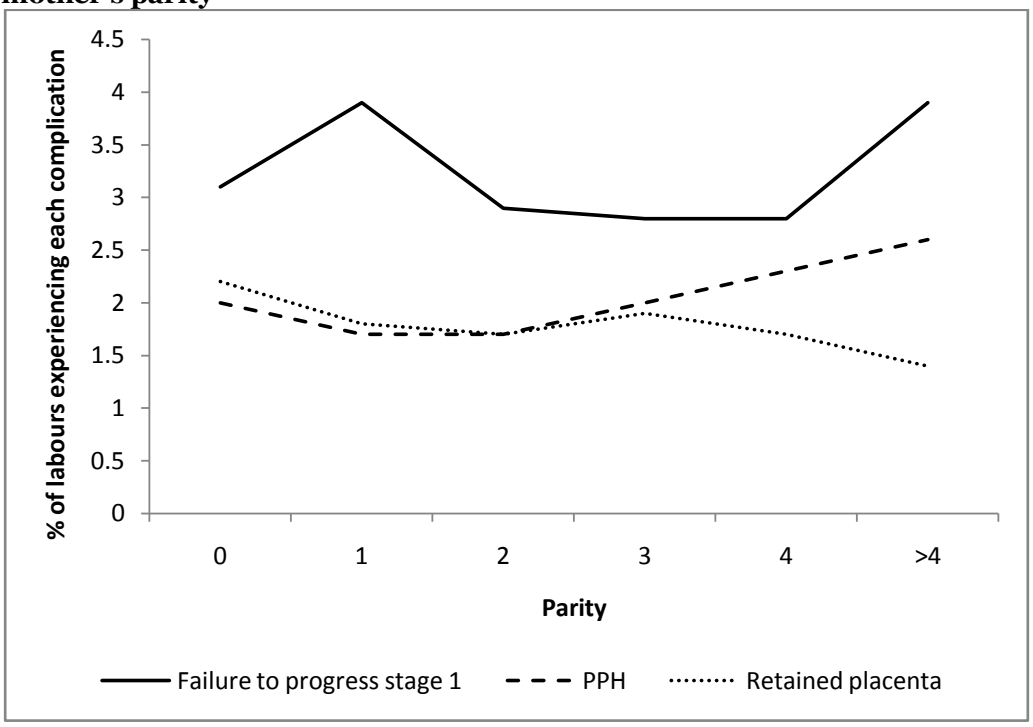


Figure 6.6 shows that the relationship between parity and the other labour complications was less clear-cut. Failure to progress in stage 1 of labour was most common among those having their second and sixth/subsequent baby. The relationship between PPH and parity was u-shaped, but incidence was highest in the highest-parity group. The relationship between retained placenta and parity was s-shaped (p=0.000 for all three complications).

Figure 6.6: Incidence of failure to progress in stage 1, PPH and retained placenta, by mother's parity



6.4.2 Age

Figure 6.7 shows that foetal distress in labour varied little by age at delivery, but was most common if the mother was aged 16-19, and least common if she was 30-39 (p=0.000). Figure 6.8 shows that incidence of the other five complications also varied according to age (p=0.056 for pyrexia and 0.000 for the other four complications). Incidence of failure to progress in stage 1, PPH, pyrexia and retained placenta was highest in the oldest age group, whereas incidence of failure to progress in stage 2 was *lower* in the oldest age groups.

Figure 6.7: Incidence of foetal distress in labour, by mother's age

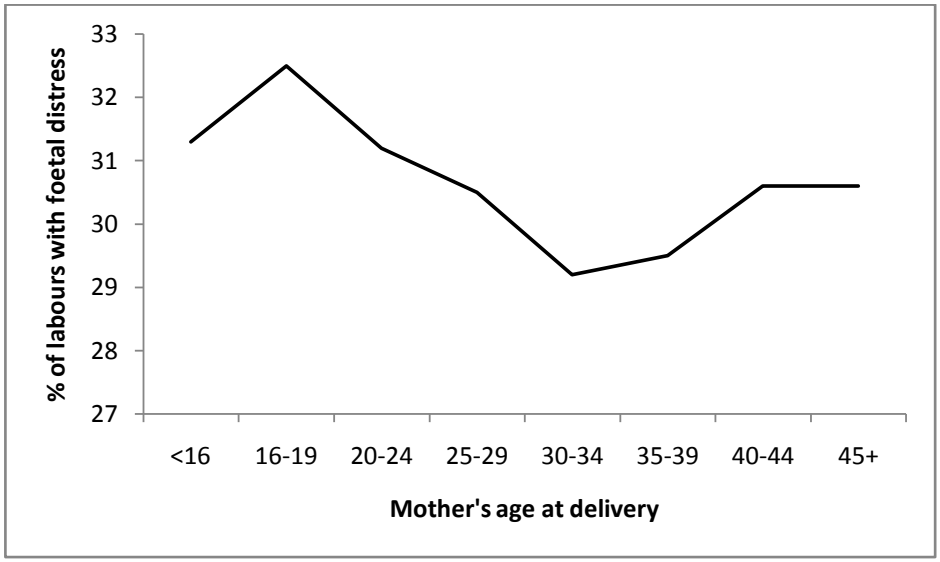
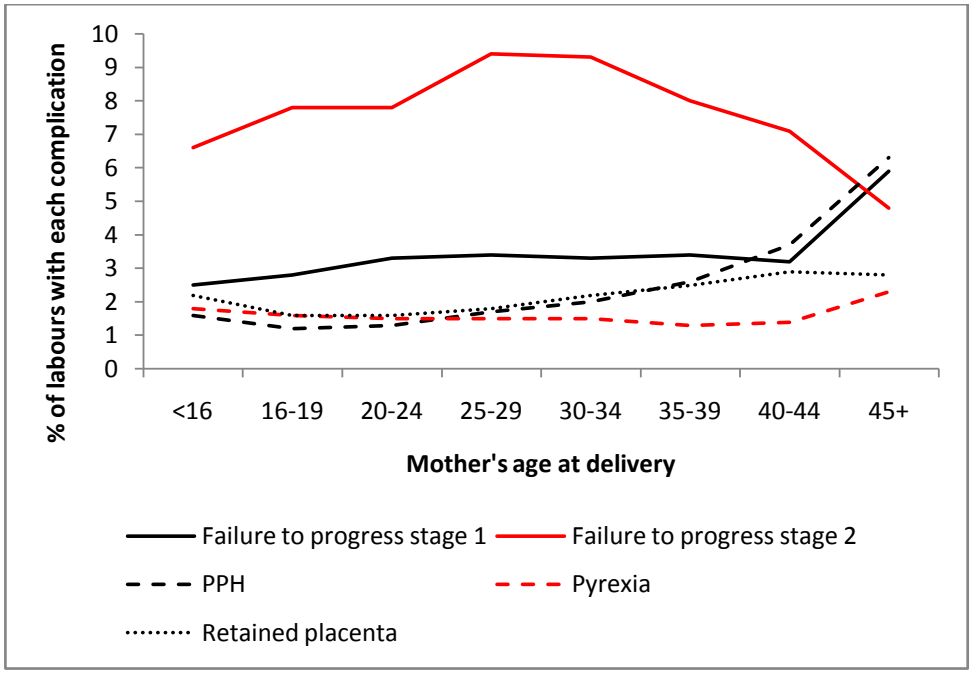


Figure 6.8: Incidence of other labour complications, by mother's age



6.4.3 Relationship status

As noted in Section 4.4.4, there was a high degree of correlation between marital status and being 'single, unsupported', both of which were recorded in SMMIS. However, this was almost completely due to married women, very few of whom were 'single, unsupported'. Among unmarried women, there was more variation in terms of whether or not the woman was 'single, unsupported'.

Women who had never been married were more likely than married or previously married women to experience: foetal distress, failure to progress in stage 2 and pyrexia (p=0.000 in each case). Similarly, unmarried women were more likely than married women to have a retained placenta (p=0.002). Conversely, married and previously-married women were slightly more likely than never-married women to experience PPH (p=0.015) and failure to progress in stage 1 (p=0.052).

'Single, unsupported' women were more likely than other women to experience foetal distress (p=0.000), pyrexia (p=0.000) and retained placenta (p=0.026), but less likely to have a PPH (p=0.003) and failure to progress in stage 2 (p=0.000). There was no significant difference in incidence of failure to progress in stage 1 between single and partnered women (p=0.172).

It is notable that women who had never been married and 'single, unsupported' women were more likely than married/'supported' women to be having their first baby, which may explain some of these patterns. It seems unlikely that marital/relationship status *per se* was a predictor of labour complications and negative pregnancy outcomes. However, because being 'single, unsupported' was significantly associated with planning a home birth (see Chapter 4), it was considered as a potential covariate in the modelling, to compensate for selection effects.

6.4.4 NHS or private care

This measure was included to test the hypothesis that women who paid at least something towards their care may have had different outcomes from those who did not. Given that home birth is often viewed as the province of the relatively affluent (see Section 2.3), its inclusion may have helped to control for some selection effects.

The vast majority (98.5%) of SMMIS records classed the mother as a "normal patient"[52], i.e. UK citizens in receipt of NHS care (and accommodation if giving birth in hospital). A further 1.3% were "private patients" (i.e. UK citizens who were paying for their care/accommodation), 0.2% were "overseas visitors" and a very small percentage (0.02%) were "amenity patients" (i.e. UK citizens who were in receipt of NHS care but paid for a private room in hospital).

[52] The use of the words "normal" and "patient" to describe women having babies is controversial, but this was the term used in the SMMIS database so it is included here in quotation marks.

"Private patients" were much less likely than other types of service user to experience foetal distress in labour (18.2% did, compared with over 30% in the other three patient categories; p=0.000). Amenity patients were most likely to experience pyrexia and failure to progress in stage 2 (p=0.000 in both cases), and "normal patients" were most likely to experience failure to progress in stage 1 (p=0.000). Incidence of PPH and retained placenta did not vary significantly according to "patient" category (p=0.849 and 0.278 respectively).

6.4.5 Area deprivation

Women living in the more deprived areas as measured by Carstairs quintile were more likely than those living in more affluent areas to experience foetal distress in labour, failure to progress in stage 1 and pyrexia in labour (p=0.000 for all three complications). Conversely, the more deprived the area, the *less* likely the mother was to experience failure to progress in stage 2 and retained placenta (p=0.000 for both complications). Incidence of PPH varied less, and showed no real pattern by Carstairs quintile (p=0.067).

6.4.6 Ethnicity/language

Ethnic group

Incidence of all six labour complications varied according to the mother's ethnic group (p=0.000 for all six). Table 6.5 details these results; the groups with the highest incidence of each complication are shown in red type, and the groups with the lowest incidence are shown in green. For four of the six complications, Black African women had high incidence, but this group had a relatively low incidence of failure to progress in stage 2 of labour. Similarly, Oriental women fared relatively badly for four labour complications, but had the lowest incidence of foetal distress in labour. White European women fared relatively well on four measures, but poorly on the other two (failure to progress in stage 2 and retained placenta).

Table 6.5: Incidence of labour complications, by mother's ethnic group

		Labour complication					
Mother's ethnic group		Foetal distress	Failure to progress stage 1	Failure to progress stage 2	PPH	Pyrexia	Retained placenta
White European	%	29.0	3.2	9.4	1.8	1.3	2.2
Black African	%	39.4	3.9	4.5	3.2	2.6	1.8
Black Caribbean	%	34.8	3.3	4.1	2.4	2.0	1.8
South Asian	%	33.0	3.6	7.2	1.5	1.6	1.1
Oriental	%	28.4	3.4	9.3	2.8	2.9	1.9
Mediterranean	%	31.4	3.7	9.3	2.0	2.2	1.4
Other	%	30.9	3.7	9.3	2.4	2.1	1.9

Language
Women who were listed as needing an interpreter were more likely than those who were not to experience foetal distress in labour and failure to progress in stage 1 (p=0.000 for both complications). Conversely, they were significantly *less* likely to experience failure to progress in stage 2 and retained placenta (p=0.000 for both measures). There was no significant variation in incidence of PPH (p=0.256) or pyrexia (p=0.276).

6.4.7 Height

Shorter women were slightly more likely than taller women to experience foetal distress in labour, failure to progress in stage 1 and pyrexia (p=0.000 for all three measures), but taller women were more likely to experience PPH, failure to progress in stage 2 and retained placenta (p=0.000 for all three complications). Unfortunately, there was a very high level of missing data for mother's height (see Appendix D), making it unsuitable for inclusion in the modelling.

6.4.8 Previous obstetric history

Number of previous miscarriages
The more miscarriages a woman had had, the less likely she was to experience foetal distress in labour and failure to progress in stage 2 of labour (p=0.000 for both complications), but the *more* likely she was to experience PPH (p=0.000) and retained placenta (0.000). There was no significant association between previous miscarriages and the other complications.

Number of previous terminations
The more terminations a woman had had, the more likely she was to experience foetal distress in labour, PPH, pyrexia and retained placenta (p=0.000 for all four complications). There was no significant association between number of previous terminations and failure to progress in labour.

Older women were more likely to have had miscarriages and terminations, so these patterns may be more to do with age than with obstetric history, but because miscarriages and terminations predicted intended place of birth (see Chapter 4), it is appropriate to consider them as potential covariates in the modelling.

6.4.9 Health behaviours

Smoking
Table 6.6 shows a 'dose/response' relationship between smoking and retained placenta, i.e. the more the mother smoked, the more likely she was to have a retained placenta. However, the opposite pattern was evident for failure to progress in stage 2, PPH and pyrexia. There was no

obvious pattern by smoking status in terms of incidence of foetal distress and failure to progress in stage 1.

Table 6.6: Incidence of labour complications, by mother's smoking status

Mother's smoking status		Labour complication: Foetal distress	Failure to progress stage 1	Failure to progress stage 2	PPH	Pyrexia	Retained placenta
Non-smoker	%	29.9	3.4	9.3	1.9	1.6	1.8
1-9 per day	%	32.1	3.2	7.9	1.6	1.3	2.4
10-19 per day	%	30.9	3.1	5.7	1.5	1.1	2.6
20+ per day	%	29.9	3.4	4.5	1.4	0.9	2.6
p		0.000	0.032	0.000	0.000	0.000	0.000

Gestation at booking

Women who had their booking appointment after 20 weeks' gestation were classed in SMMIS as 'late bookers'. There are a number of reasons why a woman may be a late booker (e.g. migration, not knowing she is pregnant), but it can be an indication of disengagement from the maternity care system (Downe et al, 2009). Late bookers were slightly less likely to experience failure to progress in stage 2 (p=0.000) but slightly more likely to experience failure to progress in stage 1 (p=0.017) and pyrexia (p=0.000). Incidence of the remaining labour complications did not vary significantly according to whether or not the woman booked late.

6.5 Descriptive analysis: characteristics of pregnancy/baby associated with labour complications and/or place of birth

6.5.1 Pregnancy risk status

Pregnancy risk status was derived from the data as described in Section 4.3.1, but with one amendment. NICE guidance states that if labour is induced, the pregnancy should be considered high-risk (National Collaborating Centre for Women's and Children's Health, 2007). Because induction of labour is considered as a covariate in its own right (see Section 6.6.5), it is not included as part of the definition of pregnancy risk status.

Table 6.7 shows that the NICE risk classification is a reasonably good predictor of some labour complications, in that high-risk pregnancies were most likely to experience the following: failure to progress in stage 1, PPH, pyrexia and retained placenta (p=0.000 for all four complications). However, the opposite pattern was evident for failure to progress in stage 2 (p=0.000). The relatively low incidence of foetal distress in the high-risk group is almost certainly due to the fact that, for this complication, the base includes elective CSs, which were far less likely than other types

of delivery to experience foetal distress. The fact that so many low-risk pregnancies experienced complications underlines the difficulty of predicting who will experience them.

Table 6.7: Incidence of labour complications, by pregnancy risk status

		Labour complication					
Pregnancy risk status		Foetal distress	Failure to progress stage 1	Failure to progress stage 2	PPH	Pyrexia	Retained placenta
High	%	29.8	3.5	8.4	3.1	1.8	2.2
Medium	%	31.4	3.5	8.5	1.6	1.4	1.8
Low	%	30.1	3.2	9.2	1.1	1.3	1.9

As noted in Section 5.2.3, analysis of high-risk pregnancies reveals that high-risk women planning home births tended to have a different 'risk profile' from high-risk women planning hospital births. For example, women with high-risk pregnancies planning a home birth were more likely to have gestational diabetes or to have experienced a previous stillbirth/neonatal death, whereas women with high-risk pregnancies planning a hospital birth were more likely to have had a previous Caesarean section or to have a multiple pregnancy. Women with the conditions that were more common in the planned hospital birth group were more likely to experience negative pregnancy outcomes. Therefore, it is not appropriate to do a simple comparison of outcomes by overall risk status; the analysis must take into account this different 'risk profile' for the comparison to be a fair one. For this reason, models using risk status as a covariate include each condition individually rather than using a single composite 'risk status' variable (see Section 6.7.3).

One of the conditions listed as 'medium-risk' is foetal abnormality (see Table 4.6). A number of antenatal tests are available which help to determine the likelihood of the baby being born with a congenital abnormality, but in many cases the presence of an abnormality is not identified for certain until after the baby is born, either because the tests are not carried out or because they are not 100% accurate. In the SMMIS data, 40.1% of those who were recorded as having antenatal indications of an abnormality were recorded as having been born with one, as were 3.0% of those who were not listed as having such indications antenatally. For this reason, both antenatal indications of congenital abnormality and actual congenital abnormality were covariates in the models. Clearly, the two are collinear, so this must be taken into account in the interpretation.

6.5.2 Amount of medical attention received

It is reasonable to expect an association between medical attention in pregnancy and labour complications, because high-risk pregnancies are more likely to have labour complications and are more likely to receive medical attention. Therefore, any association between medical attention and outcomes may be a function of pregnancy risk status. If, however, an association between medical attention and pregnancy outcome remains once pregnancy risk status and other observed factors

are held constant, it is possible that the receipt of medical attention *per se* may influence pregnancy outcomes by introducing iatrogenic harm (as suggested by Tew (1998)); although it is also possible that the association is simply due to both factors being caused by another unobserved factor such as previous babies having had congenital abnormalities.

Number of ultrasound scans

In the UK in the 1990s, most women had at least one ultrasound scan in pregnancy, but there was variation by hospital and by clinician in terms of the number of scans and when they took place (Roberts et al, 1998). It has not been possible to establish the 1990s policy in terms of the number of scans at the hospitals included in the SMMIS database. Table 6.8 shows that there was an association between the number of ultrasound scans received in pregnancy and the incidence of all six labour complications (p=0.000 for all six). Foetal distress was most common among those who had one or two scans, and least common among those who had more than four. Failure to progress in stage 1 was also least common among those having a lot of scans, and most common among those having none. Failure to progress in stage 2, on the other hand, was *least* common among those having no scans. The pattern for PPH, pyrexia and retained placenta was similar, in that these complications were most common among women who had four or more scans, and least common among those who had one scan.

Table 6.8: Incidence of labour complications, by number of ultrasound scans

		Labour complication					
No of scans		Foetal distress	Failure to progress stage 1	Failure to progress stage 2	PPH	Pyrexia	Retained placenta
None	%	27.5	4.0	6.7	1.6	1.5	1.9
One	%	30.7	3.5	8.2	1.3	1.2	1.8
Two	%	30.7	3.4	9.4	1.7	1.5	1.9
Three	%	30.2	3.0	9.4	2.1	1.7	2.2
Four	%	29.6	2.8	8.8	2.9	1.9	2.5
More than four	%	26.4	2.5	8.8	4.1	1.8	2.8

Number of antenatal clinic visits

The National Institute for Health and Clinical Excellence (NICE) (2008) recommends that multiparae with uncomplicated pregnancies should need no more than seven antenatal checks and that primiparae with uncomplicated pregnancies should need no more than ten. Over 80% of pregnancies in SMMIS recorded fewer antenatal clinic visits than this, which is surprising because the NICE guidance indicated that, prior to 2008, most pregnant women received more checks than clinically necessary. This suggests that the recording of antenatal checks in SMMIS was incomplete. According to Steer (2008b), antenatal checks that took place in women's home were probably under-recorded in SMMIS, which may explain this discrepancy. It is therefore not appropriate to

include this variable in the modelling, because it is likely that women planning a home birth were more likely than those planning a hospital birth to have antenatal checks at home.

Amniocentesis

Failure to progress in stage 2, PPH, pyrexia and retained placenta were more common among those who had had an amniocentesis than among those who had not (p=0.000 for all four complications). Amniocentesis was not, however, associated with a higher incidence of foetal distress or failure to progress in stage 1.

Chorionic villus biopsy (CVB)

Incidence of foetal distress was lower among those who had had a CVB than among those who had not (p=0.000). CVB was not associated with incidence of the other labour complications.

Foetal manipulation before delivery

Foetal manipulation is offered if there is reason to suspect malpresentation of the foetus, which is included within the definition of 'high-risk' pregnancy (see Section 4.3.1.1). Malpresentation and foetal manipulation were highly correlated, making it inappropriate to include both in the modelling. Malpresentation was selected for inclusion, because it was judged to be more likely to be associated with negative outcomes than foetal manipulation *per se*.

6.5.3 Maturity/size of foetus

Low birthweight is defined as below 2500g, and very low birthweight as below 1500g (Confidential Enquiry into Maternal and Child Health, 2009). A baby born weighing less than 500g is unlikely to survive (see Section 7.5.3). Table 6.9 shows that low birthweight was associated with a slightly higher incidence of foetal distress (but birthweight below 500g was not), and very low birthweight was associated with a considerably higher incidence of pyrexia and retained placenta. On the other hand, high birthweight (defined here as 4000g or more) was associated with failure to progress in both stages of labour, especially the second stage.

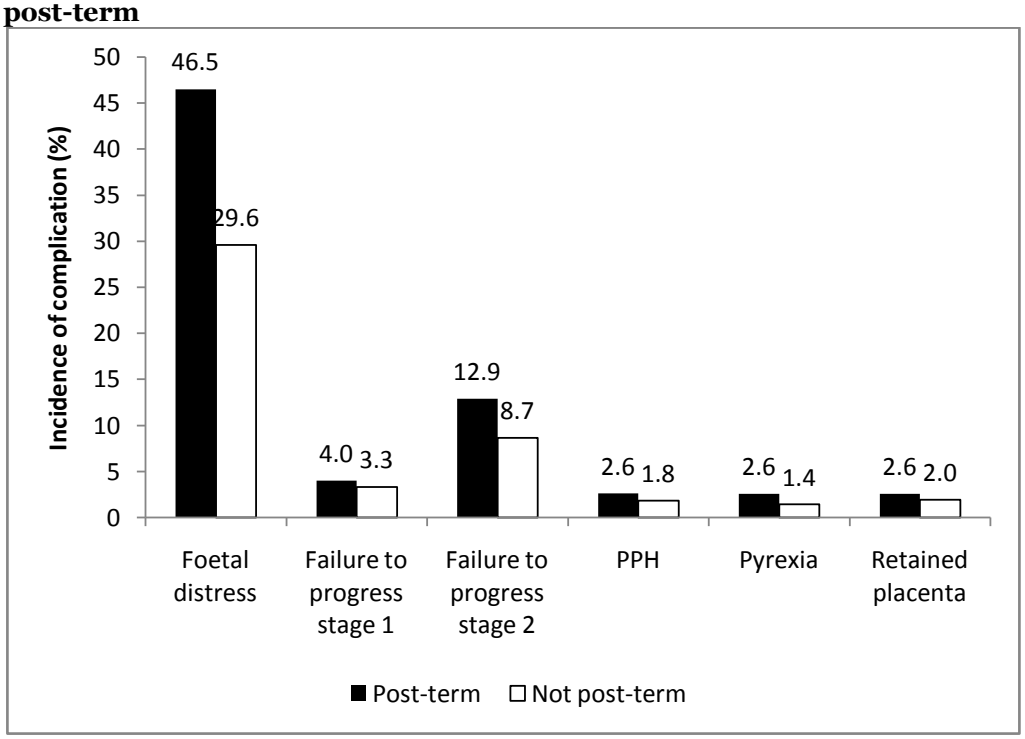
Table 6.9: Incidence of labour complications, by birthweight

		Labour complication					
Birthweight		Foetal distress	Failure to progress stage 1	Failure to progress stage 2	PPH	Pyrexia	Retained placenta
<500g	%	13.8	4.0	3.4	2.1	10.0	10.0
500g-1499g	%	32.4	2.7	1.8	4.4	6.2	5.8
1500g-2499g	%	32.8	1.8	4.1	3.0	1.6	3.2
2500g-3999g	%	29.8	3.3	8.9	1.6	1.3	1.8
4000g+	%	31.8	4.2	11.4	3.1	2.0	1.9
p		0.000	0.000	0.000	0.000	0.000	0.000

Not surprisingly, there was a high degree of positive correlation between gestation, birthweight and head circumference, so similar patterns were observed for head circumference and gestation at delivery as for birthweight. Birthweight and days of gestation were correlated at 0.625, and birthweight and head circumference at 0.705, indicating that only one of these measures should be used as a model covariate. Birthweight was selected, because low birthweight can occur even among full-term babies, and standard definitions exist for low birthweight. Furthermore, preterm labour was included within the definition of pregnancy risk status, so prematurity was included in the model via this route[53], and post-maturity (gestation longer than 41 completed weeks) was included as a binary covariate because previous research has found an association between it and some of the outcomes of interest (see Table 6.12).

Figure 6.9 shows that, if the gestation was longer than 41 weeks, incidence of all six labour complications was higher (p=0.000 for all six), and that this was particularly true for foetal distress and failure to progress in stage 2 of labour.

Figure 6.9: Incidence of labour complications, by whether or not the pregnancy was post-term



[53] When preterm labour was included in the model with perinatal death as the outcome, the odds ratios for low birthweight and very low birthweight halved, but barely changed for high birthweight (4000g+).

6.5.4 Sex of baby

In SMMIS, the baby's sex was recorded as 'male', 'female' or 'indeterminate'. Indeterminate sex was included within the definition of 'congenital abnormality', which was a covariate in its own right (see Section 6.5.5), so bivariate analysis by sex excluded babies of indeterminate sex. In the modelling, however, babies of indeterminate sex were included as a separate group, because their results were quite different from either boys or girls so it would not have made sense to combine them with either sex.

Women carrying a boy were more likely than those carrying a girl to experience foetal distress in labour (p=0.000) and failure to progress in stage 1 (p=0.001) and/or stage 2 (p=0.000), whereas those carrying a girl were more likely than those carrying a boy to experience PPH and retained placenta (p=0.000). The sex of the baby was not associated with pyrexia in labour (p=0.995).

6.5.5 Congenital abnormalities

In SMMIS, there was space to record up to five congenital abnormalities per pregnancy, and these were recorded using International Classification of Diseases (ICD) codes (World Health Organisation, 1992). The ICD coding system changed in the mid-1990s, so the SMMIS database contained codes from both the old (ICD-9) and the new (ICD-10) coding systems. ICD-9 codes starting with '74' or '75' and ICD-10 codes starting with 'Q' were classed as congenital abnormalities. Other ICD codes that were recorded in the 'congenital abnormalities' fields were not. Upon further investigation, it was found that ICD codes starting with '74', '75' and 'Q' were also recorded in two other fields: 'infant's complications' and 'other infant's complications'. In these two fields there was space to record up to ten further conditions. In this analysis, a baby was classed as having a congenital abnormality if there was a relevant ICD code in any of the three fields; a total of 19,334 records (3.8%).

Babies with congenital abnormalities were more likely to suffer distress during labour than babies without such abnormalities (31.4% and 30.1% respectively; p=0.000), and their mothers were slightly more likely to suffer pyrexia (p=0.088) and retained placenta (p=0.010). Incidence of the other labour complications was the same, whether or not there were congenital abnormalities.

6.6 Descriptive analysis: characteristics of labour/delivery associated with labour complications and/or place of birth

6.6.1 Birth attendant

In SMMIS, the "person conducting delivery" was recorded as 'midwife', 'hospital doctor', 'GP', 'other' or 'none'. There was a strong association between birth attendant and labour complications. However, it was not appropriate to include birth attendant as a covariate because it was so strongly correlated with place of birth (90.0% of planned home births were attended by a midwife, compared with 70.2% overall) and mode of delivery (95.2% of spontaneous vaginal deliveries were attended by midwives, and 93.0% of assisted and operative deliveries were attended by hospital doctors).

6.6.2 Duration of labour

The longer the labour, the more likely it was that there would be labour complications (p=0.000 for all six complications). However, it was not appropriate to consider labour duration as a predictor of labour complications, because a longer labour may have resulted from the complication(s) rather than vice versa.

6.6.3 Mode of delivery

Incidence of most labour complications was higher among women whose labours ended with an assisted or operational delivery. This is to be expected, since assisted and operational deliveries tend to be performed in response to labour complications. For these labour complications, therefore, it is not appropriate to consider mode of delivery as a predictor. The exception is PPH, incidence of which was highest among those who had a spontaneous vaginal delivery (23.6%), followed by emergency CSs (6.7%), elective CSs (4.3%), then instrumental vaginal deliveries (2.4%); p=0.000. However, because mode of delivery was so strongly correlated with place of birth (assisted and operational deliveries nearly all took place in hospital), it was not appropriate to consider mode of delivery as a covariate for PPH either.

It is likely that mode of delivery was taken into account to some extent in the modelling, because some high-and medium-risk conditions were associated with a *lower* risk of labour complications (e.g. multiple pregnancy was associated with lower risk of foetal distress, failure to progress in second stage of labour and retained placenta). It seems likely that this is due to women with these conditions being more likely to have a Caesarean section.

6.6.4 Type of pain relief used in labour

The use of anaesthesia – particularly epidural/spinal anaesthesia - was associated with a higher incidence of labour complications (p=0.000 for all six complications). However, it was not appropriate to consider pain relief as a predictor of labour complications, because decisions about pain relief may have resulted from the complication(s) rather than vice versa.

6.6.5 Induction/augmentation of labour

Incidence of labour complications was higher when labour was induced or augmented. This pattern is to be expected, since labour is usually induced/augmented as a response to a concern about the health of the mother or foetus.

Induction and augmentation were both strongly correlated with place of birth (0.2% of planned home births were induced and 3.8% were augmented, compared with 18.0% and 20.6% respectively of planned hospital births). For this reason, it was judged to be inappropriate to include them as covariates in the models with labour complications as outcomes.

6.7 Statistical modelling: methods

6.7.1 Models required to answer the research question

Research question 2: Are women who attempt a home birth less likely than those who plan a hospital birth to experience labour complications once other observed characteristics are held constant?

Research question 2 is answered using six models as described in Table 6.10, each with a labour complication as the outcome variable. These models are essentially an 'intention to treat' analysis, in which those intending a home birth at the end of pregnancy are treated as a single group, regardless of whether or not they actually gave birth at home. Thus, the complicated home birth cases are included as well as the straightforward ones (see Section 2.4.2).

Table 6.10: Models built to address the research question about the safety of planned home birth for the mother

Model	Outcome	Cases excluded
1	Foetal distress	Intended place of birth unknown, unplanned home births
2	Failure to progress in first stage of labour	Intended place of birth unknown, unplanned home births, elective CSs
3	Failure to progress in second stage of labour	Intended place of birth unknown, unplanned home births, elective CSs
4	Postpartum haemorrhage	Intended place of birth unknown, unplanned home births
5	Maternal pyrexia in labour	Intended place of birth unknown, unplanned home births, elective CSs
6	Retained placenta	Intended place of birth unknown, unplanned home births, elective CSs

In all the models it is important to test for significant interactions between place of birth and: parity, pregnancy risk status, birthweight and congenital abnormalities, to establish whether the overall findings hold true for all groups, including those at higher risk of negative outcomes.

All models have a binary outcome variable, so binary regression models (BRMs) are used (see Section 3.3.2 for a detailed description of this type of model). In all six models, the logit link function is used.

6.7.2 Outcome variables and explanatory variables included in the model building process

For each model, the outcome variable is binary (yes or no). Table 6.11 shows the number of women experiencing each labour complication who were eligible for inclusion in the modelling process and the percentage of eligible records that were recorded as having each complication.

Table 6.11: Number of women experiencing each labour complication in SMMIS

Complication	No of cases in SMMIS	% of eligible records with complication
Foetal distress	154,901	30.3
Failure to progress in 1st stage of labour	16,114	3.4
Failure to progress in 2nd stage of labour	42,460	8.8
Postpartum haemorrhage	9,448	1.8
Pyrexia	7,136	1.5
Retained placenta	9,478	2.0

Table 6.12 shows the results of a literature search which aimed to identify the known predictors of each of the selected labour complications, mainly based on studies from developed countries. It was judged to be necessary to conduct this additional search for two reasons: (1) to reassure that the key explanatory variables were included in the model and (2) the term 'pregnancy risk status' (as used in Table 6.2) was not felt to do justice to the complex relationships between specific pregnancy risk factors and the outcomes of interest. The SMMIS database contained measures of nearly all of the predictors identified via this literature search, allowing us to control for them. Some predictors were not suitable for inclusion as model covariates even if they were included in SMMIS, e.g. induction of labour (see Section 6.6.5) and analgesia (see Section 6.6.4).

Table 6.12: Previously identified predictors of selected labour complications

Complication	Predictors/risk factors	Reference(s); notes
Foetal distress	Oligohydramnios	Tongsong & Srisomboon (1993); post-term births only
	Small foetus, post-term pregnancy	Campbell et al (1997); post-term births only
	Foetal growth rate in third trimester	Owen et al (1997); predicted CS for foetal distress, rather than foetal distress *per se*
	Foetal heart rate variation in early labour	Weiner et al (1994); post-term births only
Delay in labour	Low maternal height	McGuinness & Trivedi (1999); predicted CS for delay in labour, rather than delay in labour *per se*

Table 6.12 (cont'd): Previously identified predictors of selected labour complications

Complication	Predictors/risk factors	Reference(s); notes
Failure to progress stage 1	Maternal obesity	Sheiner et al (2004)
Failure to progress in stage 2 of labour	Primiparity, birthweight ≥4000g, epidural analgesia, hydramnios, hypertensive disorders, gestational diabetes, male baby, premature rupture of membranes, induction	Feinstein et al (2002); singleton, vertex, term pregnancies only
Postpartum haemorrhage (PPH)	Age ≥35, non-white and non-black ethnic group, social exclusion, previous PPH, diabetes, multiple pregnancy, antenatal admission to hospital, taking iron at booking, taking antiepileptics at booking, taking antidepressants at booking, induction of labour, oxytocin augmentation, manual removal of placenta, emergency CS	Waterstone et al (2001); PPH defined as loss of more than 1500ml of blood or requiring transfusion of 4+ units of blood
	Placental abruption, placenta praevia, multiple pregnancy, obesity, retained placenta, induction of labour, episiotomy, birthweight ≥4000g	Stones et al (1993); PPH defined as loss of more than 1000ml of blood.
	Retained placenta, 3rd stage of labour ≥30 minutes, birthweight ≥4000g, lacerations ≥1st degree	Bais et al (2004); PPH defined as loss of more than 1000ml of blood.
Pyrexia	Induction after premature rupture of membranes	Zamzami (2006); Saudi Arabia
	Epidural analgesia, primiparity, induction of labour, long labour, administration of oxytocin, large baby, post-term baby, instrumental delivery	Impey et al (2001); pyrexia defined as temperature during labour of >37.5°C. Only included low-risk women delivering at 36-41 weeks of gestation
	Epidural anaesthesia, primiparity, labour > 12 hours	Philip et al (1999), Herbst et al (1995); pyrexia defined as temperature during labour of ≥38.0°C. Only included cases of spontaneous labour at term
Retained placenta	Sickle Cell Disease (a haemoglobinopathy)	Serjeant et al (2004); Jamaica. Retained placenta defined as retention for 60+ minutes after delivery of the baby
	Parity ≥5, induction, small placenta (<500g), blood loss ≥500ml, previous injury to uterus (e.g. CS), pre-term labour	Adelusi et al (1997). Retained placenta defined as placenta requiring manual removal
	Previous retained placenta, previous CS, pre-term labour, age >35, small placenta (≤600g), pethidine during labour, induction of labour, parity >5	Soltan & Khashoggi (1997). Retained placenta defined as retention for >60 minutes after delivery of the baby and requiring manual removal
	Pre-term labour, delivery in a "labour bed" (as opposed to delivery room), pre-eclampsia, augmentation, primiparity, parity ≥5, delivery by midwife (as opposed to physician), age ≥30, previous termination(s), non-Asian ethnic group	Combs & Laros (1991); retained placenta defined as retention for 30+ minutes after delivery of the baby

The information in Table 6.12 and the exploratory analysis (Sections 6.3-6) were used to draw up a list of covariates to include in the model building process, as detailed in Table E.8 in Appendix E. Although the analysis described in this chapter mentions a wide range of predictors of labour complications, the only predictor that is discussed in detail in the modelling results section is intended place of birth. This is because the cases and covariates included in this analysis were selected with the specific aim of making a fair comparison between those intending a home birth and those intending a hospital birth. This resulted in the deletion of certain cases, e.g. unplanned home births (see Section 5.1), and the exclusion of certain key covariates, e.g. mode of delivery (see Section 6.6). Had the aim been to identify general predictors of the outcomes, such cases and covariates would have been included, which would have affected the coefficients for some or all of the remaining covariates.

6.7.3 Model selection process

All models were selected using manual forward selection (see Appendix F for a detailed account). Each explanatory variable was added individually, with one exception: 'antenatal risk status'. As noted in Sections 5.2.3 and 6.5.1, it was not appropriate to use the summary variable which classed each pregnancy as high-, medium- or low-risk because high-risk women having planned home births tended to have different high-risk conditions than high-risk women having planned hospital births. Therefore, each individual high- or medium-risk condition listed in Tables 4.5 and 4.6 was treated as a separate covariate. Because these conditions together made up the definition of high- and medium-risk pregnancies, it was judged appropriate to add them to the model as a single 'block' of covariates rather than adding each one separately as an individual covariate.

In a few cases, the conditions listed in Tables 4.5 and 4.6 were not treated as separate covariates:

- 'Age 40+ at booking', and 'parity 6 or more' were excluded altogether because age and parity were included as covariates in their own right
- Rather than having two binary 'BMI' variables: 35+ ('high-risk') and 30-34 ('medium-risk'), a new 'BMI' variable was derived with three categories: '35+kg/m^2', '30-34 kg/m^2' and '<30 kg/m^2'
- In the same vein, a new 'haemoglobin' variable was derived, also with three categories: '<8.5g/dl' (anaemic, i.e. 'high-risk'), '8.5-10.5g/dl' (borderline anaemic, i.e. 'medium-risk') and '>10.5g/dl' (not anaemic, i.e. 'low-risk')
- Similarly, a new 'blood pressure' variable was derived, also with three categories: 'pre-eclampsia or pregnancy-induced hypertension' (derived from ICD codes – see Appendix C – i.e. 'high-risk'), 'slightly raised' (140mmHg systolic or 90mmHg diastolic, i.e. 'medium-risk') and 'not raised' (i.e. 'low-risk')

The 'pregnancy risk status' block comprised 50 individual conditions, of which 15 were collapsed into a binary 'other risk factors' variable because they were extremely rare[54]. In all of the maternal outcome models, this 'other' variable was not significantly associated with the outcome (see Tables 6.13 – 6.18). The remaining 35 high-/medium-risk conditions were included as individual covariates in the model building process.

The covariate (or block of covariates) yielding the highest $LR\chi^2$ value was selected to be included in the model, and was included in all models tested from that point on. This process was repeated with the remaining explanatory variables until Likelihood Ratio Tests (LRTs) showed that the addition of further explanatory variables did not make the model a significantly better fit overall (i.e. the p-value of the LRT was ≥0.05).

Foetal distress model

The building of an additive model resulted in a model containing all but four of the covariates in Table E.8 in Appendix E, the exceptions being: congenital abnormalities (which became non-significant once birthweight was held constant), previous miscarriages, previous terminations (both of which became non-significant once mother's age was held constant), and late booker (which became non-significant once mother's age and year of delivery were held constant); see Table F.5 in Appendix F for full details.

After the building of the additive model was complete, 18 of the individual conditions making up the antenatal risk status block did not have a significant association with the outcome (p>0.05). A likelihood ratio test (LRT) showed that the model without these complications was not a significantly worse fit to the data than the model with them (p=0.5217). Furthermore, their removal made virtually no difference to the odds ratios for the remaining covariates (no OR changed by more than 0.005), so they were excluded from the final model. Table 6.13 details the conditions that were excluded for this reason, and the p-values of their model coefficients.

[54] These were: cystic fibrosis, thromboembolism, streptococcus B, HIV, toxoplasmosis, SLE, myasthenia gravis, liver disease, scleroderma, previous PPH, previous retained placenta, alcohol abuse, abnormal foetal heart rate in pregnancy, previous hysterectomy and spinal abnormalities/previous fractured pelvis/neurological deficits. Just 148 cases (0.03%) had one or more of these complications.

Table 6.13: Pregnancy risk factors excluded from 'foetal distress' model due to having no significant association with the outcome once other covariates were held constant, and the p-values of their model coefficients

Complication	p-value	Complication	p-value
Heart condition	0.442	Coagulation disorder	0.325
Atypical antibodies	0.471	Hepatitis B/C	0.706
Chicken pox/rubella/herpes	0.353	Tuberculosis	0.715
Hyperthyroidism	0.652	Pre-existing diabetes	0.058
Kidney disorder	0.795	Epilepsy	0.948
Psychiatric disorder	0.077	Gestational diabetes	0.674
Substance misuse	0.567	Inflammatory bowel disorder	0.056
Previous baby >4.5kg	0.686	Large for dates	0.205
Fibroids	0.725	Other high-/medium-risk condition	0.560

The final additive model was a good fit to the data, as evidenced by the fact that just 16,997 (3.3%) of the model's standardised residuals were outside the range -2 to 2. Once the final additive model had been built, interaction terms were added to assess whether or not they made a statistically and substantively significant improvement to the model. The addition of interaction terms was theory-driven, with a focus on interaction terms involving intended place of birth. The testing of such terms aimed to answer the question of whether the overall results on the safety of planned home birth were masking sub-groups of women for whom the pattern was different.

LRTs were used to assess whether interaction terms made a statistically significant improvement to the model ($p<0.05$). The full list of interaction terms that were tested can be found in Table F.5 in Appendix F, of which seven resulted in a statistically significant improvement to the fit of the model. These were the interactions between intended place of birth and: (1) hospital, (2) time of birth, (3) malpresentation diagnosed before labour, (4) parity, (5) the mother having asthma, (6) labour commencing before 37 weeks' gestation and (7) antenatal evidence to suggest a congenital abnormality. It was not possible to include all of these interaction terms in the final model, because of collinearity problems. Only two of them caused a change to the overall pattern of incidence of foetal distress being higher among women who intended a hospital birth: malpresentation diagnosed before labour and maternal asthma. In these two situations, once the other covariates were held constant, foetal distress was more common among those intending a home birth than among those intending a hospital birth. Because the other five significant interaction terms did not change the overall conclusion of the model (i.e. that foetal distress was more common among those who intended a hospital birth than among those who intended a home birth once other covariates were held constant), they were not included in the final model. It should, however, be noted that intended place of birth interacted significantly with these five characteristics. Women who intended a hospital birth were more likely than those who intended a home birth to experience foetal distress, but the magnitude of the difference varied according to hospital, time of birth, parity, preterm labour and congenital abnormalities.

Failure to progress in first stage of labour model

The building of an additive model resulted in a model containing all but nine of the covariates in Table E.8 in Appendix E, the exceptions being: month, previous terminations, previous miscarriages, congenital abnormalities, amniocentesis (none of which had a significant association with the outcome at the bivariate level and did not become significant once other covariates were added to the model), smoking status, gestation >41 weeks (both of which became non-significant once birthweight was held constant), 'single, unsupported' (which became non-significant once ethnic group was held constant) and chorionic villus biopsy (which became non-significant once parity was held constant).

After the building of the additive model was complete, 22 of the individual conditions making up the antenatal risk status block did not have a significant association with the outcome ($p>0.05$). A likelihood ratio test (LRT) showed that the model without these complications was not a significantly worse fit to the data than the model with them ($p=0.2158$). Furthermore, their removal made very little difference to the odds ratios for the remaining covariates (no OR changed by more than 0.02), so they were excluded from the final model. Table 6.14 details the conditions that were excluded for this reason, and the p-values of their model coefficients.

Table 6.14: Pregnancy risk factors excluded from 'failure to progress in stage 1' model due to having no significant association with the outcome once other covariates were held constant, and the p-values of their model coefficients

Complication	p-value	Complication	p-value
Heart condition	0.127	Pre-existing hypertension	0.801
Asthma	0.872	Coagulation disorder	0.096
Atypical antibodies	0.811	Hepatitis B/C	0.345
Chicken pox/rubella/herpes	0.988	Hyperthyroidism	0.073
Kidney disorder	0.809	Epilepsy	0.732
Psychiatric disorder	0.649	Previous stillbirth/neonatal death	0.088
Substance misuse	0.698	Gestational diabetes	0.577
BMI 30-34	0.070	BMI 35+	0.987
Oligo/polyhydramios	0.225	Inflammatory bowel disorder	0.190
Previous baby >4.5kg	0.054	Large for dates	0.581
Fibroids	0.459	Other high-/medium-risk condition	0.772

Once the final additive model had been built, interaction terms were added as described in the previous section. One of them (intended place of birth * parity) resulted in a model which was a significantly better fit to the data (see Table F.6 for details), and was therefore included in the final model (see Section 6.8.2).

Failure to progress in second stage of labour model

The building of an additive model resulted in a model containing all but five of the covariates in Table E.8 in Appendix E, the exceptions being: congenital abnormalities, previous terminations (neither of which had a significant association with the outcome at the bivariate level and did not become significant once other covariates were added to the model), previous miscarriages (which became non-significant once age was held constant), sex of baby (which became non-significant once birthweight was held constant) and chorionic villus biopsy (which became non-significant once amniocentesis was held constant).

After the building of the additive model was complete, 21 of the individual conditions making up the antenatal risk status block did not have a significant association with the outcome ($p>0.05$). A likelihood ratio test (LRT) showed that the model without these complications was a slightly worse fit to the data than the model with them ($p=0.0640$). However, their removal made very little difference to the odds ratios for the remaining covariates (no OR changed by more than 0.05), so they were excluded from the final model. Table 6.15 details the conditions that were excluded for this reason, and the p-values of their model coefficients.

Table 6.15: Pregnancy risk factors excluded from 'failure to progress in stage 2' model due to having no significant association with the outcome once other covariates were held constant, and the p-values of their model coefficients

Complication	p-value	Complication	p-value
Heart condition	0.259	Pre-existing hypertension	0.239
Asthma	0.931	Haemoglobinopathies	0.092
Coagulation disorder	0.199	Atypical antibodies	0.764
Hepatitis B/C	0.120	Chicken pox/rubella/herpes	0.091
Hyperthyroidism	0.339	Pre-existing diabetes	0.904
Kidney disorder	0.134	Epilepsy	0.874
Psychiatric disorder	0.785	Substance misuse	0.320
Recurrent antepartum haemorrhage	0.108	Inflammatory bowel disorder	0.439
Previous baby >4.5kg	0.101	Large for dates	0.247
Suspected congenital abnormality	0.116	Fibroids	0.094
Other high-/medium-risk condition	0.134		

Once the final additive model had been built, interaction terms involving intended place of birth were added. One of them (intended place of birth * parity) resulted in a model which was a significantly better fit to the data. However, residual analysis of the resultant model showed that the model fit was relatively poor for primiparae, so further interaction terms involving parity were added to see if this improved the fit of the model. As can be seen in Table F.7 in Appendix F, 14

covariates interacted with parity to significantly improve the model fit[55]. It was not possible to include all of them due to collinearity problems, so the focus was on those which altered the model's substantive conclusions. Just one altered the overall pattern of higher-parity women being less likely to experience delay in stage 2 of labour: the interaction between parity and birthweight. For this reason, this was the only interaction term included in the final model (see Section 6.8.3). Once it was included, the interaction between parity and intended place of birth became non-significant.

Postpartum haemorrhage (PPH) model

The building of an additive model resulted in a model containing all but eight of the covariates in Table E.8 in Appendix E, the exceptions being: month of delivery, chorionic villus biopsy, congenital abnormalities, interpreter required (all of which had no significant association with PPH at the bivariate level and did not become significant once other covariates were added to the model), amniocentesis (which became non-significant once age was held constant), previous terminations (which became non-significant once ethnic group was held constant), late booker (which became non-significant once 'number of ultrasound scans' was held constant) and Carstairs quintile (which did not significantly improve the fit of the final additive model).

After the building of the additive model was complete, 18 of the individual conditions making up the antenatal risk status block did not have a significant association with the outcome ($p>0.05$). A likelihood ratio test (LRT) showed that the model without these complications was not a significantly worse fit to the data than the model with them ($p=0.5960$). Furthermore, their removal made very little difference to the odds ratios for the remaining covariates (no OR changed by more than 0.04), so they were excluded from the final model. Table 6.16 details the conditions that were excluded for this reason, and the p-values of their model coefficients.

Table 6.16: Pregnancy risk factors excluded from 'PPH' model due to having no significant association with the outcome once other covariates were held constant, and the p-values of their model coefficients

Complication	p-value	Complication	p-value
Heart condition	0.667	Pre-existing hypertension	0.740
Asthma	0.570	Coagulation disorder	0.079
Atypical antibodies	0.136	Hepatitis B/C	0.392
Chicken pox/rubella/herpes	0.357	Hyperthyroidism	0.371
Pre-existing diabetes	0.170	Kidney disorder	0.974
Epilepsy	0.979	Psychiatric disorder	0.706
Substance misuse	0.999	Gestational diabetes	0.554
Inflammatory bowel disorder	0.097	Large for dates	0.108
Suspected congenital abnormality	0.731	Other high-/medium-risk condition	0.910

[55] These were the interactions between parity and: multiple pregnancy, malpresentation, birthweight, hospital, year, time, ethnic group, Carstairs quintile, anaemia, preterm labour, gestational diabetes, BMI, gestational hypertension/pre-eclampsia and intended place of birth.

Once the final additive model had been built, interaction terms involving intended place of birth were added. However, none of them resulted in a model which was a significantly better fit to the data (see Table F.8 in Appendix F for details), which was not surprising because there were only 40 cases of PPH in the 'intended a home birth' group. Therefore, the final model contained no interaction terms (see Section 6.8.4).

Pyrexia model

The building of an additive model resulted in a model containing all but eight of the covariates in Table E.8 in Appendix E, the exceptions being: interpreter required (which had no significant association with pyrexia at the bivariate level and did not become significant once other covariates were added to the model), 'single unsupported' (which became non-significant when parity was held constant), sex of baby (which became non-significant once birthweight was held constant), chorionic villus biopsy (which became non-significant once pregnancy risk status was held constant), patient category, late booker (both of which became non-significant once ethnic group was held constant), Carstairs quintile and number of ultrasound scans (neither of which significantly improved the fit of the additive model.

After the building of the additive model was complete, 24 of the individual conditions making up the antenatal risk status block did not have a significant association with the outcome at the 95% confidence level ($p>0.05$). A likelihood ratio test (LRT) showed that the model without these complications was not a significantly worse fit to the data than the model with them ($p=0.4018$). The removal of the 24 conditions made virtually no difference to the odds ratios for the remaining covariates (the only OR which changed by more than 0.05 was that for the small group of babies born weighing less than 500g, which changed by just 0.14). Table 6.17 details the conditions that were excluded, and the p-values of their model coefficients.

Table 6.17: Pregnancy risk factors excluded from 'pyrexia' model due to having no significant association with the outcome once other covariates were held constant, and the p-values of their model coefficients

Complication	p-value	Complication	p-value
Heart condition	0.176	Pre-existing hypertension	0.345
Asthma	0.198	Haemoglobinopathies	0.210
Coagulation disorder	0.659	Atypical antibodies	0.324
Hepatitis B/C	0.491	Chicken pox/rubella/herpes	0.380
Hyperthyroidism	0.154	Pre-existing diabetes	0.233
Kidney disorder	0.168	Epilepsy	0.727
Psychiatric disorder	0.304	Borderline gestational hypertension	0.559
Gestational hypertension/pre-eclampsia	0.445	Recurrent antepartum haemorrhage	0.590
Malpresentation	0.310	Substance misuse	0.559
Small for dates	0.428	Oligo/polyhydramnios	0.532
Inflammatory bowel disorder	0.297	Previous baby >4.5kg	0.199
Fibroids	0.087	Other high-/medium-risk condition	0.778

Once the final additive model had been built, interaction terms involving intended place of birth were added. None made a significant improvement to the overall fit of the model (see Table F.9), which was not surprising because there were only 27 cases of pyrexia in the 'intended a home birth' group. Therefore the final model did not contain any interactions (see Section 6.8.5).

Retained placenta model

The building of an additive model resulted in a model containing all but eight of the covariates in Table E.8 in Appendix E, the exceptions being: patient category (which had no significant association with retained placenta at the bivariate level and did not become significant once other covariates were added to the model), time of birth, congenital abnormalities, chorionic villus biopsy (all of which became non-significant once birthweight was held constant), interpreter required (which became non-significant once age was held constant), Carstairs quintile (which became non-significant once smoking status was held constant), late booker (which became non-significant once year was held constant) and month (which did not improve the fit of the additive model).

After the building of the additive model was complete, 25 of the individual conditions making up the antenatal risk status block did not have a significant association with the outcome at the 95% confidence level ($p>0.05$). A likelihood ratio test (LRT) showed that the model without these complications was not a significantly worse fit to the data than the model with them ($p=0.1466$). The removal of the 25 conditions made virtually no difference to the odds ratios for the remaining covariates (no OR changed by more than 0.04). Table 6.18 details the conditions that were excluded, and the p-values of their model coefficients.

Table 6.18: Pregnancy risk factors excluded from 'retained placenta' model due to having no significant association with the outcome once other covariates were held constant, and the p-values of their model coefficients

Complication	p-value	Complication	p-value
Heart condition	0.397	Pre-existing hypertension	0.821
Asthma	0.630	Haemoglobinopathies	0.837
Coagulation disorder	0.738	Atypical antibodies	0.845
Hepatitis B/C	0.650	Chicken pox/rubella/herpes	0.080
Hyperthyroidism	0.176	Kidney disorder	0.355
Psychiatric disorder	0.408	Previous stillbirth/neonatal death	0.911
Placenta praevia	0.093	Borderline anaemia	0.242
Gestational hypertension/pre-eclampsia	0.364	Borderline gestational hypertension	0.087
Anaemia	0.083	Substance misuse	0.688
Gestational diabetes	0.501	Small for dates	0.070
Oligo/polyhydramnios	0.071	Previous baby >4.5kg	0.136
Large for dates	0.426	Fibroids	0.148
Other high-/medium-risk condition	0.926		

Once the final additive model had been built, interaction terms involving intended place of birth were added. None made a significant improvement to the overall fit of the model (see Table F.10 in Appendix F), which was not surprising because there were only 75 cases of retained placenta in the 'intended a home birth' group. Therefore the final model did not contain any interaction terms.

6.7.4 Reference categories

Table 6.19 details the reference categories selected for each categorical explanatory variable, and therefore describes a 'reference pregnancy' for these models. The same reference category was used in all the models for ease of presenting and interpreting the results. In most cases, the reference category was the group with the lowest overall incidence of labour complications. There were two main exceptions to this rule: (1) if the group with the lowest incidence was too small to be a reference category, the largest group was selected instead, and (2) for variables with an inherent order (e.g. year of birth), where possible a category at one of the extremes was selected. However, in some cases (e.g. mother's age), the groups at either end of the continuum were too small to be used as reference categories. In these cases, the group with the lowest incidence of labour complications was selected instead.

Table 6.19: Characteristics of a reference pregnancy for the 'labour complications' models

Explanatory variable	Reference category	Explanatory variable	Reference category
Intended place of birth at end of pregnancy	Home	Conditions making up antenatal risk status	No for each
Year of birth	1988*	Mother's ethnic group	W European
Month of birth	September	Interpreter required?	No
Time of birth	10:00-11:59	Smoking status	Non-smoker
Hospital providing care	Hillingdon	Gestation >41 weeks?	No
Parity	2	Number of ultrasound scans	1***
Mother's age at delivery	30-34**	Chorionic villus biopsy	No
Single, unsupported	No	Birthweight	2500g-3999g
Patient category	Normal	Sex of baby	Female
Carstairs quintile	1		

* 1988-2001 in the retained placenta model
** 30+ in the pyrexia model
*** 0-2 in the retained placenta model

6.8 Statistical modelling: results

6.8.1 Foetal distress model

Table 6.20 shows the log odds, standard errors, relative risks (see Section 3.3.7) and 95% confidence intervals for the relative risks from the model with foetal distress as the outcome. The results for intended place of birth are shown first in the table, and then other covariates are shown in the order used in the conceptual framework (see Table 6.2). The relative risk is interpreted as the number of times by which the risk of a woman in that category experiencing foetal distress was greater/less than the risk of a woman in the reference category doing so, assuming an otherwise reference pregnancy.

Table 6.20: Results of 'foetal distress' model

	Log odds	Standard error	p-value of log odds	Relative risk	95% confidence interval for relative risk	
Intended place of birth main effect (reference = home)						
Hospital	0.8381	0.0372	***	2.16	2.03	2.29
Asthma main effect (reference = no)						
Yes	0.9330	0.3071	***	2.35	1.37	3.82
Intended place of birth * asthma interaction						
Hospital * asthma	-0.8492	0.3087	***	2.32	0.71	6.14
Malpresentation main effect (reference = no)						
Yes	1.3100	0.2384	***	3.23	2.18	4.59
Intended place of birth * malpresentation interaction						
Hospital * malpresentation	-1.6079	0.2389	***	1.65	0.64	3.86
Year of delivery (reference = 1988)						
1989	0.0911	0.0164	***	1.09	1.06	1.12
1990	0.1172	0.0162	***	1.12	1.08	1.15
1991	0.1511	0.0162	***	1.15	1.12	1.19
1992	0.0999	0.0163	***	1.10	1.07	1.13
1993	0.0852	0.0164	***	1.08	1.05	1.12
1994	0.1137	0.0164	***	1.11	1.08	1.15
1995	0.0468	0.0177	***	1.05	1.01	1.08
1996	0.0884	0.0170	***	1.09	1.05	1.12
1997	0.0969	0.0171	***	1.10	1.06	1.13
1998	0.1133	0.0171	***	1.11	1.08	1.15
1999	0.0562	0.0172	***	1.05	1.02	1.09
2000	0.0114	0.0171		1.01	0.98	1.04

Table 6.20 (cont'd): Results of 'foetal distress' model

	Log odds	Standard error	p-value of log odds	Relative risk	95% confidence interval for relative risk	
Month of delivery (reference = September)						
January	0.0573	0.0155	***	1.06	1.03	1.09
February	0.0377	0.0158	**	1.04	1.01	1.07
March	0.0151	0.0154	-	1.01	0.99	1.04
April	0.0421	0.0154	***	1.04	1.01	1.07
May	0.0328	0.0152	**	1.03	1.00	1.06
June	0.0333	0.0152	**	1.03	1.00	1.06
July	0.0368	0.0151	**	1.04	1.01	1.06
August	0.0518	0.0151	***	1.05	1.02	1.08
October	0.0203	0.0152	-	1.02	0.99	1.05
November	0.0177	0.0154	-	1.02	0.99	1.05
December	0.0285	0.0154	*	1.03	1.00	1.06
Time of delivery (reference = 10:00-11:59)						
00:00-01:59	0.2603	0.0152	***	1.28	1.24	1.31
02:00-03:59	0.1936	0.0154	***	1.20	1.17	1.23
04:00-05:59	0.1662	0.0156	***	1.17	1.14	1.20
06:00-07:59	0.0781	0.0159	***	1.08	1.05	1.11
08:00-09:59	0.1688	0.0156	***	1.17	1.14	1.21
12:00-13:59	0.1877	0.0152	***	1.19	1.16	1.23
14:00-15:59	0.2071	0.0150	***	1.22	1.18	1.25
16:00-17:59	0.3362	0.0150	***	1.37	1.34	1.40
18:00-19:59	0.3266	0.0150	***	1.36	1.32	1.39
20:00-21:59	0.3156	0.0152	***	1.34	1.31	1.38
22:00-23:59	0.2843	0.0150	***	1.31	1.27	1.34
Hospital (reference = Hillingdon)						
Ashford	0.1461	0.0225	***	1.15	1.10	1.19
Bedford	0.2441	0.0178	***	1.26	1.22	1.30
Central Middlesex	0.0023	0.0223	-	1.00	0.96	1.04
Chelsea & Westminster	0.0535	0.0169	***	1.05	1.02	1.08
Ealing	0.0297	0.0217	-	1.03	0.99	1.07
Edgware	0.1572	0.0163	***	1.16	1.13	1.19
Hemel Hempstead	0.1477	0.0170	***	1.15	1.11	1.18
Luton & Dunstable	0.3940	0.0150	***	1.45	1.41	1.48
Northwick Park	0.6830	0.0156	***	1.88	1.84	1.92
St Mary's	0.0761	0.0175	***	1.07	1.04	1.11
Stevenage	0.2525	0.0168	***	1.27	1.23	1.31
Watford	0.3231	0.0162	***	1.35	1.32	1.39
Welwyn Garden City	0.0655	0.0176	***	1.06	1.03	1.10
West Middlesex	0.0522	0.0180	***	1.05	1.02	1.09
Parity (reference = 2)						
0	0.9358	0.0108	***	2.35	2.32	2.38
1	0.1125	0.0109	***	1.11	1.09	1.13
3	-0.0154	0.0180	-	0.99	0.95	1.02
4	0.0661	0.0273	**	1.06	1.01	1.12
>4	0.1483	0.0308	***	1.15	1.09	1.22

Table 6.20 (cont'd): Results of 'foetal distress' model

	Log odds	Standard error	p-value of log odds	Relative risk	95% confidence interval for relative risk	
Mother's age at delivery (reference = 30-34)						
<16	-0.4908	0.0856	***	0.63	0.53	0.74
16-19	-0.3805	0.0165	***	0.70	0.67	0.72
20-24	-0.2118	0.0101	***	0.82	0.80	0.83
25-29	-0.0950	0.0081	***	0.91	0.90	0.93
35-39	0.1227	0.0112	***	1.12	1.10	1.15
40-44	0.2354	0.0241	***	1.25	1.19	1.30
45+	0.2449	0.1061	**	1.26	1.04	1.52
Single, unsupported? (reference = no)						
Yes	0.0498	0.0099	***	1.05	1.03	1.07
Missing	-0.3125	0.1252	**	0.74	0.58	0.94
Patient category (reference = 'normal')						
Amenity	0.0690	0.2191	-	1.07	0.71	1.59
Overseas	-0.0333	0.0730	-	0.97	0.85	1.11
Private	-0.5726	0.0361	***	0.58	0.54	0.62
Carstairs quintile (reference = 1)						
2	0.0210	0.0104	*	1.02	1.00	1.04
3	0.0496	0.0103	***	1.05	1.03	1.07
4	0.0809	0.0110	***	1.08	1.06	1.10
5	0.1414	0.0130	***	1.14	1.12	1.17
Missing	0.0953	0.0139	***	1.09	1.07	1.12
Mother's ethnic group (reference = White European)						
Black African	0.5006	0.0178	***	1.59	1.55	1.64
Black Caribbean	0.2903	0.0194	***	1.31	1.27	1.36
Mediterranean	0.1376	0.0211	***	1.14	1.10	1.18
Oriental	-0.0656	0.0267	**	0.94	0.89	0.99
South Asian	0.2038	0.0108	***	1.21	1.19	1.23
Other	0.0593	0.0164	***	1.06	1.03	1.09
Missing	0.1264	0.0216	***	1.13	1.08	1.17
Interpreter needed? (reference = no)						
Yes	0.1640	0.0218	***	1.17	1.12	1.21
Smoking status (reference = non-smoker)						
Light smoker	0.1446	0.0114	***	1.15	1.12	1.17
Medium smoker	0.2133	0.0127	***	1.22	1.19	1.25
Heavy smoker	0.2377	0.0202	***	1.25	1.21	1.30
Missing	0.0350	0.0445	-	1.03	0.95	1.12
Gestation > 41 weeks? (reference = no)						
Yes	0.6044	0.0147	***	1.75	1.71	1.79

Table 6.20 (cont'd): Results of 'foetal distress' model

	Log odds	Standard error	p-value of log odds	Relative risk	95% confidence interval for relative risk	
Placental abruption? (reference = no)						
Yes	0.5861	0.0448	***	1.72	1.59	1.86
BMI (reference = <30)						
30-34	0.1896	0.0135	***	1.20	1.17	1.22
35+	0.0437	0.0086	***	1.04	1.03	1.06
Recurrent antepartum haemorrhage? (reference = no)						
Yes	0.1578	0.0317	***	1.16	1.09	1.23
Gestational hypertension/pre-eclampsia? (reference = no)						
Yes	0.1551	0.0114	***	1.16	1.13	1.18
Borderline	0.0105	0.0599	-	1.01	0.90	1.13
Small for dates? (reference = no)						
Yes	0.1487	0.0391	***	1.15	1.07	1.23
Oligo/polyhydramnios? (reference = no)						
Yes	0.1466	0.0697	**	1.15	1.01	1.30
Haemoglobinopathies? (reference = no)						
Yes	0.1368	0.0340	***	1.14	1.07	1.21
Suspected congenital abnormality? (reference = no)						
Yes	0.1149	0.0213	***	1.11	1.07	1.16
Previous CS? (reference = no)						
Yes	0.0805	0.0136	***	1.08	1.05	1.11
Anaemia? (reference = no)						
Borderline	0.0184	0.0084	**	1.02	1.00	1.03
Yes	0.0662	0.0131	***	1.06	1.04	1.09
Previous stillbirth/neonatal death? (reference = no)						
Yes	0.0562	0.0270	**	1.05	1.00	1.11
Pre-existing hypertension? (reference = no)						
Yes	-0.1243	0.0523	**	0.89	0.81	0.98
Multiple pregnancy? (reference = no)						
Yes	-0.4433	0.0245	***	0.65	0.62	0.69
Preterm labour? (reference = no)						
Yes	-0.5396	0.0125	***	0.60	0.58	0.61
Placenta praevia? (reference = no)						
Yes	-0.6297	0.0597	***	0.55	0.49	0.61

Table 6.20 (cont'd): Results of 'foetal distress' model

	Log odds	Standard error	p-value of log odds	Relative risk	95% confidence interval for relative risk	
Number of ultrasound scans (reference = 1)						
0	-0.1026	0.0270	***	0.91	0.86	0.95
2-4	0.0005	0.0071	-	1.00	0.99	1.01
>4	-0.0753	0.0163	***	0.93	0.90	0.96
Missing	-0.1013	0.0342	***	0.91	0.85	0.97
Amniocentesis? (reference = no)						
Yes	0.0069	0.0177	-	1.01	0.97	1.04
Missing	-0.1179	0.0410	***	0.89	0.83	0.97
Chorionic villus biopsy? (reference = no)						
Yes	-0.1584	0.0536	***	0.86	0.78	0.95
Missing	0.0738	0.0356	**	1.07	1.00	1.14
Birthweight (reference = 2500g-3999g)						
<500g	-0.5467	0.1635	***	0.59	0.43	0.81
500g-1499g	0.5858	0.0320	***	1.72	1.63	1.82
1500g-2499g	0.4297	0.0154	***	1.49	1.46	1.53
4000+g	0.1295	0.0106	***	1.13	1.11	1.15
Sex of baby (reference = girl)						
Boy	0.0937	0.0063	***	1.09	1.08	1.10
Indeterminate	-0.1133	0.2845	-	0.90	0.52	1.51
Constant	-2.8608	0.0448	***	n/a	n/a	n/a

*** p<0.01 / ** p<0.05 / * p<0.1

Foetal distress was the most common labour complication; it was recorded in 30.3% of SMMIS cases. In the unadjusted data, the risk of foetal distress was 2.38 times greater if the woman had a planned hospital birth than if she intended a home birth. Once other observed covariates were held constant, the relative risk was only slightly smaller at 2.16 (if there was no asthma or malpresentation), and therefore still has significant implications for the absolute number of cases of this complication. In other words, the observed difference in risk of foetal distress was not simply due to women who intended a home birth tending to be from groups who are less likely to experience foetal distress.

If there was a reference pregnancy, the risk of foetal distress was 2.16 times higher if the woman intended a hospital birth than if she intended a home birth, once the other covariates in Table 6.20 were held constant. As noted in Section 6.1, however, it is likely that foetal distress in labour was more likely to be noticed in hospital than at home, because the baby's heart rate is more likely to be continuously monitored in hospital than at home. Therefore, the higher relative risk among planned hospital births may be at least partly explained by differences in protocol between birth settings. On the other hand, elective Caesareans were included in the figures; because elective

Caesarean is only possible for those who plan a hospital birth and Caesareans are less likely to involve foetal distress (see Section 6.1), their inclusion will have made the results for the home group seem worse in relation to the hospital group.

There were two situations in which the overall pattern did not apply: if malpresentation had been diagnosed before the commencement of labour and if the mother had asthma. Figure 6.10 shows that, when there was malpresentation, the relative risk of foetal distress in labour was twice as high among those who intended a home birth than among those who intended a hospital birth. If the woman intended a home birth with a diagnosis of malpresentation, the risk of foetal distress was 3.23 times higher than if the woman intended a home birth without such a diagnosis (assuming an otherwise reference pregnancy). By contrast, if the woman intended a *hospital* birth and had a diagnosis of malpresentation in an otherwise reference pregnancy, the risk of foetal distress was just 1.65 times higher than if the woman intended a home birth without such a diagnosis. The elective Caesarean rate was relatively high in cases of malpresentation (36.8%, compared with 5.9% overall), which will have contributed to this pattern. It is, of course, possible that women who planned a home birth in the knowledge that their baby was malpresented did so precisely because they wished to avoid a Caesarean.

Figure 6.10: Relative risk of foetal distress, by intended place of birth and whether malpresentation was diagnosed before labour

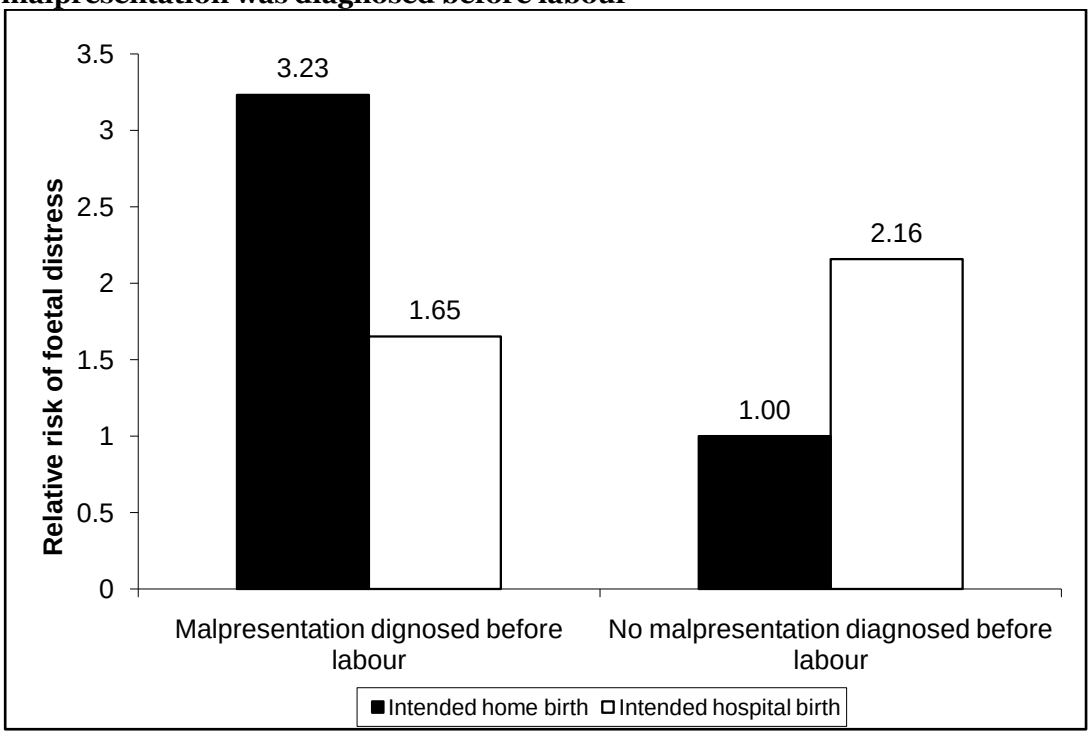
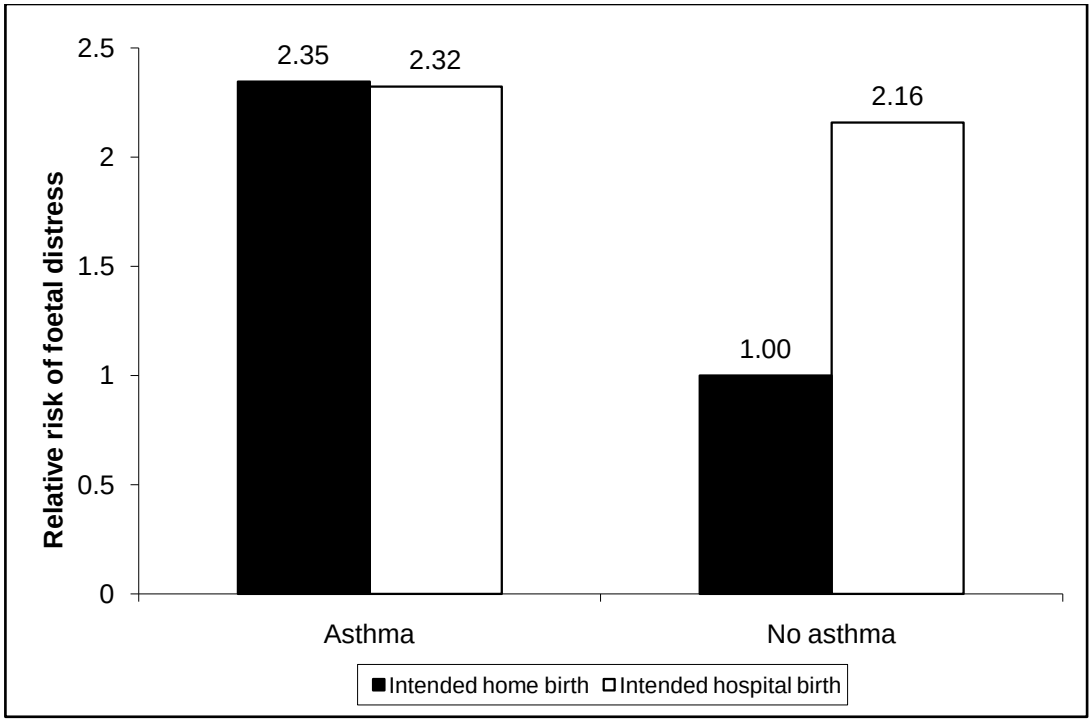


Figure 6.11 shows that, if a woman with asthma intended a home birth, the risk of foetal distress was 2.35 times higher than if the woman intended a home birth without such a diagnosis. If the woman intended a *hospital* birth and had asthma, the risk of foetal distress was 2.32 times higher than if the woman intended a home birth without such a diagnosis. In other words, if the woman had

asthma, there was virtually no difference in the risk of foetal distress whether or not she intended a home birth.

Figure 6.11: Relative risk of foetal distress, by intended place of birth and whether mother had asthma



Under current NICE guidance (see Section 4.3.1), malpresentation and asthma would have led the pregnancy to be classed as 'high-risk'. These results would affirm the advice that the women in these situations are at increased risk of foetal distress in labour if they attempt a home birth than if they plan a hospital birth. These results are all the more striking when we take into account the likelihood of foetal distress being more likely to be noticed in hospital.

It is notable that some 'high-/medium-risk' conditions were associated with a significantly *lower* risk of foetal distress: pre-existing hypertension (RR = 0.89), multiple pregnancy (RR= 0.65) and placenta praevia (RR = 0.55). In the case of multiple pregnancy and placenta praevia, this reflected the pattern in the observed data and will have been due to the inclusion of elective CSs in the analysis, because women with these conditions would be among those most likely to have an elective CS, and elective CSs were far less likely to experience foetal distress than were those who attempted a vaginal birth. Pre-existing hypertension, on the other hand, was just as common in the observed data among those who intended a home birth as among those who intended a hospital birth. It became associated with a significantly lower risk of foetal distress once gestational hypertension was added to the model, indicating that the two covariates were confounded (89% of those who had pre-existing hypertension went on to develop gestational hypertension, compared with 8% overall).

Foetal distress was rare if the baby was born by elective Caesarean (it occurred in 3.4% of elective Caesareans, compared with 28.8% of vaginal births). Because elective Caesareans are available only in hospital, their inclusion in this analysis will probably have made the risk of foetal distress lower for the 'intended a hospital birth' group.

To test the sensitivity of the results to the inclusion or exclusion of elective Caesareans, the model was re-run without them. This model was selected using a stepwise approach with the command to include a covariate if the p-value of the coefficient was <0.05. This resulted in an additive model, and then two-way interactions were tested in the same way as for the original model (see Section 6.7.3). The same two interactions were included in the model excluding elective Caesareans as were included in the model including elective Caesareans, i.e. intended place of birth * maternal asthma and intended place of birth * malpresentation diagnosed in pregnancy.

This model selection process resulted in a model containing mostly the same covariates as the model detailed in Table 6.20. The only covariate which was not selected into the stepwise model was 'amniocentesis', and an additional six 'higher-risk' conditions were included: pre-existing diabetes (RR = 1,28, 95% CI 1.16-1.41), inflammatory bowel disorder (RR = 1.28, 95% CI 1.02-1.59), 'large-for-dates' (RR = 1.23, 95% CI 1.03-1.47), oligo/polyhydramnios (RR = 1.21, 95% CI 1.06-1.37), previous stillbirth/neonatal death (RR = 1.11, 95% CI 1.06-1.17) and previous baby with birthweight >4.5kg (RR = 1.10, 95% CI 1.01-1.19).

The exclusion of elective Caesareans made very little difference to the relative risk of foetal distress when comparing those who intended a home birth and those who intended a hospital birth, and it did not change the substantive conclusions outlined above. In the absence of asthma and malpresentation, intending a hospital birth was associated with a 2.18-times higher risk of foetal distress (compared with 2.16 in the model containing elective Caesareans)[56]. If the mother had asthma and intended a hospital birth, the risk of foetal distress was 2.36 times higher than if she did not have asthma and intended a home birth (compared with 2.32 in the model containing elective Caesareans). If malpresentation had been diagnosed in pregnancy, however, the risk associated with planning a hospital birth was considerably higher if elective Caesareans were excluded (RR = 2.72, compared with 1.65 if elective Caesareans were included), which narrowed the gap between those who intended a home birth and those who intended a hospital birth. Nevertheless, it remained true that, in cases of malpresentation, the risk of foetal distress was significantly higher if a home birth was intended than if a hospital birth was intended (RR of 3.23 and 2.72 respectively, when compared with those who intended a home birth without an antepartum diagnosis of malpresentation).

[56] It is likely that the change is so small because factors which are known to predict elective Caesarean (e.g. malpresentation and multiple pregnancy) were held constant in the original model.

Similarly, the exclusion of elective Caesareans made hardly any difference to the coefficients for the other covariates in the model. The only relative risks which changed by more than 0.1 were:

- birthweight 500g-1499g (RR 1.41, compared with 1.72 in the original model),
- mother aged 45+ at delivery (RR 1.51, compared with 1.26 in the original model),
- previous Caesarean(s) (RR 1.78, compared with 1.08 in the original model)
- time of birth (RRs for each 2-hour time period were 0.2-0.4 lower if elective Caesareans were excluded than if they were included, resulting in the relative risk for those delivering between 8am and 10am, and 12 noon and 10pm not being significantly different from those delivering between 10am and 12 noon.)

These differences make sense, because all of these covariates were associated with elective Caesareans; elective Caesareans were relatively common if: the baby weighed 500-1499g (8.5% had an elective Caesarean, compared with 5.9% overall), if the mother was aged 45+ (20.7%), if the mother had had previous Caesarean(s) (39.2%), and if the baby was born during the daytime.

Therefore we can state that the conclusions drawn from the 'foetal distress' model are not sensitive to the inclusion or exclusion of elective Caesarean sections.

6.8.2 Failure to progress in stage 1 of labour model

Table 6.21 shows the log odds, standard errors, relative risks and 95% confidence intervals for the relative risks from the model with failure to progress in stage 1 of labour as the outcome. The results for intended place of birth are shown first in the table, and then other covariates are shown in the order used in the conceptual framework (see Table 6.2).

Table 6.21: Results of 'failure to progress in stage 1 of labour' model

	Log odds	Standard error	p-value of log odds	Relative risk	95% confidence interval for relative risk	
Intended place of birth main effect (reference = home)						
Hospital	0.0766	0.1381	-	1.08	0.83	1.40
Parity main effect (reference = 2)						
0	1.2812	0.1779	***	3.44	2.49	4.64
1	0.3542	0.1685	**	1.41	1.02	1.94
3	-0.0938	0.2599	-	0.91	0.55	1.50
>3	-1.4735	0.7231	**	0.23	0.06	0.95
Intended place of birth * parity interaction effect						
Hospital*parity 0	-1.0542	0.1799	***	1.35	0.52	3.37
Hospital*parity 1	-0.0356	0.1706	-	1.47	0.59	3.54
Hospital*parity 3	0.0082	0.2641	-	0.99	0.27	3.41
Hospital*parity >3	1.4413	0.7251	**	1.04	0.05	6.58
Year of delivery (reference = 1988)						
1989	-0.0492	0.0421	-	0.95	0.88	1.03
1990	0.0474	0.0409	-	1.05	0.97	1.14
1991	0.0437	0.0408	-	1.04	0.96	1.13
1992	0.1097	0.0406	***	1.11	1.03	1.20
1993	0.0431	0.0413	-	1.04	0.96	1.13
1994	0.1042	0.0407	**	1.11	1.02	1.20
1995	0.0145	0.0440	-	1.01	0.93	1.10
1996	-0.1056	0.0438	**	0.90	0.83	0.98
1997	-0.1071	0.0439	**	0.90	0.83	0.98
1998	-0.0949	0.0437	**	0.91	0.84	0.99
1999	-0.2923	0.0460	***	0.75	0.69	0.82
2000	-0.2247	0.0451	***	0.80	0.73	0.88

Table 6.21 (cont'd): Results of 'failure to progress in stage 1 of labour' model

	Log odds	Standard error	p-value of log odds	Relative risk	95% confidence interval for relative risk	
Time of delivery (reference = 10:00-11:59)						
00:00-01:59	0.1997	0.0411	***	1.22	1.12	1.32
02:00-03:59	0.0745	0.0424	*	1.08	0.99	1.16
04:00-05:59	-0.0292	0.0435	-	0.97	0.89	1.05
06:00-07:59	-0.0654	0.0446	-	0.94	0.86	1.02
08:00-09:59	-0.1259	0.0462	***	0.88	0.81	0.96
12:00-13:59	0.1859	0.0420	***	1.20	1.11	1.31
14:00-15:59	0.2580	0.0411	***	1.29	1.19	1.39
16:00-17:59	0.4170	0.0398	***	1.50	1.40	1.62
18:00-19:59	0.3556	0.0398	***	1.42	1.31	1.52
20:00-21:59	0.3585	0.0401	***	1.42	1.32	1.53
22:00-23:59	0.2656	0.0404	***	1.30	1.20	1.39
Hospital providing care (reference = Hillingdon)						
Ashford	0.0588	0.0578	-	1.06	0.95	1.19
Bedford	0.7127	0.0401	***	2.00	1.86	2.20
Central Middlesex	-0.0832	0.0592	-	0.92	0.82	1.00
Chelsea & Westminster	0.1663	0.0429	***	1.18	1.08	1.28
Ealing	-0.2827	0.0603	***	0.76	0.67	0.84
Edgware	0.3762	0.0401	***	1.44	1.34	1.58
Hemel Hempstead	0.1001	0.0432	**	1.10	1.02	1.19
Luton & Dunstable	0.5749	0.0365	***	1.75	1.64	1.90
Northwick Park	-0.1925	0.0434	***	0.83	0.76	0.88
St Mary's	0.1985	0.0445	***	1.21	1.12	1.33
Stevenage	-0.5214	0.0518	***	0.60	0.54	0.65
Watford	-0.3955	0.0483	***	0.68	0.62	0.75
Welwyn Garden City	0.0103	0.0455	-	1.01	0.93	1.11
West Middlesex	0.0801	0.0455	*	1.08	0.99	1.18
Mother's age at delivery (reference = 30-34)						
<16	-0.3349	0.2551	-	0.72	0.44	1.17
16-19	-0.2336	0.0443	***	0.79	0.73	0.86
20-24	-0.1033	0.0254	***	0.90	0.86	0.95
25-29	-0.0175	0.0206	-	0.98	0.94	1.02
35-39	0.0551	0.0282	*	1.06	1.00	1.12
40-44	0.0549	0.0630	-	1.06	0.93	1.19
45+	0.6556	0.2286	***	1.89	1.23	3.00
"Patient category" (reference = "normal")						
Amenity	-1.1629	1.0070	-	0.32	0.04	2.24
Overseas	-0.3359	0.2288	-	0.72	0.46	1.09
Private	-0.4344	0.0986	***	0.65	0.54	0.78

Table 6.21 (cont'd): Results of 'failure to progress in stage 1 of labour' model

	Log odds	Standard error	p-value of log odds	Relative risk	95% confidence interval for relative risk	
Carstairs quintile (reference = 1)						
2	-0.0075	0.0269	-	0.99	0.94	1.05
3	0.0190	0.0267	-	1.02	0.97	1.07
4	0.0378	0.0281	-	1.04	0.98	1.10
5	0.0809	0.0319	**	1.08	1.02	1.15
Missing	-0.0484	0.0363	-	0.95	0.89	1.02
Ethnic group (reference = White European)						
Black African	0.1821	0.0451	***	1.20	1.10	1.31
Black Caribbean	0.0589	0.0507	-	1.06	0.96	1.16
Mediterranean	0.0910	0.0521	*	1.09	0.99	1.21
Oriental	0.0284	0.0665	-	1.03	0.90	1.17
South Asian	0.1163	0.0267	***	1.12	1.07	1.18
Other	0.0538	0.0406	-	1.05	0.97	1.14
Missing	0.0153	0.0490	-	1.02	0.92	1.11
Interpreter required? (reference = no)						
Yes	0.1485	0.0510	***	1.16	1.05	1.28
Late booker? (reference = no)						
Yes	0.0811	0.0287	***	1.08	1.02	1.15
Missing	0.0185	0.0268	-	1.02	0.97	1.07
Previous CS? (reference = no)						
Yes	0.7320	0.0303	***	2.04	1.93	2.21
Multiple pregnancy? (reference = no)						
Yes	0.2051	0.0664	***	1.22	1.08	1.36
Haemoglobinopathies? (reference = no)						
Yes	0.1673	0.0811	**	1.18	1.01	1.38
Anaemia? (reference = no)						
Borderline	0.0516	0.0211	**	1.05	1.01	1.11
Yes	0.1128	0.0318	***	1.12	1.05	1.19
Suspected congenital abnormality? (reference = no)						
Yes	0.1075	0.0534	**	1.11	1.00	1.25
Recurrent antepartum haemorrhage? (reference = no)						
Yes	-0.2267	0.1027	**	0.80	0.66	0.98
Preterm labour? (reference = no)						
Yes	-0.2416	0.0335	***	0.79	0.74	0.84

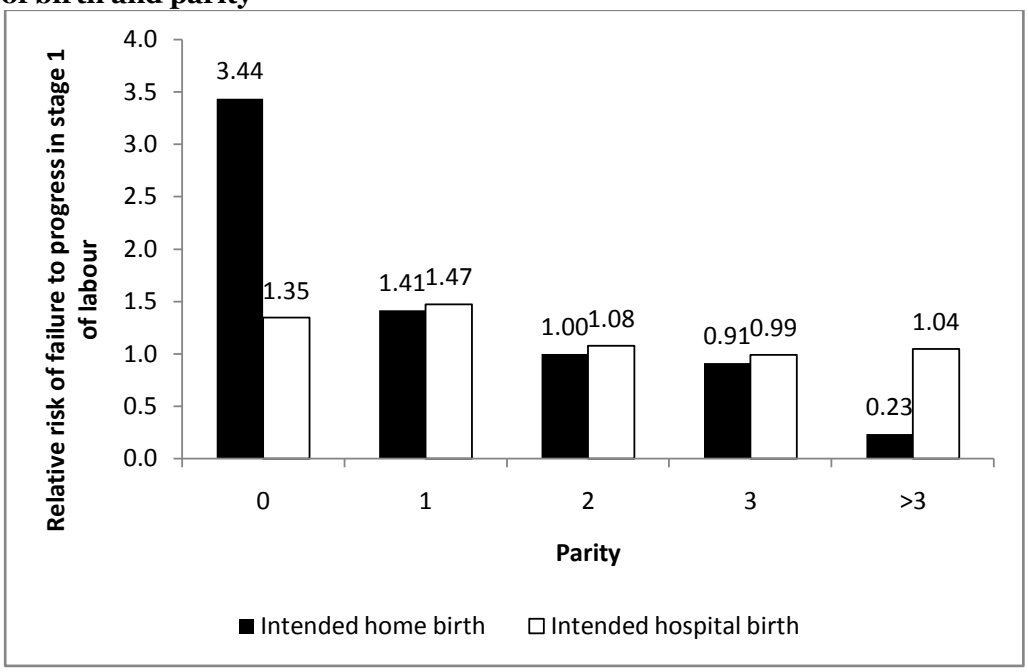
Table 6.21 (cont'd): Results of 'failure to progress in stage 1 of labour' model

	Log odds	Standard error	p-value of log odds	Relative risk	95% confidence interval for relative risk	
Gestational hypertension/pre-eclampsia? (reference = no)						
Borderline	-1.2101	0.2796	***	0.30	0.17	0.52
Yes	-0.3056	0.0339	***	0.74	0.69	0.80
Malpresentation? (reference = no)						
Yes	-0.3730	0.0548	***	0.69	0.62	0.76
Pre-existing diabetes? (reference = no)						
Yes	-0.3705	0.1729	**	0.69	0.50	0.96
Small for dates? (reference = no)						
Yes	-0.6817	0.1592	***	0.51	0.37	0.69
Placenta praevia? (reference = no)						
Yes	-0.6982	0.2162	***	0.50	0.33	0.75
Placental abruption? (reference = no)						
Yes	-0.7159	0.1871	***	0.49	0.34	0.71
Number of ultrasound scans (reference = 1)						
0	0.1265	0.0620	**	1.13	1.01	1.22
2	0.0147	0.0193	-	1.01	0.98	1.05
3	-0.0498	0.0267	*	0.95	0.90	1.00
4	-0.1049	0.0405	-	0.90	0.83	0.97
>4	-0.1549	0.0473	***	0.86	0.78	0.94
Missing	0.0259	0.0831	-	1.03	0.87	1.21
Birthweight (reference = 2500g-3999g)						
<1500g	0.0779	0.0885	-	1.08	0.91	1.28
1500g-2499g	-0.4466	0.0505	***	0.64	0.58	0.50
4000+g	0.2214	0.0247	***	1.24	1.19	1.32
Sex of baby (reference = girl)						
Boy	0.0401	0.0162	**	1.04	1.01	0.93
Indeterminate	1.1642	0.4371	***	3.08	1.35	7.54
Constant	-3.9785	0.1475	***			

*** p<0.01 / ** p<0.05 / * p<0.1

Failure to progress in stage 1 of labour occurred in 3.4% of SMMIS pregnancies. In the unadjusted data, it was the only labour complication to be more common among those who intended a home birth than among those who intended a hospital birth; the risk of failure to progress in stage 1 of labour among those intending a hospital birth was 0.88 times that among those intending a home birth. Figure 6.12 shows that this was due to primiparae; women having their first baby were at higher risk of failure to progress in stage 1 if they intended a home birth, but parous women were at slightly higher risk of failure to progress in stage 1 if they intended a hospital birth.

Figure 6.12: Relative risk of failure to progress in stage 1 of labour, by intended place of birth and parity



Failure to progress in labour is known to be more common for first pregnancies (National Collaborating Centre for Women's and Children's Health, 2007), and it is possible that the way in which labour length is measured may be different for home births, e.g. if the woman is typically assessed for progress earlier or later in the process if she is planning a home birth. However, there is no obvious reason why the risk of failure to progress in stage 1 should be so much higher at home just for women having their first baby, which begs the question of whether birth attendants were more likely to diagnose failure to progress in stage 1 for home birthing primiparae than for hospital birthing primiparae. However, analysis of actual labour length suggests not. For primiparae, the mean duration of stage 1 was longer among those intending a home birth (10.7 hours, compared with 8.9 hours for those intending a hospital birth), whereas for multiparae the opposite was true. The same pattern is evident if failure to progress in stage 1 is defined as '>11.6 hours' (i.e. more than one standard deviation above the mean). This indicates that failure to progress in stage 1 of labour was indeed more common for those intending a home birth among primiparae, but more common for those intending a hospital birth among multiparae.

As was the case in the foetal distress model, some 'high-/medium-risk' conditions were associated with a significantly *lower* risk of failure to progress in stage 1 of labour: recurrent antepartum haemorrhage (RR = 0.80), preterm labour (RR= 0.79), gestational hypertension/pre-eclampsia (RR = 0.74), malpresentation (RR = 0.69), being 'small for dates' (RR = 0.51), placenta praevia (RR = 0.50) and placental abruption (RR = 0.49). In the observed data also, all of these conditions were associated with a lower incidence of failure to progress; it was not due to confounding with other observed covariates.

6.8.3 Failure to progress in stage 2 of labour model

Table 6.22 shows the log odds, standard errors, relative risks and 95% confidence intervals for the relative risks from the model with failure to progress in second stage of labour as the outcome. The results for intended place of birth are shown first in the table, and then other covariates are shown in the order used in the conceptual framework (see Table 6.2).

Table 6.22: Results of 'failure to progress in stage 2 of labour' model

	Log odds	Standard error	p-value of log odds	Relative risk	95% confidence interval for relative risk	
Intended place of birth (reference = home)						
Hospital	0.6601	0.0753	***	1.92	1.66	2.22
Year of delivery (reference = 1988)						
1989	0.0231	0.0331	-	1.02	0.96	1.09
1990	0.2485	0.0314	***	1.28	1.20	1.36
1991	0.3352	0.0309	***	1.39	1.31	1.48
1992	0.3949	0.0308	***	1.48	1.39	1.57
1993	0.5217	0.0305	***	1.68	1.58	1.78
1994	0.5874	0.0302	***	1.79	1.69	1.90
1995	0.6204	0.0321	***	1.85	1.74	1.97
1996	0.6293	0.0311	***	1.87	1.76	1.98
1997	0.6988	0.0309	***	2.00	1.88	2.12
1998	0.7134	0.0308	***	2.03	1.91	1.73
1999	0.4930	0.0319	***	1.63	1.53	1.84
2000	0.5548	0.0317	***	1.73	1.63	1.84
Month of delivery (reference = April-August)						
December-March	-0.0570	0.0128	***	0.94	0.92	0.97
November	-0.0099	0.0204	-	0.99	0.95	1.03
October	0.0383	0.0196	*	1.04	1.00	1.08
September	-0.0280	0.0199	-	0.97	0.94	1.01
Time of delivery (reference = 10:00-11:59)						
00:00-01:59	-0.3210	0.0261	***	0.73	0.69	0.76
02:00-03:59	-0.3213	0.0267	***	0.73	0.69	0.77
04:00-05:59	-0.2531	0.0266	***	0.78	0.74	0.82
06:00-07:59	-0.2586	0.0269	***	0.77	0.73	0.82
08:00-09:59	-0.0709	0.0267	***	0.93	0.88	0.98
12:00-13:59	-0.0671	0.0258	***	0.94	0.89	0.98
14:00-15:59	-0.1153	0.0257	***	0.89	0.85	0.94
16:00-17:59	-0.1343	0.0255	***	0.88	0.83	0.92
18:00-19:59	-0.1170	0.0251	***	0.89	0.85	0.93
20:00-21:59	-0.1857	0.0255	***	0.83	0.79	0.87
22:00-23:59	-0.2935	0.0258	***	0.75	0.71	0.79

Table 6.22 (cont'd): Results of 'failure to progress in stage 2 of labour' model

	Log odds	Standard error	p-value of log odds	Relative risk	95% confidence interval for relative risk	
Hospital providing care (reference = Hillingdon)						
Ashford	-0.3845	0.0403	***	0.68	0.63	0.74
Bedford	0.0391	0.0285	-	1.04	0.98	1.10
Central Middlesex	-0.2468	0.0430	***	0.78	0.72	0.85
Chelsea & Westminster	-0.2208	0.0272	***	0.80	0.76	0.85
Ealing	0.0966	0.0365	***	1.10	1.03	1.18
Edgware	-0.3987	0.0290	***	0.67	0.64	0.71
Hemel Hempstead	-0.4093	0.0285	***	0.67	0.63	0.70
Luton & Dunstable	0.0013	0.0250	-	1.00	0.95	1.05
Northwick Park	-0.0681	0.0264	**	0.93	0.89	0.98
St Mary's	0.2634	0.0278	***	1.30	1.23	1.37
Stevenage	-0.7099	0.0314	***	0.49	0.46	0.52
Watford	-0.1513	0.0266	***	0.86	0.82	0.91
Welwyn Garden City	0.0777	0.0269	***	1.08	1.03	1.14
West Middlesex	-0.0513	0.0292	*	0.95	0.90	1.01
Mother's age at delivery (reference = 30-34)						
<16	-1.0672	0.1604	***	0.35	0.25	0.47
16-19	-0.8022	0.0285	***	0.45	0.43	0.48
20-24	-0.5092	0.0172	***	0.60	0.58	0.62
25-29	-0.1796	0.0135	***	0.84	0.81	0.86
35-39	0.0826	0.0200	***	1.09	1.04	1.13
40-44	0.1497	0.0476	***	1.16	1.06	1.27
45+	0.2199	0.2747	-	1.24	0.73	2.12
Single, unsupported? (reference = no)						
Yes	-0.1388	0.0175	***	0.87	0.84	0.90
Missing	0.3616	0.2116	*	1.43	0.95	2.15
"Patient category" (reference = "normal")						
Amenity	0.2043	0.3321	-	1.22	0.64	2.33
Overseas	-0.2033	0.1488	-	0.82	0.61	1.09
Private	-0.6097	0.0629	***	0.55	0.48	0.62
Carstairs quintile (reference = 1)						
2	-0.0335	0.0168	**	0.97	0.94	1.00
3	-0.0354	0.0169	**	0.97	0.93	1.00
4	-0.0562	0.0186	***	0.95	0.91	0.98
5	-0.1186	0.0230	***	0.89	0.85	0.93
Missing	-0.1248	0.0238	***	0.88	0.84	0.93
Mother's ethnic group (reference = White European)						
Black African	-0.7673	0.0410	***	0.47	0.43	0.50
Black Caribbean	-0.7573	0.0455	***	0.47	0.43	0.51
Mediterranean	-0.1859	0.0354	***	0.83	0.78	0.89
Oriental	-0.2279	0.0435	***	0.80	0.73	0.87
South Asian	-0.0993	0.0197	***	0.91	0.87	0.94
Other	-0.1792	0.0275	***	0.84	0.79	0.88
Missing	-0.0976	0.0369	***	0.91	0.84	0.98

Table 6.22 (cont'd): Results of 'failure to progress in stage 2 of labour' model

	Log odds	Standard error	p-value of log odds	Relative risk	95% confidence interval for relative risk	
Interpreter required? (reference = no)						
Yes	-0.2130	0.0462	***	0.81	0.74	0.89
Smoking status (reference = nonsmoker)						
Light smoker	-0.0920	0.0203	***	0.91	0.88	0.95
Medium smoker	-0.1527	0.0254	***	0.86	0.82	0.90
Heavy smoker	-0.2222	0.0453	***	0.80	0.73	0.88
Missing	-0.0865	0.0824	-	0.92	0.78	1.08
Late booker? (reference = no)						
Yes	-0.0357	0.0212	*	0.97	0.93	1.01
Missing	-0.0373	0.0176	**	0.96	0.93	1.00
Previous Caesarean(s)? (reference = no)						
Yes	1.3832	0.0298	***	3.91	3.71	4.13
Multiple pregnancy? (reference = no)						
Yes	0.9057	0.0403	***	2.45	2.27	2.64
Previous stillbirth/neonatal death? (reference = no)						
Yes	0.4367	0.0796	***	1.54	1.32	1.80
Oligo-/polyhydramnios? (reference = no)						
Yes	0.2611	0.1247	**	1.30	1.02	1.65
Gestational diabetes? (reference = no)						
Yes	0.1109	0.0250	***	1.12	1.06	1.17
Anaemia? (reference = no)						
Borderline	0.0386	0.0147	***	1.04	1.01	1.07
Yes	0.0059	0.0268	-	1.01	0.95	1.06
BMI (reference = <30)						
30-34	-0.0201	0.0254	-	0.98	0.93	1.03
35+	-0.1069	0.0151	***	0.90	0.87	0.93
Malpresentation diagnosed in pregnancy? (reference = no)						
Yes	-0.2077	0.0327	***	0.81	0.76	0.87
Preterm labour? (reference = no)						
Yes	-0.2613	0.0225	***	0.77	0.74	0.81
Small for dates? (reference = no)						
Yes	-0.3129	0.0946	***	0.73	0.61	0.88
Placenta praevia? (reference = no)						
Yes	-0.5401	0.1413	***	0.58	0.44	0.77

Table 6.22 (cont'd): Results of 'failure to progress in stage 2 of labour' model

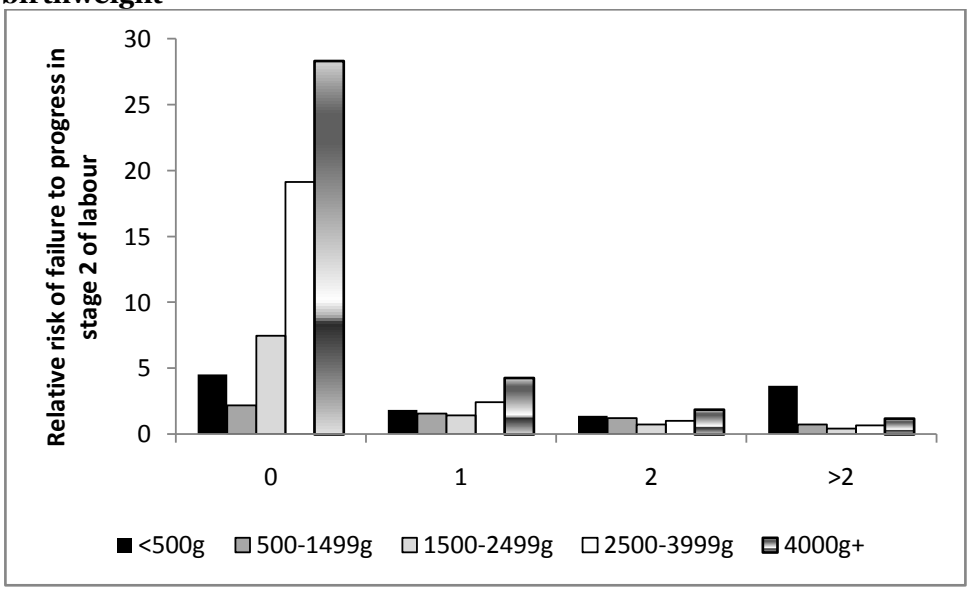
	Log odds	Standard error	p-value of log odds	Relative risk	95% confidence interval for relative risk	
Placental abruption? (reference = no)						
Yes	-0.9126	0.1345	***	0.40	0.31	0.52
Gestational hypertension/pre-eclampsia? (reference = no)						
Borderline	-1.3825	0.1847	***	0.25	0.18	0.36
Yes	0.0052	0.0185	-	1.01	0.97	1.04
Gestation >41 weeks? (reference = no)						
Yes	0.0917	0.0229	***	1.10	1.05	1.14
Number of ultrasound scans (reference = 1)						
0	0.0225	0.0502	-	1.02	0.93	1.13
2	0.0153	0.0132	-	1.02	0.99	1.04
3	-0.0168	0.0172	-	0.98	0.95	1.02
4	-0.0629	0.0253	**	0.94	0.89	0.99
>4	-0.1037	0.0291	***	0.90	0.85	0.95
Missing	-0.3627	0.0652	***	0.70	0.61	0.79
Amniocentesis? (reference = no)						
Yes	0.0471	0.0289	-	1.05	0.99	1.11
Missing	-0.1985	0.0466	***	0.82	0.75	0.90
Parity main effect (reference = 2)						
0	3.0742	0.0401	***	19.13	18.17	20.01
1	0.8945	0.0418	***	2.42	2.24	2.62
>2	-0.4408	0.0740	***	0.64	0.56	0.75
Birthweight main effect (reference = 2500g-3999g)						
<500g	0.3311	1.0237	-	1.39	0.19	9.67
500g-1499g	0.1821	0.2987	-	1.20	0.67	2.14
1500g-2499g	-0.3116	0.1809	*	0.73	0.51	1.04
4000g+	0.6367	0.0790	***	1.88	1.61	2.19
Interaction between parity and birthweight						
Parity 0 * 1500g-2499g	-0.7104	0.1834	***	7.46	3.48	15.32
Parity 0 * 4000g+	-0.1761	0.0813	**	28.32	20.72	36.89
Parity 0 * 500g-1499g	-2.4751	0.3288	***	2.17	0.59	7.67
Parity 0 * <500g	-1.8767	1.0954	*	4.51	0.07	93.53
Parity 1 * 1500g-2499g	-0.2297	0.1999	-	1.42	0.62	3.20
Parity 1 * 4000g+	-0.0557	0.0867	-	4.28	2.88	6.30
Parity 1 * 500g-1499g	-0.6310	0.3503	*	1.56	0.40	5.82
Parity 1 * <500g	-0.6204	1.2528	-	1.82	0.02	75.04
Parity >2 * 1500g-2499g	-0.1633	0.3380	-	0.40	0.13	1.28
Parity >2 * 4000g+	-0.0113	0.1518	-	1.20	0.66	2.17
Parity >2 * 500g-1499g	-0.0645	0.5457	-	0.73	0.12	4.27
Parity >2 * <500g	1.4226	1.4589	-	3.65	0.02	107.01
Constant	-5.0565	0.0918	***	n/a	n/a	n/a

*** p<0.01 / ** p<0.05 / * p<0.1

Failure to progress in stage 2 of labour occurred in 8.8% of pregnancies in SMMIS, making it the second most common labour complication after foetal distress. In the unadjusted data, the risk of failure to progress in stage 2 of labour was 3.16 times higher if a hospital birth was intended than if a home birth was intended. After adjustment for the other covariates in the model, the relative risk was smaller, but was still large at 1.92.

Figure 6.13 shows that, among primiparae, the risk of failure to progress in stage 2 of labour was much higher if the baby was relatively heavy. Among multiparae, there was relatively little variation in relative risk according to birthweight.

Figure 6.13: Relative risk of failure to progress in stage 2 of labour, by parity and birthweight



Again, some 'high-/medium-risk' conditions were associated with a significantly *lower* risk of failure to progress in stage 2 of labour once the other covariates were held constant: BMI of 35+ (relative risk 0.90 in comparison to BMI of <30), malpresentation (relative risk 0.81), preterm labour (relative risk 0.77), being 'small for dates' (relative risk 0.73), placenta praevia (relative risk 0.58), placental abruption (relative risk 0.40), borderline hypertension (relative risk 0.25). In the observed data also, all of these conditions were associated with a lower incidence of failure to progress; it was not due to confounding with other observed covariates. In most cases, it is probably due to the condition being more likely to result in a Caesarean section and therefore such cases being less likely to get to the second stage of labour.

6.8.4 Postpartum haemorrhage (PPH) model

Table 6.23 shows the log odds, standard errors, relative risks and 95% confidence intervals for the relative risks from the model with PPH as the outcome. The results for intended place of birth are shown first in the table, and then other covariates are shown in the order used in the conceptual framework (see Table 6.2).

Table 6.23: Results of 'PPH' model

	Log odds	Standard error	p-value of log odds	Relative risk	95% CI for relative risk	
Intended place of birth (reference = home)						
Hospital	0.9379	0.1602	***	2.54	1.86	3.47
Year (reference = 1988)						
1989	0.0732	0.0627	-	1.08	0.95	1.22
1990	0.1971	0.0604	***	1.22	1.08	1.37
1991	0.1503	0.0605	**	1.16	1.03	1.31
1992	0.1997	0.0598	***	1.22	1.09	1.37
1993	0.0773	0.0613	-	1.08	0.96	1.22
1994	0.1399	0.0602	**	1.15	1.02	1.29
1995	0.2613	0.0632	***	1.30	1.15	1.47
1996	0.1866	0.0613	***	1.20	1.07	1.36
1997	0.2861	0.0603	***	1.33	1.18	1.50
1998	0.3867	0.0590	***	1.47	1.31	1.65
1999	0.4057	0.0594	***	1.50	1.33	1.68
2000	0.4393	0.0588	***	1.55	1.38	1.74
Time of birth (reference = 10:00-11:59)						
00:00-01:59	-0.0425	0.0492	-	0.96	0.87	1.06
02:00-03:59	-0.2323	0.0532	***	0.79	0.71	0.88
04:00-05:59	-0.0667	0.0513	-	0.94	0.85	1.03
06:00-07:59	-0.2021	0.0546	***	0.82	0.73	0.91
08:00-09:59	-0.0088	0.0488	-	0.99	0.90	1.09
12:00-23:59	0.0309	0.0345	-	1.03	0.96	1.10
Hospital providing care (reference = Hillingdon)						
Ashford	0.0604	0.0802	-	1.06	0.91	1.24
Bedford	-0.2608	0.0658	***	0.77	0.68	0.88
Central Middlesex	-0.0940	0.0797	-	0.91	0.78	1.06
Chelsea & Westminster	0.1952	0.0527	***	1.21	1.10	1.35
Ealing	0.2541	0.0732	***	1.29	1.12	1.49
Edgware	0.1004	0.0542	*	1.11	0.99	1.23
Hemel Hempstead	-0.2731	0.0606	***	0.76	0.68	0.86
Luton & Dunstable	0.4055	0.0485	***	1.50	1.36	1.65
Northwick Park	0.3418	0.0511	***	1.41	1.27	1.55
St Mary's	-0.0377	0.0541	-	0.96	0.87	1.07
Stevenage	-0.0190	0.0589	-	0.98	0.87	1.10
Watford	-0.0821	0.0560	-	0.92	0.83	1.03
Welwyn Garden City	-0.0942	0.0587	-	0.91	0.81	1.02
West Middlesex	0.1035	0.0581	*	1.11	0.99	1.24

Table 6.23 (cont'd): Results of 'PPH' model

	Log odds	Standard error	p-value of log odds	Relative risk	95% CI for relative risk	
Parity (reference = 2)						
0	0.4887	0.0359	***	1.63	1.52	1.74
1	0.0936	0.0356	***	1.10	1.023	1.18
3	0.0532	0.0559	-	1.05	0.95	1.18
4	0.1658	0.0802	**	1.18	1.01	1.38
>4	0.1084	0.0898	-	1.11	0.93	1.33
Mother's age at delivery (reference = 30-34)						
<16	-0.2291	0.3084	-	0.80	0.43	1.45
16-19	-0.4689	0.0659	***	0.63	0.55	0.71
20-24	-0.3408	0.0364	***	0.71	0.66	0.76
25-29	-0.1219	0.0271	***	0.89	0.84	0.93
35-39	0.1562	0.0324	***	1.17	1.10	1.24
40-44	0.4602	0.0582	***	1.58	1.41	1.77
45+	0.9930	0.2045	***	2.69	1.81	3.99
Single, unsupported? (reference = no)						
Yes	0.0083	0.0345	-	1.01	0.94	1.08
Missing	-1.4947	0.5830	**	0.22	0.07	0.70
Ethnic group (reference = White European)						
Black African	0.4007	0.0498	***	1.49	1.35	1.64
Black Caribbean	0.2269	0.0593	***	1.25	1.12	1.41
Mediterranean	-0.0282	0.0693	-	0.97	0.85	1.11
Oriental	0.3622	0.0735	***	1.43	1.24	1.66
South Asian	-0.2169	0.0383	***	0.81	0.75	0.87
Other	0.0525	0.0497	-	1.05	0.96	1.16
Missing	-0.0206	0.0766	-	0.98	0.84	1.14
Previous miscarriages (continuous)	0.0304	0.0146	**	1.03	1.00	1.06
Smoker? (reference = no)						
Yes	-0.1145	0.0314	***	0.89	0.84	0.95
Missing	0.0667	0.1263	-	1.07	0.83	1.37
Placental abruption? (reference = no)						
Yes	2.4877	0.0656	***	11.72	10.41	13.11
Placenta praevia? (reference = no)						
Yes	2.4405	0.0591	***	11.19	10.06	12.38
Multiple pregnancy? (reference = no)						
Yes	1.1567	0.0464	***	3.16	2.89	3.45
Fibroids? (reference = no)						
Yes	1.0959	0.3285	***	2.98	1.57	5.60

Table 6.23 (cont'd): Results of 'PPH' model

	Log odds	Standard error	p-value of log odds	Relative risk	95% CI for relative risk	
Oligo/polyhydramnios? (reference = no)						
Yes	0.6688	0.1611	***	1.95	1.42	2.66
Previous Caesarean(s)? (reference = no)						
Yes	0.6147	0.0352	***	1.85	1.72	1.97
Malpresentation diagnosed in pregnancy? (reference = no)						
Yes	0.4925	0.0355	***	1.63	1.53	1.75
Anaemia? (reference = no)						
Borderline	0.1726	0.0272	***	1.19	1.13	1.25
Yes	0.4395	0.0367	***	1.55	1.44	1.66
Haemoglobinopathies? (reference = no)						
Yes	0.3444	0.0986	***	1.41	1.16	1.71
Gestational hypertension/pre-eclampsia? (reference = no)						
Borderline	0.1627	0.1656	-	1.18	0.85	1.62
Yes	0.3384	0.0326	***	1.40	1.32	1.49
Recurrent antepartum haemorrhage? (reference = no)						
Yes	0.2894	0.0732	***	1.33	1.16	1.54
BMI (reference = <30)						
30-34	0.2936	0.0406	***	1.34	1.24	1.45
35+	0.1214	0.0273	***	1.13	1.07	1.19
Previous baby >4.5kg? (reference = no)						
Yes	0.2680	0.0990	***	1.31	1.08	1.58
Previous stillbirth/neonatal death? (reference =no)						
Yes	0.2678	0.0707	***	1.31	1.14	1.50
Preterm labour? (reference = no)						
Yes	0.2256	0.0348	***	1.25	1.17	1.34
Small for dates? (reference = no)						
Yes	-0.6223	0.1846	***	0.54	0.37	0.77
Gestation >41 weeks? (reference = no)						
Yes	0.4192	0.0458	***	1.52	1.39	1.66
No of ultrasound scans (reference = 1)						
0	0.0867	0.0949	-	1.09	0.91	1.31
2	0.1357	0.0283	***	1.14	1.08	1.21
3	0.2056	0.0341	***	1.23	1.15	1.31
4	0.3063	0.0432	***	1.36	1.25	1.48
>4	0.3920	0.0443	***	1.48	1.36	1.61
Missing	0.0037	0.0993	-	1.00	0.83	1.22

Table 6.23 (cont'd): Results of 'PPH' model

	Log odds	Standard error	p-value of log odds	Relative risk	95% CI for relative risk	
Birthweight (reference = 2500g-3999g)						
<500g	-1.2303	0.4054	***	0.29	0.13	0.65
500g-1499g	-0.3568	0.0770	***	0.70	0.60	0.81
1500g-2499g	-0.2176	0.0450	***	0.80	0.74	0.88
4000+g	0.8061	0.0298	***	2.23	2.11	2.36
Sex of baby (reference = girl)						
Boy	-0.1264	0.0213	***	0.88	0.85	0.92
Indeterminate	0.7848	0.6071	-	2.19	0.67	7.05
Constant	-6.0118	0.1768	***	n/a	n/a	n/a

*** p<0.01 / ** p<0.05 / * p<0.1

PPH affected 1.8% of pregnancies in SMMIS and is the only labour complication from this analysis acknowledged by the Healthcare Commission (2008) as a "potential marker" for maternal mortality (see Section 5.3.1), so although it was relatively rare as a complication, it can be regarded as among the more serious outcomes for mothers. In the unadjusted data, the risk of PPH was 3.28 times greater if the woman intended a hospital birth than if she intended a home birth. Once other observed covariates were held constant, this relative risk was smaller – but still large - at 2.54, and therefore still has significant implications for the absolute number of women experiencing this serious labour complication. In other words, the unadjusted difference in risk of PPH cannot simply be explained by the observed differences between the characteristics of women planning home birth and those planning hospital birth.

It is also important to note that elective CSs were included in the figures; because elective CS is only possible for those who planned a hospital birth and women who have CSs are much less likely to experience PPH (see Section 6.1), their inclusion will have made the results for the hospital group seem better in relation to the home group.

Just one 'high-/medium-risk' condition was associated with a significantly *lower* risk of PPH: being 'small for dates' (RR = 0.54). In the observed data also, being 'small for dates' was associated with a lower incidence of PPH; it was not due to confounding with other observed covariates.

Waterstone et al (2001) found that having had a PPH in a previous pregnancy was a strong predictor of PPH in subsequent pregnancies, so ideally previous PPH would have been a covariate in this model. Although previous PPH was one of the conditions which rendered a pregnancy to be classed as 'high-risk' (see Table 4.5), it was recorded in SMMIS for just 0.03 pregnancies per thousand (see Appendix C), which meant there were insufficient known cases of previous PPH for it to be included as an individual covariate (see Section 6.7.3). Given that incidence of PPH was much

higher than 0.03 per thousand (Waterstone et al (2001) estimated the incidence in the UK of blood loss >1500ml to be 6.7 per thousand, so the incidence of blood loss >1000ml will have been even higher than this), it is clear that this particular high-risk condition was under-recorded in SMMIS. Had it been possible to include previous PPH as a covariate in this model, it is likely that the risk associated with planning a hospital birth would have been lower, because it is reasonable to suppose that women who had previously experienced PPH would be more likely than the norm to plan a hospital birth.

PPH was more common if the baby was delivered by Caesarean section than if it was born vaginally (PPH occurred in 6.7% of emergency Caesareans and 4.3% of elective Caesareans, compared with just 1.1% of vaginal births). Because elective Caesareans are available only in hospital, their inclusion in this analysis will have made the risk of PPH higher for the 'intended a hospital birth' group. It could be argued that this was unfair to planned hospital births, because elective Caesareans are normally performed in response to fears about the safety of vaginal delivery, e.g. if the foetus is malpresented.

To test the sensitivity of the results to the inclusion or exclusion of elective Caesareans, the model was re-run without them. This model was selected using a stepwise approach with the command to include a covariate if the p-value of the coefficient was <0.05. This resulted in an additive model, and then two-way interactions were tested in the same way as for the original model (see Section 6.7.3). As with the original model, no interaction terms significantly improved the fit of the additive model, so none was included in the final model.

This model selection process resulted in a model containing mostly the same covariates as the model detailed in Table 6.23; the only covariates which were not selected into the stepwise model were 'previous miscarriages' and 'fibroids', and an additional 'higher-risk' condition was included: pre-existing diabetes (RR = 1,34, 95% CI 1.02-1.76).

The conclusions drawn from the 'PPH' model are not sensitive to the inclusion or exclusion of elective Caesarean sections. If elective Caesareans were excluded, intending a hospital birth was associated with a 2.41-times higher risk of PPH in comparison to intending a home birth (in the model including elective Caesareans, the relative risk was 2.54). Similarly, the exclusion of elective Caesareans made hardly any difference to the coefficients for the other covariates in the model. The only relative risks which changed by more than 0.1 were: (i) previous Caesarean(s) (RR 2.15, compared with 1.85 in the original model), (ii) borderline gestational hypertension (RR 1.37, compared with 1.18 in the original model), and (iii) placental abruption (RR 12.93, compared with 11.72 in the original model). These differences make sense, because all three of these covariates were associated with elective Caesareans.

6.8.5 Pyrexia in labour model

Table 6.24 shows the log odds, standard errors, relative risks and 95% confidence intervals for the relative risks from the model with pyrexia as the outcome. The results for intended place of birth are shown first in the table, and then other covariates are shown in the order used in the conceptual framework (see Table 6.2).

Table 6.24: Results of 'pyrexia' model

	Log odds	Standard error	p-value for log odds	Relative risk	95% CI for relative risk	
Intended place of birth (reference = home)						
Hospital	0.7454	0.1945	***	2.10	1.44	3.07
Year of delivery (reference = 1988)						
1989	0.0045	0.0688	-	1.00	0.88	1.15
1990	0.0775	0.0668	-	1.08	0.95	1.23
1991	0.0666	0.0666	-	1.07	0.94	1.22
1992	-0.0884	0.0688	-	0.92	0.80	1.05
1993	0.0130	0.0672	-	1.01	0.89	1.16
1994	0.0579	0.0665	-	1.06	0.93	1.21
1995	0.3109	0.0690	***	1.36	1.19	1.56
1996	0.2623	0.0667	***	1.30	1.14	1.48
1997	0.3825	0.0655	***	1.47	1.29	1.66
1998	0.3540	0.0656	***	1.42	1.25	1.62
1999	0.3698	0.0657	***	1.45	1.27	1.64
2000	0.5691	0.0632	***	1.77	1.56	2.00
Month of delivery (reference = September)						
January-June	-0.0582	0.0445	-	0.94	0.86	1.03
July	0.0571	0.0567	-	1.06	0.95	1.18
August	0.1269	0.0560	**	1.14	1.02	1.27
October-December	0.0478	0.0470	-	1.05	0.96	1.15
Time of delivery (reference = 10:00-11:59)						
00:00-01:59	0.3638	0.0592	***	1.44	1.28	1.61
02:00-03:59	0.2411	0.0616	***	1.27	1.13	1.43
04:00-05:59	0.0961	0.0641	-	1.10	0.97	1.25
06:00-07:59	-0.0764	0.0678	-	0.93	0.81	1.06
08:00-09:59	0.1269	0.0658	*	1.14	1.00	1.29
12:00-13:59	-0.1734	0.0683	**	0.84	0.74	0.96
14:00-15:59	-0.1519	0.0669	**	0.86	0.75	0.98
16:00-17:59	0.1295	0.0623	**	1.14	1.01	1.29
18:00-19:59	0.2131	0.0605	***	1.24	1.10	1.39
20:00-21:59	0.3426	0.0595	***	1.41	1.25	1.58
22:00-23:59	0.5305	0.0572	***	1.70	1.52	1.90

Table 6.24 (cont'd): Results of 'pyrexia' model

	Log odds	Standard error	p-value for log odds	Relative risk	95% CI for relative risk	
Hospital providing care (reference = Hillingdon)						
Ashford	-0.0341	0.0904	-	0.97	0.81	1.15
Bedford	-0.4266	0.0752	***	0.65	0.56	0.76
Central Middlesex	-0.0502	0.0835	-	0.95	0.81	1.12
Chelsea & Westminster	0.2098	0.0561	***	1.23	1.10	1.38
Ealing	0.4608	0.0723	***	1.58	1.38	1.82
Edgware	-0.2817	0.0641	***	0.75	0.67	0.86
Hemel Hempstead	-0.2063	0.0663	***	0.81	0.71	0.93
Luton & Dunstable	-0.3643	0.0604	***	0.69	0.62	0.78
Northwick Park	0.0190	0.0580	-	1.02	0.91	1.14
St Mary's	0.2540	0.0561	***	1.29	1.15	1.44
Stevenage	-0.6318	0.0770	***	0.53	0.46	0.62
Watford	-0.1576	0.0636	**	0.85	0.75	0.97
Welwyn Garden City	-0.1729	0.0677	**	0.84	0.74	0.96
West Middlesex	0.1528	0.0623	**	1.16	1.03	1.32
Parity (reference = 2)						
0	1.7805	0.0575	***	5.90	5.28	6.57
1	0.2372	0.0616	***	1.27	1.12	1.43
>2	-0.0089	0.0865	-	0.99	0.84	1.17
Mother's age at delivery (reference = 30+)						
<16	-0.3003	0.2938	-	0.74	0.42	1.32
16-19	-0.2992	0.0580	***	0.74	0.66	0.83
20-24	-0.1425	0.0358	***	0.87	0.81	0.93
25-29	-0.0377	0.0290	-	0.96	0.91	1.02
Ethnic group (reference = White European)						
Black African	0.3827	0.0566	***	1.47	1.31	1.64
Black Caribbean	0.2540	0.0664	***	1.29	1.13	1.47
Mediterranean	0.2191	0.0681	***	1.24	1.09	1.42
Oriental	0.5840	0.0743	***	1.79	1.55	2.07
South Asian	0.2487	0.0393	***	1.28	1.19	1.38
Other	0.2112	0.0552	***	1.23	1.11	1.38
Missing	-0.1822	0.0954	*	0.83	0.69	1.00
Previous miscarriages (continuous)	0.0770	0.0185	***	1.08	1.04	1.12
Previous terminations (continuous)	0.1881	0.0204	***	1.21	1.16	1.26
Smoking status (reference = nonsmoker)						
Light smoker	-0.1454	0.0468	***	0.86	0.79	0.95
Medium smoker	-0.0903	0.0553	-	0.91	0.82	1.02
Heavy smoker	-0.1969	0.0964	**	0.82	0.68	0.99
Missing	0.1008	0.1580	-	1.11	0.81	1.51
Previous Caesarean(s)? (reference = no)						
Yes	1.0763	0.0592	***	2.93	2.61	3.28

Table 6.24 (cont'd): Results of 'pyrexia' model

	Log odds	Standard error	p-value for log odds	Relative risk	95% CI for relative risk	
Large for dates? (reference = no)						
Yes	0.6656	0.2617	**	1.94	1.16	3.24
Previous stillbirth/neonatal death? (reference = no)						
Yes	0.3352	0.1237	***	1.40	1.10	1.78
Preterm labour? (reference = no)						
Yes	0.2867	0.0431	***	1.33	1.22	1.45
Multiple pregnancy? (reference = no)						
Yes	0.2258	0.0700	***	1.25	1.09	1.44
BMI (reference = <30)						
30-34	0.2271	0.0509	***	1.25	1.14	1.39
35+	0.0185	0.0318	-	1.02	0.96	1.08
Gestational diabetes? (reference = no)						
Yes	0.2071	0.0503	***	1.23	1.11	1.36
Congenital abnormality suspected during pregnancy? (reference = no)						
Yes	0.1968	0.0775	**	1.22	1.05	1.42
Anaemia? (reference = no)						
Borderline	0.0713	0.0324	**	1.07	1.01	1.14
Yes	0.1208	0.0522	**	1.13	1.02	1.25
Placental abruption? (reference = no)						
Yes	-0.4010	0.1794	**	0.67	0.47	0.95
Placenta praevia? (reference = no)						
Yes	-0.8401	0.2924	***	0.43	0.24	0.77
Gestation >41 weeks? (reference = no)						
Yes	0.3940	0.0469	***	1.48	1.35	1.62
Amniocentesis? (reference = no)						
Yes	0.1558	0.0573	***	1.17	1.04	1.31
Missing	-0.0880	0.0812	-	0.92	0.78	1.07
Birthweight (reference = 2500g-3999g)						
<500g	1.5709	0.1971	***	4.79	3.26	7.00
500g-1499g	1.1116	0.0722	***	3.03	2.63	3.49
1500g-2499g	-0.1311	0.0575	**	0.88	0.78	0.98
4000+g	0.5766	0.0367	***	1.78	1.66	1.91
Born with congenital abnormality? (reference = no)						
Yes	-0.1948	0.0697	***	0.82	0.72	0.94
Constant	-6.7340	0.2185	***	n/a	n/a	n/a

*** p<0.01 / ** p<0.05 / * p<0.1

Pyrexia affected 1.5% of pregnancies in SMMIS. In the unadjusted data, the risk of pyrexia was 3.95 times greater if the woman intended a hospital birth than if she intended a home birth. After adjustment for the other covariates in the model, the relative risk was smaller, but still large; the risk was 2.10 times higher if a hospital birth was intended than if a home birth was intended. Again, therefore, the unadjusted difference in risk of pyrexia cannot simply be explained by the observed differences between the characteristics of women planning home birth and those planning hospital birth.

Again, some 'high-/medium-risk' conditions were associated with a significantly *lower* risk of pyrexia: placental abruption (RR = 0.67) and placenta praevia (RR = 0.43). In the observed data also, placenta praevia was associated with a lower incidence of failure to progress; so the model result was not due to confounding with other observed covariates. Incidence of placental abruption, on the other hand, was the same in the unadjusted data regardless of intended place of birth; it became associated with a lower risk of pyrexia once birthweight was held constant, indicating that placental abruption and birthweight were confounded. Given that placental abruption often results in an immediate delivery, this is not surprising.

6.8.6 Retained placenta model

Table 6.25 shows the log odds, standard errors, relative risks and 95% confidence intervals for the relative risks from the model with retained placenta as the outcome. The results for intended place of birth are shown first in the table, and then other covariates are shown in the order used in the conceptual framework (see Table 6.2).

Table 6.25: Results of 'retained placenta' model

	Log odds	Standard error	p-value of log odds	Relative risk	95% CI for relative risk	
Intended place of birth (reference = home)						
Hospital	0.5863	0.1176	***	1.79	1.42	2.23
Year of delivery (reference = 1988-1991)						
1992	0.1577	0.0401	***	1.17	1.08	1.26
1993	0.1039	0.0413	**	1.11	1.02	1.20
1994	0.1611	0.0403	***	1.17	1.09	1.27
1995	0.1601	0.0448	***	1.17	1.07	1.28
1996-2000	0.0635	0.0283	**	1.06	1.01	1.12
Hospital providing care (reference = Hillingdon)						
Ashford	0.1399	0.0694	**	1.15	1.00	1.31
Bedford	0.0266	0.0581	-	1.03	0.92	1.15
Central Middlesex	-0.1286	0.0793	-	0.88	0.75	1.03
Chelsea & Westminster	0.2850	0.0505	***	1.33	1.20	1.46
Ealing	0.1187	0.0723	-	1.12	0.98	1.29
Edgware	-0.0955	0.0557	*	0.91	0.82	1.01
Hemel Hempstead	-0.0507	0.0547	-	0.95	0.85	1.06
Luton & Dunstable	0.0544	0.0495	-	1.06	0.96	1.16
Northwick Park	-0.0699	0.0541	-	0.93	0.84	1.04
St Mary's	0.0137	0.0541	-	1.01	0.91	1.13
Stevenage	-0.0490	0.0558	-	0.95	0.85	1.06
Watford	0.1229	0.0514	**	1.13	1.02	1.25
Welwyn Garden City	0.0238	0.0549	-	1.02	0.92	1.14
West Middlesex	0.0812	0.0569	-	1.08	0.97	1.21
Parity (reference = 2)						
0	0.4045	0.0354	***	1.49	1.39	1.60
1	0.1729	0.0361	***	1.19	1.11	1.27
3	0.0766	0.0575	-	1.08	0.96	1.21
4	-0.0753	0.0936	-	0.93	0.77	1.11
>4	-0.2717	0.1173	**	0.76	0.61	0.96

Table 6.25 (cont'd): Results of 'retained placenta' model

	Log odds	Standard error	p-value of log odds	Relative risk	95% CI for relative risk	
Mother's age at delivery (reference = 30-34)						
<16	-0.2515	0.2727	-	0.78	0.46	1.32
16-19	-0.5587	0.0591	***	0.57	0.51	0.64
20-24	-0.4128	0.0343	***	0.66	0.62	0.71
25-29	-0.2052	0.0265	***	0.82	0.77	0.86
35-39	0.1013	0.0343	***	1.11	1.03	1.18
40-44	0.2244	0.0702	***	1.25	1.09	1.43
45+	0.3628	0.3242	-	1.43	0.76	2.67
Single, unsupported? (reference = no)						
Yes	0.0169	0.0321	-	1.02	0.96	1.08
Missing	-0.9585	0.4530	**	0.39	0.16	0.93
Ethnic group (reference = White European)						
Black African	-0.1824	0.0637	***	0.83	0.74	0.94
Black Caribbean	-0.2477	0.0687	***	0.78	0.68	0.89
Mediterranean	-0.4821	0.0830	***	0.62	0.53	0.73
Oriental	-0.1598	0.0874	*	0.85	0.72	1.01
South Asian	-0.5441	0.0428	***	0.58	0.54	0.63
Other	-0.1939	0.0560	***	0.82	0.74	0.92
Missing	0.0146	0.0671	-	1.01	0.89	1.16
Previous miscarriages (continuous)	0.0993	0.0139	***	1.10	1.07	1.13
Previous terminations (continuous)	0.0862	0.0196	***	1.09	1.05	1.13
Smoking status (reference = nonsmoker)						
Light smoker	0.2622	0.0351	***	1.30	1.21	1.39
Medium smoker	0.3704	0.0374	***	1.44	1.34	1.55
Heavy smoker	0.3585	0.0582	***	1.43	1.27	1.59
Missing	0.1697	0.1335	-	1.18	0.91	1.53
Inflammatory bowel disorder? (reference = no)						
Yes	0.6130	0.2970	**	1.83	1.03	3.22
Malpresentation diagnosed in pregnancy? (reference = no)						
Yes	0.2949	0.0466	***	1.34	1.22	1.46
Congenital abnormality suspected during pregnancy? (reference = no)						
Yes	0.2557	0.0615	***	1.29	1.14	1.45
Recurrent antepartum haemorrhage? (reference = no)						
Yes	0.1853	0.0918	**	1.20	1.01	1.43
Preterm labour? (reference = no)						
Yes	0.1314	0.0367	***	1.14	1.06	1.22

Table 6.25 (cont'd): Results of 'retained placenta' model

	Log odds	Standard error	p-value of log odds	Relative risk	95% CI for relative risk	
Previous Caesarean(s)? (reference = no)						
Yes	0.1165	0.0494	**	1.12	1.02	1.23
BMI (reference = <30)						
30-34	-0.1445	0.0491	***	0.87	0.79	0.95
35+	-0.0364	0.0279	-	0.96	0.91	1.02
Multiple pregnancy? (reference = no)						
Yes	-0.1887	0.0644	***	0.83	0.73	0.94
Placental abruption? (reference = no)						
Yes	-0.4099	0.1497	***	0.67	0.50	0.89
Pre-existing diabetes? (reference = no)						
Yes	-0.4360	0.2037	**	0.65	0.44	0.96
Epilepsy? (reference = no)						
Yes	-0.4575	0.2107	**	0.63	0.42	0.96
Gestation >41 weeks? (reference = no)						
Yes	0.2939	0.0458	***	1.34	1.23	1.46
No of ultrasound scans (reference = 1)						
0	0.0561	0.0881	-	1.06	0.89	1.25
2	0.0270	0.0262	-	1.03	0.98	1.08
3	0.1067	0.0328	***	1.11	1.04	1.18
4	0.1957	0.0444	***	1.21	1.11	1.32
>4	0.2318	0.0483	***	1.26	1.15	1.38
Missing	0.0477	0.0976	-	1.05	0.87	1.27
Amniocentesis? (reference = no)						
Yes	0.1343	0.0494	***	1.14	1.04	1.26
Missing	0.0895	0.0753	-	1.09	0.94	1.26
Birthweight (reference = 2500+g)						
<500g	1.4349	0.1988	***	4.09	2.81	5.88
500-1499g	0.8987	0.0711	***	2.43	2.12	2.77
1500g-2499g	0.4163	0.0440	***	1.51	1.39	1.64
Sex of baby (reference = girl)						
Boy	-0.1918	0.0209	***	0.83	0.79	0.86
Indeterminate	0.3696	0.4546	-	1.44	0.60	3.44
Constant	-4.7850	0.1284	***	n/a	n/a	n/a

*** p<0.01 / ** p<0.05 / * p<0.1

Retained placenta affected 2.0% of pregnancies in SMMIS. In the unadjusted data, the risk of retained placenta was 1.88 times greater if the woman intended a hospital birth than if she intended a home birth. This relative risk was barely changed by holding the other observed covariates constant; the risk was 1.79 times higher if a hospital birth was intended than if a home birth was intended, assuming an otherwise reference pregnancy. Again, therefore, the unadjusted difference in risk of retained placenta cannot simply be explained by the observed differences between the characteristics of women planning home birth and those planning hospital birth.

Again, some 'high-/medium-risk' conditions were associated with a significantly *lower* risk of retained placenta: BMI of 30-34 (RR = 0.87), multiple pregnancy (RR = 0.83), placental abruption (RR = 0.67), pre-existing diabetes (RR = 0.65) and epilepsy (RR = 0.63). In the case of BMI, this reflected the pattern in the observed data. Multiple pregnancy, on the other hand, was associated with a *higher* risk of retained placenta in the observed data, but once mother's age was held constant, the pattern was reversed, indicating that the higher incidence of retained placenta among multiple pregnancies was due to older women being more likely to have multiple pregnancies rather than to multiple pregnancy being independently associated with retained placenta. Incidence of placental abruption, pre-existing diabetes and epilepsy was the same in the observed data, regardless of intended place of birth. As in the pyrexia model (see Section 6.8.5), placental abruption became associated with a lower risk of retained placenta once birthweight was held constant. Pre-existing diabetes became associated with a lower risk of retained placenta once previous miscarriages were held constant (incidence of miscarriages was higher if the mother was diabetic). Epilepsy became associated with a lower risk of retained placenta once ethnic group was held constant (incidence of epilepsy was much higher among White European women than among other ethnic groups, especially Mediterranean and Black African).

6.9 Summary and discussion

Table 6.26 shows the incidence, relative risk and 95% confidence intervals for all six labour complications modelled in this chapter. The relative risk represents the number of times by which the risk of the outcome is greater/less if a hospital birth was intended rather than a home birth. The 'home birth' group includes those women who intended a home birth at the end of pregnancy but were transferred to hospital during labour.

Table 6.26: Incidence, unadjusted & adjusted relative risks with 95% confidence intervals for labour complications (reference category = intended a home birth)

Outcome	Incidence	Unadjusted RR	Adjusted RR	95% CI for adjusted RR
Foetal distress	30.3%	2.38	2.16*	2.03 - 2.29
Failure to progress in stage 1	3.4%	0.88	1.08**	0.83 – 1.40
Failure to progress in stage 2	8.8%	3.16	1.92	1.66 – 2.22
Postpartum haemorrhage	1.8%	3.28	2.54	1.86 – 3.47
Pyrexia	1.5%	3.95	2.10	1.44 – 3.07
Retained placenta	2.0%	1.88	1.79	1.42 – 2.23

* Assuming mother did not have asthma and no malpresentation was diagnosed before labour. If the mother had asthma, the relative risk was the same whether a home birth or a hospital birth was intended. If there was malpresentation, the risk of foetal distress was 1.96 times higher if a home birth was intended than if a hospital birth was intended.

** Assuming the woman was having her third baby. There was no significant difference between those intending a home birth and those intending a hospital birth if the mother was having her second, third or fourth baby. If she was having her first baby, the risk of failure to progress in stage 1 was higher if a home birth was intended, but if she was having her fifth or subsequent baby, the risk was higher if a hospital birth was intended (see below for full details).

Before adjustment for the other covariates in the model, the risk of five of the six labour complications (i.e. all except failure to progress in stage 1 of labour) was 2 to 4 times higher if a hospital birth was intended than if a home birth was intended. For all five of these outcomes, adjustment for the other model covariates resulted in the relative risk getting smaller, indicating that the difference in incidence by intended place of birth was partly due to the kind of woman who plans a home birth being the kind of woman who is less likely to have labour complications. However, in all five cases, the adjusted risk of the negative outcome was about twice as high if a hospital birth was intended than if a home birth was intended, indicating that only part of the observed difference in incidence was due to women who intend a home birth having different observed characteristics from women who intend a hospital birth. These results suggest that either there is something about labouring at home *per se* which significantly reduces the risk of experiencing these five labour complications, or one or more unmeasured covariates cause both

intended place of birth and labour complications (e.g. an underlying propensity towards labour complications).

It is important to note that foetal distress was almost certainly more likely to be noticed in hospital than at home because of the routine use of foetal heart monitors in hospital. The higher risk of foetal distress for hospital births may, therefore, be at least partly due to differences in measurement protocols. Similarly, it should be noted that previous postpartum haemorrhage (PPH) is known to predict PPH in the current pregnancy. Because it was not possible to include previous PPH as a covariate in the 'PPH' model (see Section 6.8.4), the higher risk of PPH for hospital births may be partly due to women who plan a hospital birth being more likely to have experienced PPH in a previous pregnancy.

One labour complication displayed a different pattern to the other five: 'failure to progress in stage 1 of labour'. Incidence of this labour complication was lower if a hospital birth was intended (unadjusted relative risk 0.88). The modelling found that this was true only if the woman was having her first baby; in this group the adjusted relative risk was 0.39. If she was having her second, third or fourth baby, there was no significant difference in risk of failure to progress in stage 1 according to intended place of birth. If she was having her fifth or higher-order baby, the adjusted relative risk was 4.52.

In summary, therefore, based on these results, women intending a home birth are significantly less likely than those intending a hospital birth to experience labour complications, with a few specific exceptions:

1. If the mother has asthma, the baby is just as likely to become distressed in labour whether she intends a home birth or a hospital birth
2. If malpresentation has been diagnosed before labour commences, foetal distress is more likely to occur if a home birth is attempted than if there is a planned hospital birth.
3. If the woman is having her first baby, she is more likely to be diagnosed with failure to progress in stage 1 of labour if she attempts a home birth than if she intends a hospital birth.

As will be seen in Chapter 7, however, in cases of foetal distress or failure to progress in stage 1 of labour, perinatal death is no more likely to occur if a home birth was intended than if a hospital birth was intended.

Given that labour complications are associated with infant mortality (see Section 7.6.1) and instrumental/operative delivery (Owen et al, 1997; McGuinness & Trivedi, 1999), there would be benefits to both mother and baby if the incidence of labour complications could be reduced. If these associations are causal (which they may or may not be), these results suggest that an increase in the proportion of planned home births attended by skilled midwives might significantly reduce the

incidence of labour complications, which would have positive knock-on effects on outcomes for babies and maternal morbidity, and would result in reduced costs for the NHS. Lack of funds is often given as a reason why NHS trusts do not feel able to offer home birth to more women; these results suggest that, in the long run, money may be saved.

This chapter contains relatively little discussion of the other predictors of labour complications, because the cases and covariates included in this analysis were selected with the specific aim of making a fair comparison between those intending a home birth and those intending a hospital birth. This resulted in the deletion of certain cases, e.g. unplanned home births and elective Caesarean sections (see Sections 5.1 and 6.1), and the exclusion of certain key covariates, e.g. analgesia and mode of delivery (see Section 6.6). Had the aim been to work out what characteristics predict the outcomes, such cases and covariates would almost certainly have been included, which would have affected the coefficients for some or all of the remaining covariates. Nevertheless, the results of this analysis support the findings of previous research which aimed to identify predictors of these outcomes (see Table 6.12). This gives us confidence in the quality of the data and the analytical approach used. Table 6.27 is included here for completeness; it summarises the factors which independently predicted each outcome, once the other factors in the table were held constant.

Table 6.27: Risk factors for each labour complication

	Maternal outcome					
	Foetal distress	Failure to progress stage 1	Failure to progress stage 2	PPH	Pyrexia	Retained placenta
Intended place of birth	✓	✓	✓	✓	✓	✓
Year of delivery	✓	✓	✓	✓	✓	✓
Month of delivery	✓		✓		✓	
Time of delivery	✓	✓	✓	✓	✓	
Hospital providing care	✓	✓	✓	✓	✓	✓
Parity	✓	✓	✓	✓	✓	✓
Mother's age	✓	✓	✓	✓	✓	✓
Mother's relationship status	✓		✓	✓		✓
NHS patient (i.e. not private)	✓	✓	✓			
Deprivation of mother's area of residence	✓	✓	✓			
Mother's ethnic group	✓	✓	✓	✓	✓	✓
Interpreter required	✓	✓	✓			
Previous miscarriages				✓	✓	✓
Previous terminations					✓	✓

Table 6.27 (cont'd): Risk factors for each labour complication

	Maternal outcome					
	Foetal distress	**Failure to progress stage 1**	**Failure to progress stage 2**	**PPH**	**Pyrexia**	**Retained placenta**
Previous CS	✓	✓	✓	✓	✓	✓
Number of ultrasound scans	✓	✓	✓	✓		✓
Amniocentesis			✓		✓	✓
Smoking status	✓		✓	✓	✓	✓
Late booker		✓				
Asthma	✓					
Haemoglobinopathies	✓	✓		✓		
Previous stillbirth/neonatal death	✓		✓	✓	✓	
Multiple pregnancy		✓	✓	✓	✓	
Placenta praevia				✓		
Placental abruption	✓			✓		
Recurrent antepartum haemorrhage	✓			✓		✓
Gestational hypertension / pre-eclampsia	✓			✓		
Gestational diabetes			✓		✓	
Pre-term labour				✓	✓	✓
Post-term labour	✓		✓	✓	✓	✓
Anaemia	✓	✓	✓	✓	✓	
Malpresentation	✓			✓		✓
Mother's BMI	✓			✓	✓	
Birthweight	✓	✓	✓	✓	✓	✓
Small for dates	✓					
Large for dates					✓	
Previous baby >4.5kg				✓		
Oligo/polyhydramnios	✓		✓	✓		
Inflammatory bowel disorder						✓
Congenital abnormality suspected during pregnancy	✓	✓			✓	✓
Baby born with congenital abnormality					✓	
Fibroids				✓		
Sex of baby	✓	✓		✓		✓

Some characteristics do not appear in Table 6.27, despite their having been included in the model selection process, namely: whether or not the mother had a chorionic villus biopsy during pregnancy, and whether or not she had any of the following conditions: heart condition, pre-existing hypertension, bleeding/coagulation disorder, atypical antibodies, hepatitis B/C, chicken pox/rubella/herpes, hyperthyroidism, pre-existing diabetes, kidney disorder, epilepsy, psychiatric disorder and substance misuse. In other words, these characteristics do not predict any of the six labour complications.

Having had a Caesarean section in the past predicts all six labour complications in the current pregnancy. This may, of course, simply be due to previous Caesarean(s) being a proxy variable for underlying risk factors that carry forward from one pregnancy to the next. If, however, having a Caesarean is, in and of itself, a predictor of future labour complications, this is of concern, because planned hospital births in a consultant-led unit are more likely to end in emergency Caesarean than planned home births (National Collaborating Centre for Women's and Children's Health, 2004). If a lower Caesarean rate would result in a lower incidence of labour complications in subsequent pregnancies, with positive effects on maternal and infant morbidity, and likely reductions in costs, the implications are significant both in terms of reproductive health and NHS finances.

Likewise, we cannot be certain that the associations between previous terminations and labour complications, and between amniocentesis and labour complications are causal relationships, but the possibility that these procedures cause labour complications should be considered and pregnant women advised accordingly.

Having more than four ultrasound scans was associated with a lower risk of foetal distress and failure to progress in stages 1 and 2, whereas having more than one scan was associated with a higher incidence of postpartum haemorrhage (PPH) and having more than two was associated with a higher incidence of retained placenta, even when other risk factors for these complications were held constant. Once again, care should be exercised in making causal inferences, because it is possible that those who have more scans are more likely to have conditions that predict PPH and retained placenta. This, and the finding that having a lot of scans was associated with a lower risk of foetal distress, makes it difficult to take a position on the suggestion that over-dependence on medical technology can lead to the mother not feeling able to take control of her labour and delivery (Tew, 1998).

Chelsea & Westminster stands out as the only hospital to have a significantly higher relative risk of all six labour complications when compared with the reference hospital (Hillingdon). However, as noted earlier, variations by hospital may be due at least partly to hospital-level variations in policies and practices in terms of recording the incidence of these complications. No hospital stands out as having the highest risk of more than one complication.

It is notable that the group of pregnancies analysed here includes high- and medium-risk pregnancies as well as low-risk ones. Current policy in England & Wales is that planned home birth should be an option for all women, but that women with high-risk pregnancies should be advised to give birth in hospital. These results suggest that this policy should be reconsidered. Although this analysis confirms that most high- and medium-risk conditions predict one or more negative pregnancy outcomes, there is no evidence from SMMIS to suggest that planning a hospital birth is a more sensible choice than planning a home birth if the pregnancy is high- or medium-risk; there is a higher risk of a negative maternal outcome regardless of the intended place of birth. The one exception is malpresentation – if this is diagnosed before labour commences, this study indicates that the baby is more likely to become distressed in labour if a home birth is attempted.

In the 1980s and 1990s, although the home birth ratio was low in comparison to the present day, there were probably more midwives in the workforce who had experience of attending home births. This may have led to the outcomes for home births being more positive than they would be under the same conditions today. While this should not detract from the overall message about the theoretical safety of home as a birth setting, it does have practical implications for the training and early work experience of modern-day midwives. If, as a result of these findings, there was a drive to increase the proportion of births taking place at home, this would have to be done gradually to give the midwifery workforce the chance to develop the appropriate skills and experience.

The finding that women who intend a hospital birth are significantly more likely to experience labour complications even when their different observed profile is taken into account raises the question of whether policies and practices in hospitals actually cause labour complications to occur. Although an association does not necessarily imply a causal link, the possibility of a causal link must be considered, and questions asked about whether hospitals could do more to lower the risk of labour complications.

6.10 Chapter 6 key points

This chapter makes a novel contribution to existing knowledge in three main ways:

1. Through the use of multivariate modelling techniques and application of the knowledge gained in Chapter 4 of this thesis, it makes a very good attempt to control for selection effects. Few, if any, previous studies of the safety of home birth have been able to control for such a large number of potential confounders.

2. The large number of observations in the dataset has permitted the modelling of a number of relatively rare outcomes, e.g. postpartum haemorrhage (PPH). Only one of the previous studies identified in the literature review (Chamberlain et al, 1997) compared the incidence of PPH by intended place of birth, and that study did not attempt to control for confounding. PPH is

known to be a major contributor to maternal mortality in the UK and worldwide, so in a country with a low maternal mortality rate such as the UK, any debate about the safety of different birth settings would be advised to consider PPH as an important measure of safety from the perspective of the mother.

3. This study includes high-risk pregnancies, whereas the norm is to restrict such analyses to low-risk pregnancies. In all developed countries which have a policy on place of birth, hospital birth is deemed to be safer than home birth for high-risk pregnancies, yet this assumption appears not to be based on solid research evidence. In most developed countries all – or nearly all – high-risk pregnancies have planned hospital births, so in those countries it would not be possible to include high-risk pregnancies in a comparison of the safety of different birth settings. However, 11% of the planned home births in the SMMIS dataset were to women who would have been classed as 'high-risk' in the present day, which means this study is able to consider the safety of home birth for high-risk as well as low-risk pregnancies.

The key messages of this chapter are as follows:

- Even after adjustment for characteristics such as pregnancy risk status and parity, intending a hospital birth was associated with a 2.5-times higher risk of PPH (loss of >1000ml of blood), compared with intending a home birth. It is possible that part of this difference can be explained by the fact that the model did not control for previous PPH, which is known to be a strong predictor of PPH in the current pregnancy, and which would be likely to lead a woman to choose hospital birth in subsequent pregnancies. However, PPH is a rare event, so it is unlikely that this omission is fully responsible for the large difference between home and hospital birth.

- Similarly, compared with intending a home birth, intending a hospital birth is associated with approximately double the risk of: pyrexia in labour, failure to progress in stage 2 of labour, and retained placenta, even when potential confounders are held constant. There is no obvious reason to suppose that these complications were more likely to be recorded in hospital than at home.

- If the mother does not have asthma and the foetus is not malpresented, the risk of foetal distress in labour (as measured by abnormal foetal heart rate and/or meconium-stained liquor) is also significantly higher if a hospital birth is intended than if a home birth is intended. However, given that foetal heart rate monitoring is more common in hospital than at home, it is possible that all or some of this difference is due to an abnormal heart rate being more likely to be noticed in hospital than at home.

7 Is planned home birth in the UK safe for babies?

This chapter compares the incidence of perinatal mortality between babies whose mothers intended a home birth (whether or not they were actually born at home) and babies whose mothers intended and had a hospital birth, when other observed factors are held constant. Alongside the analyses in Chapter 6, this analysis will contribute to the debate about whether home birth is safe for everyone, some people or no-one. As noted in Chapter 6, this study is observational and is almost certainly subject to selection effects, only some of which will be controlled for via the inclusion of model covariates which are known to be associated with propensity to choose home birth (see Chapter 4).

The chapter begins with a summary of the observed variations in incidence of perinatal death according to intended place of birth (Section 7.1). In the unadjusted data, incidence of perinatal death was higher among those who had a planned hospital birth than among those who planned a home birth, but the difference was not statistically significant. The statistical modelling described later in this chapter aims to work out whether, once other observed characteristics are held constant, a significant difference emerges between those who intended a home birth and those who intended a hospital birth in terms of the risk of perinatal death.

Section 7.2 discusses the conceptual and analytical frameworks, which are similar to those used to model labour complications (see Chapter 6). The main exception is that the framework for analysis of perinatal death includes these labour complications in addition to other characteristics of the mother and her pregnancy. The main objection to home birth is that, if something goes wrong in labour, there is a heightened risk to the baby due to a delay in accessing emergency medical care. The validity of this objection can be assessed through the inclusion in the modelling of interaction terms involving intended place of birth and labour complications.

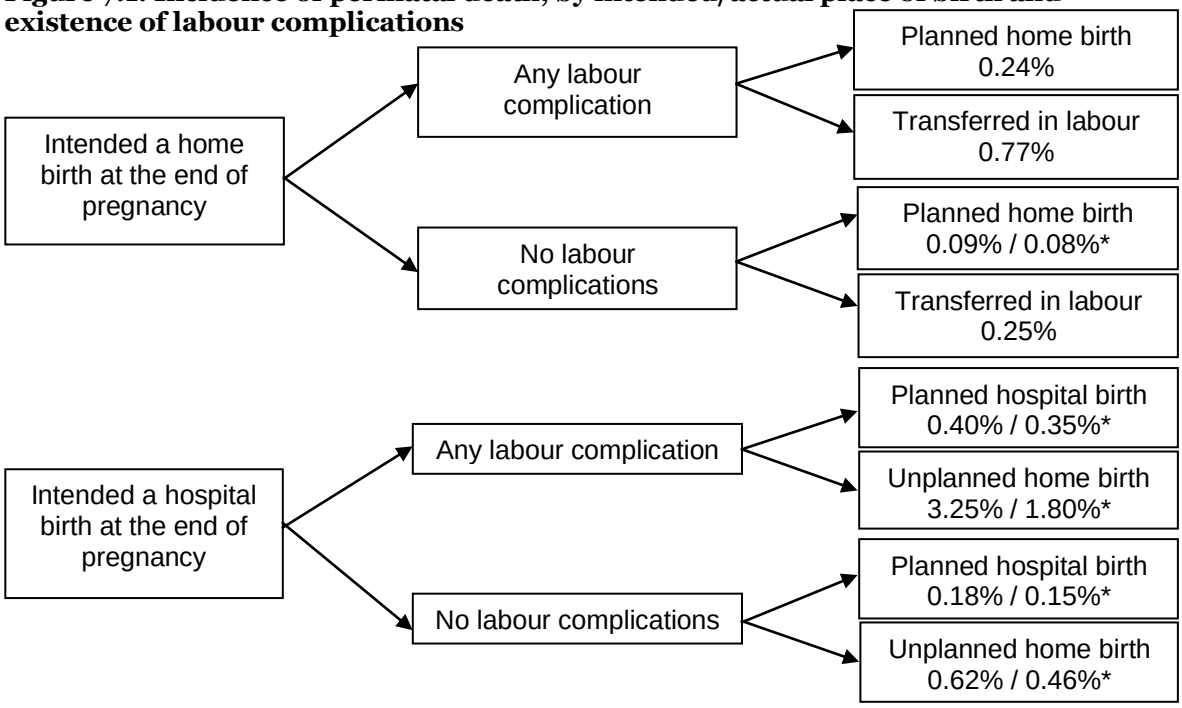
Sections 7.3-7.6 detail the descriptive analysis of factors that are or may be associated with perinatal death, and show that most of the identified covariates are associated with the outcome at the bivariate level. As noted in Section 3.3.1, the descriptive analysis is shown in some detail, to aid understanding of the complex relationships between the large number of explanatory variables included in the statistical modelling. Without this understanding, it would be difficult to judge whether the statistical models are appropriate tools for answering the research question.

Section 7.7 describes how the statistical modelling was carried out, details the explanatory variables excluded due to not having an independent association with perinatal death, and explains the difficult decisions which had to be made regarding the inclusion of interaction terms. Section 7.8 presents the modelling results, and Section 7.9 discusses these results, focusing on what can be concluded from them, and equally importantly, what *cannot* be concluded due to the rarity of the outcome variable.

7.1 Bivariate associations between place of birth and perinatal death

Figure 7.1 details the incidence of perinatal death according to intended/actual place of birth and whether or not there were labour complications.

Figure 7.1: Incidence of perinatal death, by intended/actual place of birth and existence of labour complications



* The first figure represents the result if indeterminate stillbirths were included and the second represents the result if they were excluded. If only one figure is shown, it was unaffected by the inclusion/exclusion of indeterminate stillbirths. (See Section 5.3.2 for a discussion of indeterminate stillbirths.)

Incidence of perinatal death was similar among those who intended a hospital birth at the end of pregnancy than among those who intended a home birth (0.27%/0.24%[57] and 0.17%/0.16% respectively; p=0.101/0.165). Regardless of intended/actual place of birth, pregnancies with labour complications were more likely than those without complications to end in perinatal death. Among those who *did* experience labour complications, unplanned home births were most likely to end in perinatal death, and planned home births were least likely to do so (p=0.000). However, there was no significant variation between planned home births, transfers to hospital and planned hospital births (p=0.328/0.240). The same pattern was evident among those who did *not* have labour complications (p=0.000/0.001 if unplanned home births were included, p=0.343/0.299 if they were excluded).

[57] The first figure represents the percentage if indeterminate stillbirths are included, the second if they are excluded. This pattern applies throughout this section. If only one figure is shown, this means the figure was unaffected by the inclusion/exclusion of indeterminate stillbirths.

The above analysis treats 'labour complications' as a single variable. Analysis of those experiencing individual labour complications found that, for most complications, there was no significant variation ($p>0.3$) in incidence of perinatal death between those having planned home births, those having planned hospital births and those transferring to hospital after attempting a home birth. The two exceptions were cord presentation/prolapse and retained placenta; cases with these two complications were most likely to end in perinatal death if a home birth was attempted and the mother was transferred to hospital in labour. However, even these differences were not significant at the 95% level ($p=0.064$ for cord presentation/prolapse and 0.057 for retained placenta). There were just four cases of cord presentation/prolapse in the 'intended a home birth' group, all of which were transferred to hospital in labour and one of which ended in perinatal death. There were 75 cases of retained placenta in the 'intended a home birth' group, of which 18 were transferred to hospital in labour and one ended in perinatal death.

7.2 Conceptual and analytical frameworks

Although the outcome variable under consideration in this chapter is perinatal death, the aim of this analysis is *not* to identify and quantify all of the predictors of perinatal death. The aim is to make a fair comparison between the incidence of perinatal death among those who intended a home birth and those who had a planned hospital birth. For this reason, the population used for the analysis excludes deaths that would have occurred regardless of birth setting, e.g. stillbirths in which the baby died before labour onset and lethal congenital anomalies (see Section 5.3.2). The exclusion of cases which make a significant contribution to perinatal mortality rates makes these models unsuitable for identifying more general predictors of perinatal death.

A number of factors are or may be associated with perinatal death, or with place of birth. It is important to consider these as potential covariates. They are largely the same as for the maternal outcomes models (see Table 6.3), and grouped into four 'families': (1) external factors (Section 7.3), (2) characteristics of the mother (Section 7.4), (3) characteristics of the pregnancy/baby (Section 7.5), and (4) characteristics of labour/delivery (Section 7.6). Under the heading 'characteristics of labour/delivery', labour complications are considered as covariates in order to answer the question: 'if there were complications, were those who attempted a home birth more likely than those who had a planned hospital birth to have negative infant outcomes?' The labour complications covariates were derived from ICD codes as described in Table 5.2.

In the modelling, labour complications are included only as part of interactions with intended place of birth, and not as main effects. This was because infant death was much more common if there were labour complications (see Section 7.1) and labour complications were significantly less common if a home birth was intended (see Chapter 6). If, therefore, labour complications were to be held constant in the models, this would artificially mask any 'home birth effect' on infant

mortality that was due to home births being less likely to experience labour complications. For example, in Section 6.8.1 it is shown that intending a home birth is associated with a much lower risk of foetal distress, and in Section 7.7.3 it is explained that foetal distress is a predictor of perinatal death. It follows that holding foetal distress constant in the perinatal death model would cause the estimate of the risk of perinatal death associated with planning a home birth to increase. If labouring at home causes a lowering of the risk of foetal distress, then this increase would be an artificial one, because the model would not be taking into account the effect of planning a home birth on the risk of experiencing foetal distress. Of course, we do not know whether or not labour at home causes a lower risk of foetal distress, because we have only identified a statistical association, not a causal link. However, the magnitude of the difference in risk of labour complications between those planning a home birth and those planning a hospital birth (see Chapter 6) indicates that the possibility of a causal link must be taken seriously.

It could be argued that this approach might make hospital birth appear less safe in relation to home birth because in SMMIS planned home births tended to be to parous, 'low-risk' women. However, the inclusion of characteristics such as parity, age, obstetric history and pregnancy risk status as model covariates guards against this problem.

Notwithstanding this, it is important to address the main argument against home birth, i.e. that it is dangerous for the mother not to be in hospital in case there are complications. To address this argument, it is important to look at the outcomes of home birth cases which did experience labour complications and compare them with the outcomes of hospital birth cases which experienced complications. This is done by including interaction terms involving intended place of birth and labour complications.

7.3 Descriptive analysis: external factors associated with negative infant outcomes and/or place of birth

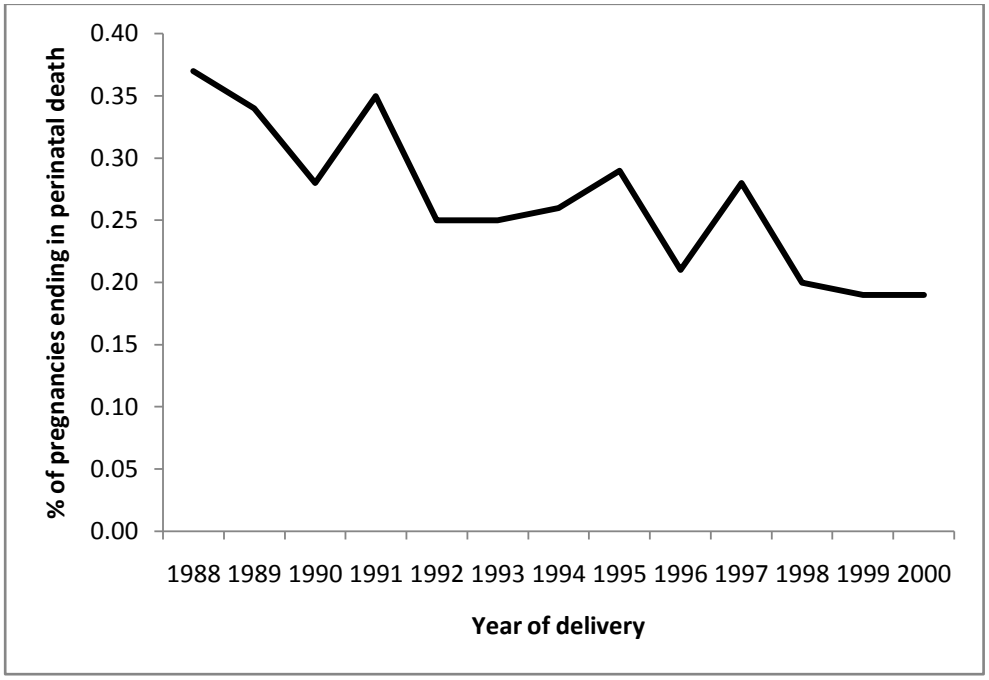
From here on, all analysis excludes unplanned home births (see Section 5.1). Analysis of perinatal death also excludes: lethal congenital anomalies, antepartum stillbirths, birthweights below 500g and birth at less than 22 weeks' gestation (see Section 5.3.2). This leaves 508,630 cases for analysis (including 172 indeterminate stillbirths), of which 1,356 (0.27%) ended in perinatal death. Where the descriptive analysis suggested an interaction between a covariate and intended place of birth, it is described below. If there is no such discussion, it can be assumed that the descriptive analysis did not detect an interaction effect.

7.3.1 When delivery took place

Year

Figure 7.2 shows that incidence of perinatal death fluctuated slightly over the 13-year period, but the underlying trend was a downward one (p=0.000).

Figure 7.2: Incidence of perinatal death, by year



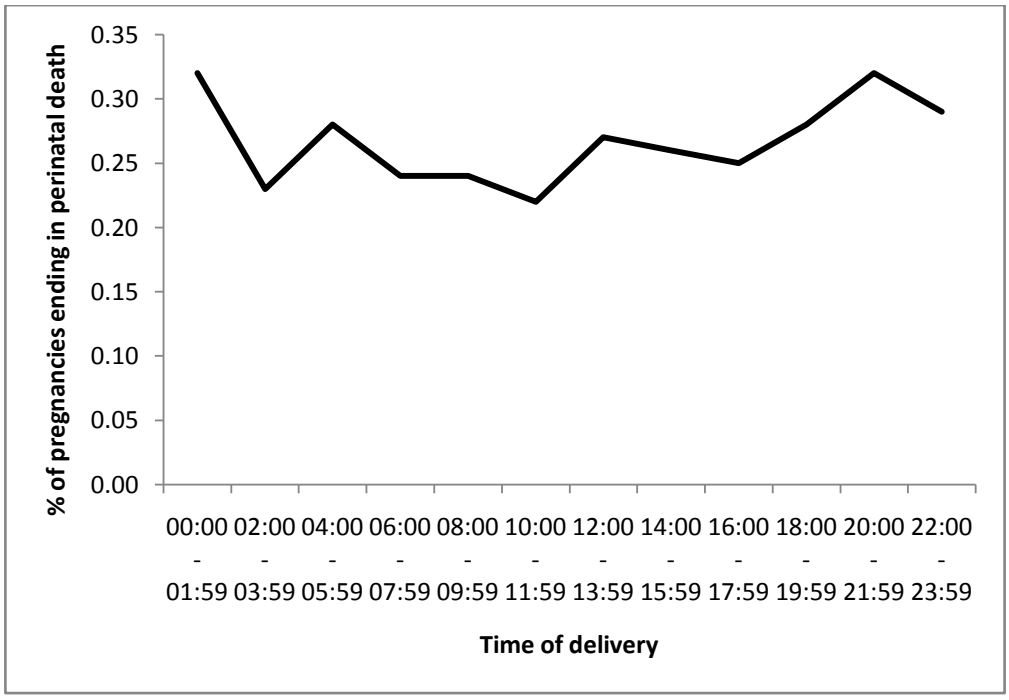
Month

Incidence of perinatal death varied little by month (p=0.054), but was slightly higher in the winter.

Time of day

Figure 7.3 shows that there was little variation by time of day in incidence of perinatal death, but babies born between 10pm and 2am were most likely to die (p=0.034).

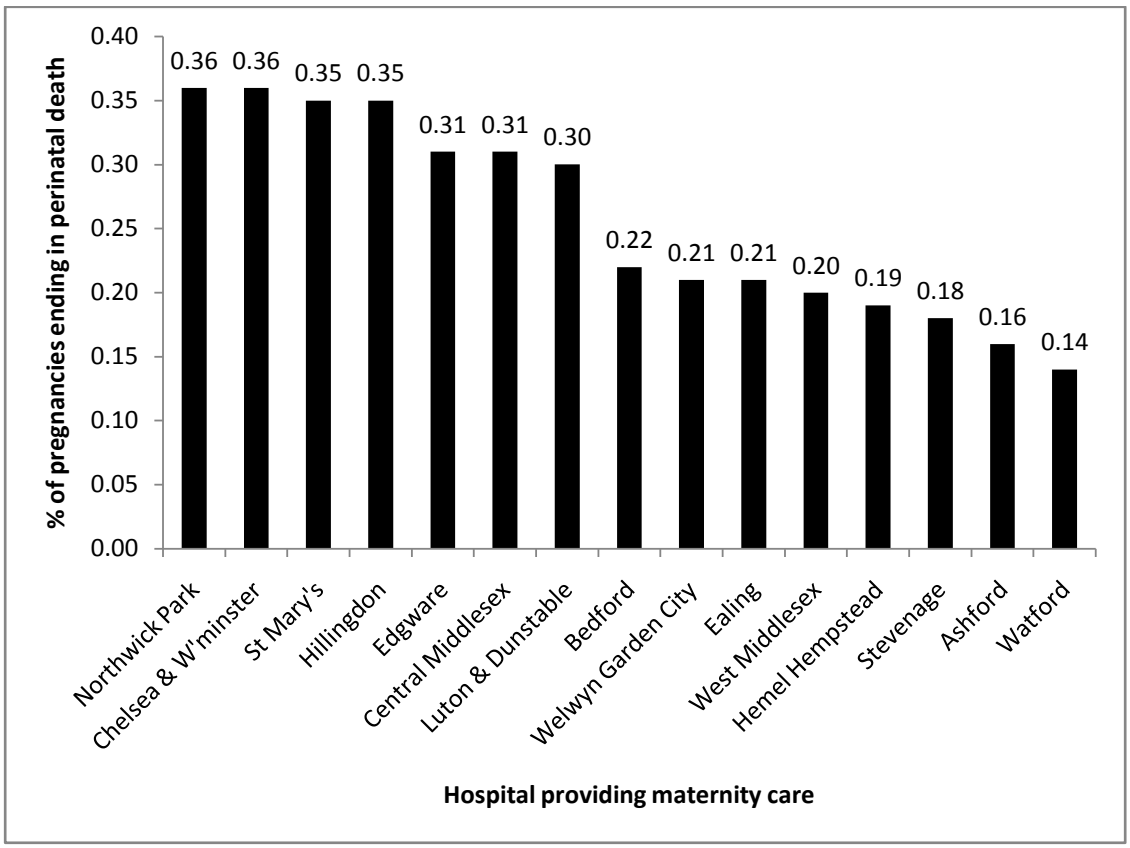
Figure 7.3: Incidence of perinatal death, by time of birth



7.3.2 Hospital providing care

Figure 7.4 shows that perinatal death was most common at the Northwick Park and Chelsea & Westminster units, and least common at the Watford unit (p=0.000).

Figure 7.4: Incidence of perinatal death, by hospital providing care

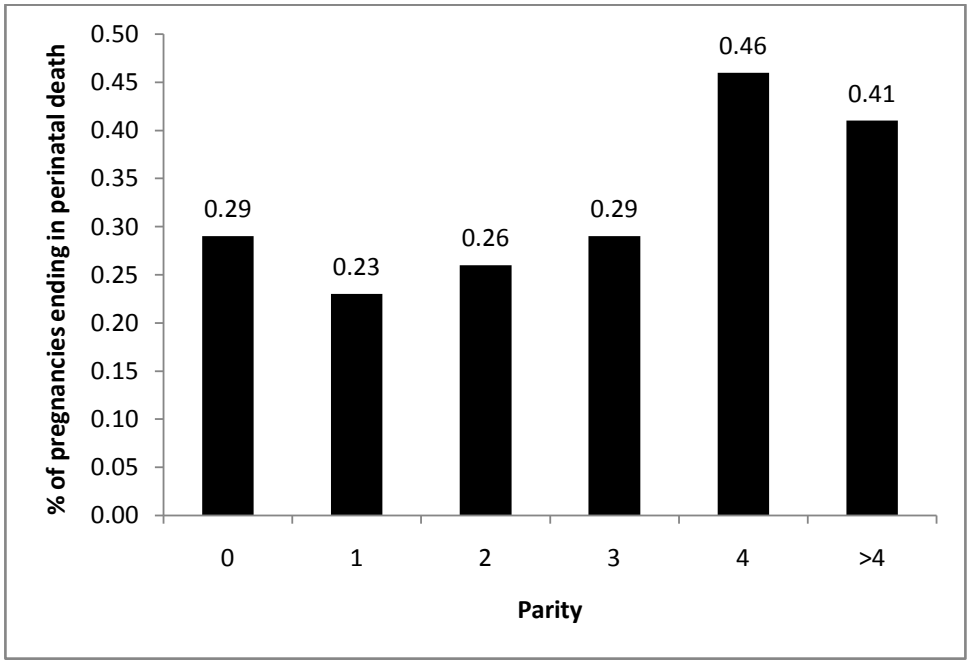


7.4 Descriptive analysis: mother's characteristics associated with negative infant outcomes and/or place of birth

7.4.1 Parity

Figure 7.5 shows that perinatal death was most common if the mother was parity 4 or higher, and more common if the mother was having her first baby than if she was having her second or third baby (p=0.000).

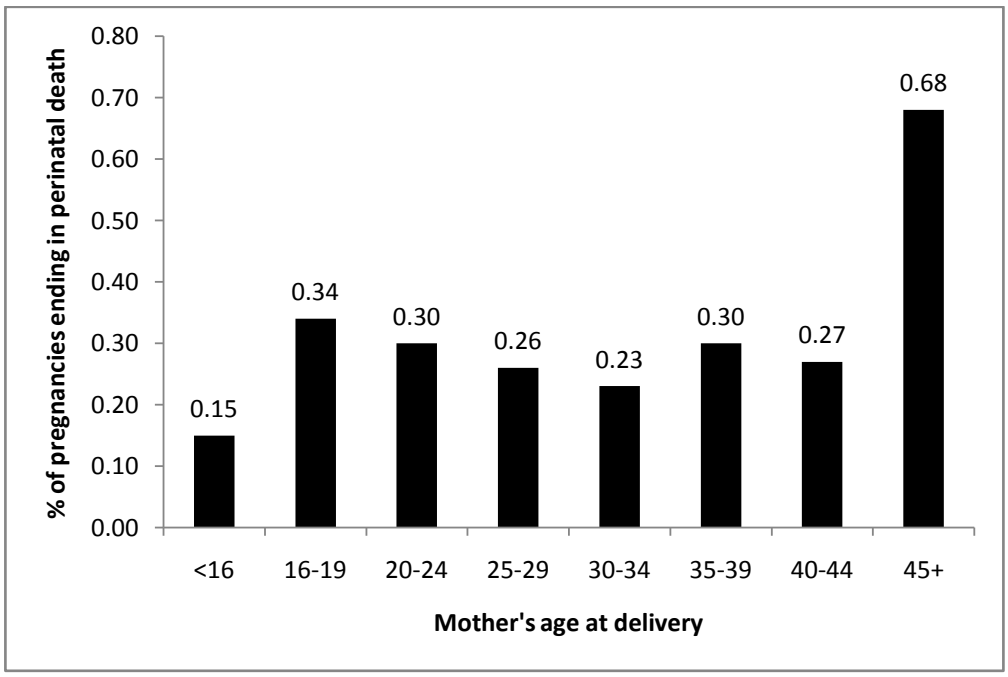
Figure 7.5: Incidence of perinatal death, by mother's parity



7.4.2 Age

Figure 7.6 shows that incidence of perinatal death was highest in the 45+ age group and lowest in the under-16 age group, but varied little among the other age groups (p=0.000).

Figure 7.6: Incidence of perinatal death, by mother's age



7.4.3 Relationship status

The babies of 'single, unsupported' women were more likely than the babies of partnered women to suffer perinatal mortality (0.34% and 0.25% respectively, p=0.000.

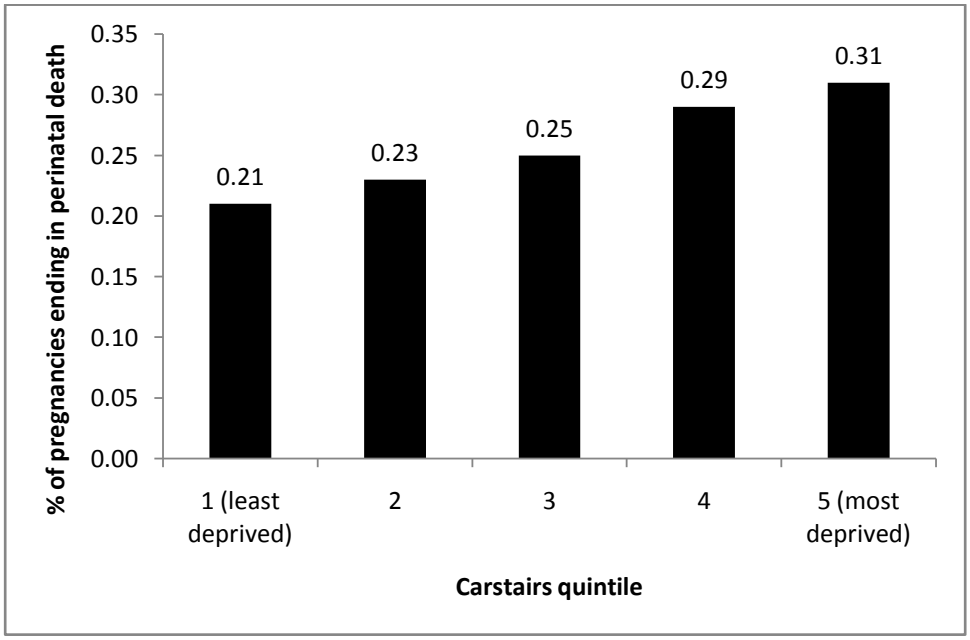
7.4.4 NHS or private care

Incidence of perinatal death was slightly higher among "overseas visitors" and "amenity patients" than among "normal patients" and "private patients" (p=0.043). Please see Section 6.4.4 for an explanation of the different patient types.

7.4.5 Deprivation

Figure 7.7 shows that babies born to women living in more deprived areas had higher incidence of perinatal mortality (p=0.000 for both measures).

Figure 7.7: Incidence of perinatal death, by Carstairs quintile of mother's area of residence

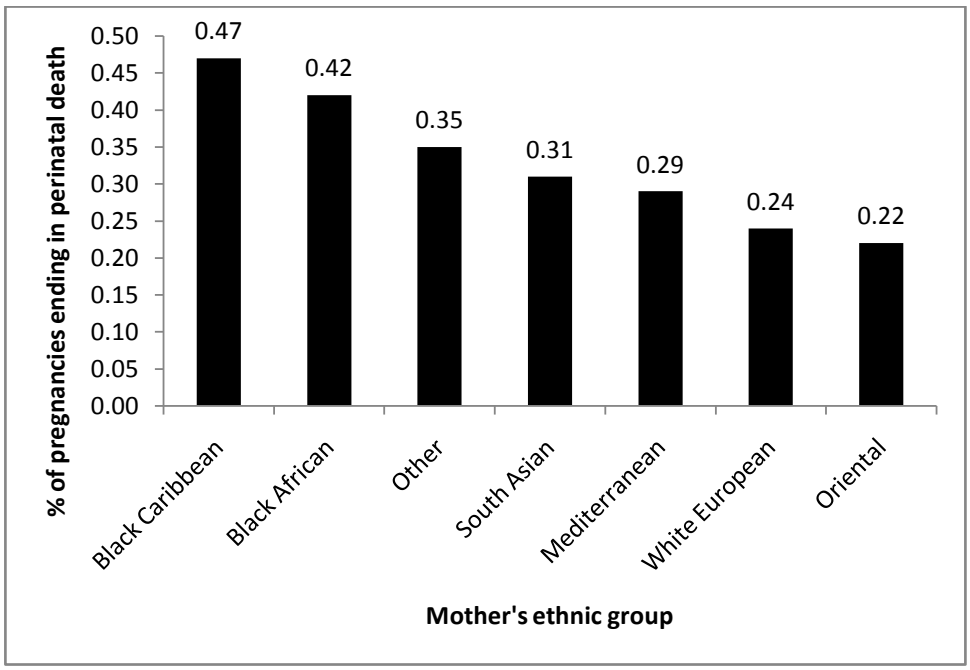


7.4.6 Ethnicity/language

Ethnic group

Figure 7.8 shows that babies born to Black African and Black Caribbean women were most likely to suffer perinatal death, and those born to White European and Oriental women were least likely to do so (p=0.000).

Figure 7.8: Incidence of perinatal death, by mother's ethnic group



Language

Perinatal death was slightly more common if the mother needed an interpreter than if she did not (p=0.047).

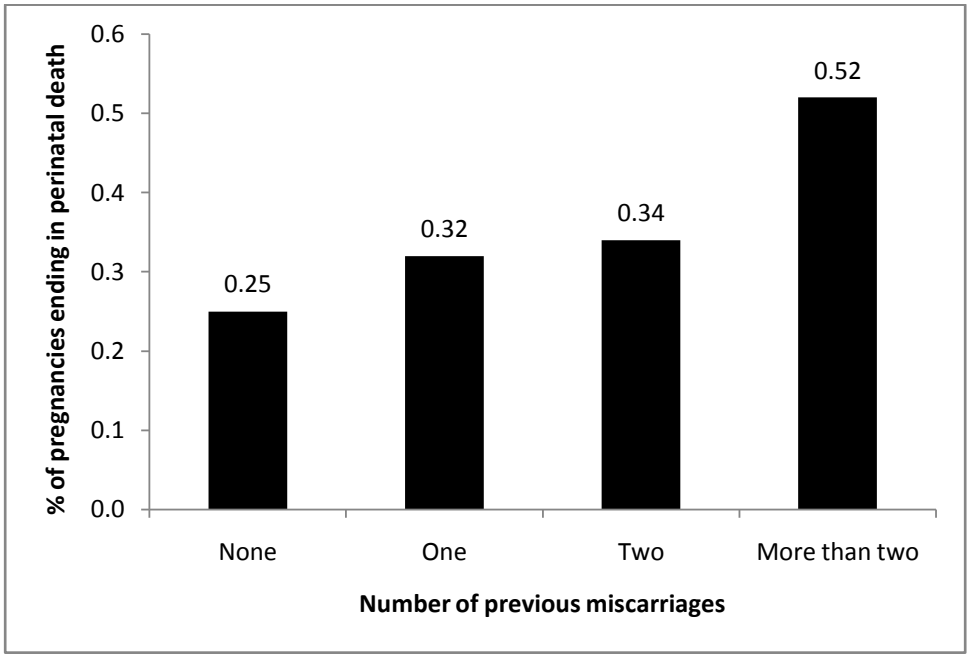
7.4.7 Previous obstetric history

Number of previous miscarriages

Figure 7.9 shows that babies born to women who had had more miscarriages were more likely to die perinatally (p=0.000).

Older women were more likely to have had miscarriages, so the relatively high incidence of perinatal death among those who had had more miscarriages may simply be a function of age. However, because previous miscarriages was a predictor of intended place of birth (see Chapter 4), it is appropriate to consider this as a potential covariate at the modelling stage, to help compensate for selection effects.

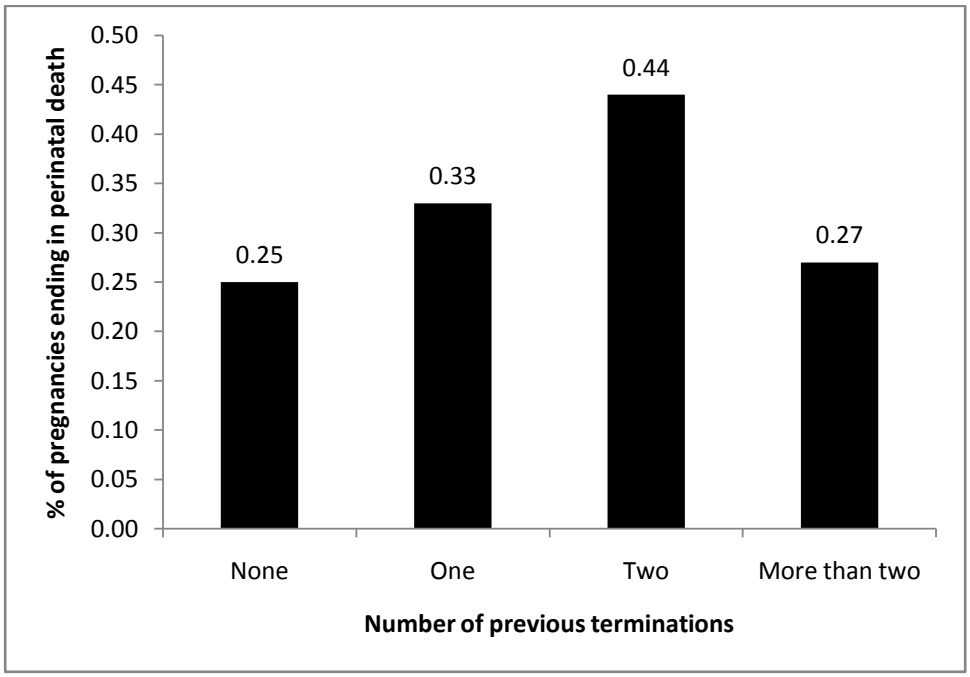
Figure 7.9: Incidence of perinatal death, by number of previous miscarriages



Number of previous terminations

Figure 7.10 shows that babies born to women who had had two previous terminations were most likely to suffer perinatal death (p=0.000), but those who had had more than two were not at significantly higher risk of perinatal death than women who had never had a termination.

Figure 7.10: Incidence of perinatal death, by number of previous terminations

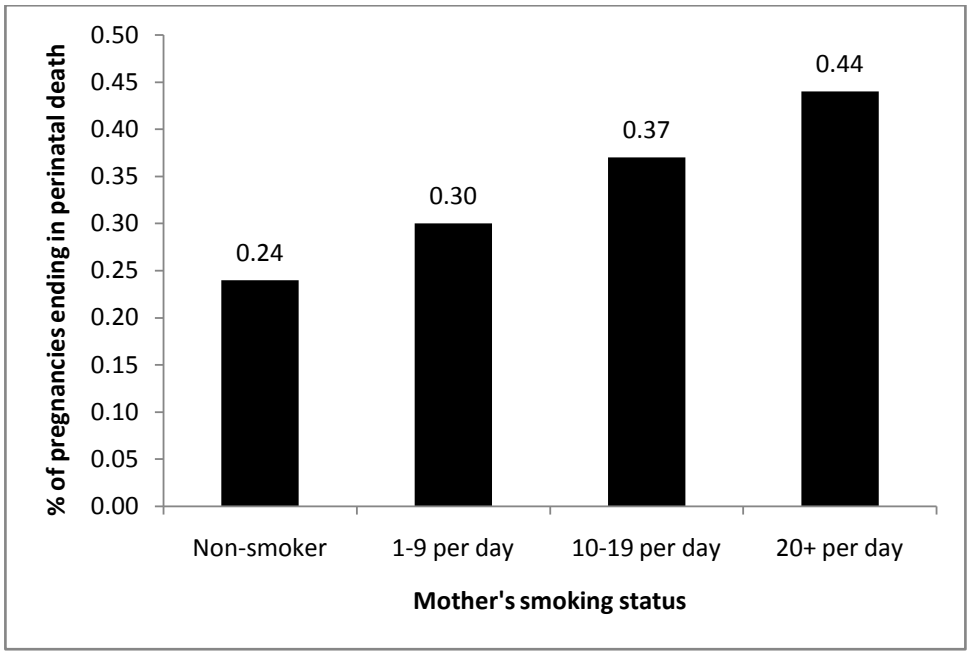


7.4.8 Health behaviours

Smoking

Figure 7.11 shows that, the more the mother smoked, the more likely it was that her baby would suffer perinatal death (p=0.000).

Figure 7.11: Incidence of perinatal death, by mother's smoking status



Gestation at booking

Babies born to 'late bookers' (see Section 6.4.9) were more likely to die perinatally than those born to women who did not book late (p=0.000).

7.5 Descriptive analysis: characteristics of pregnancy/baby associated with negative infant outcomes and/or place of birth

7.5.1 Pregnancy risk status

Pregnancy risk status was derived from the data as described in Section 4.3.1.1. High-risk pregnancies were the most likely to end in perinatal death (0.51% compared with 0.27% overall). However, there was no significant difference in incidence of perinatal death between medium-risk (0.12%) and low-risk pregnancies (0.15%).

The individual 'high-' and 'medium-risk' conditions which were most likely to be associated with perinatal death are shown in Table 7.1. If a condition is not shown in Table 7.1, it was not associated with a significantly higher risk of perinatal death when compared with cases which did not have the condition.

Table 7.1: High- and medium-risk conditions associated with a significantly higher risk of perinatal death (p<0.05)

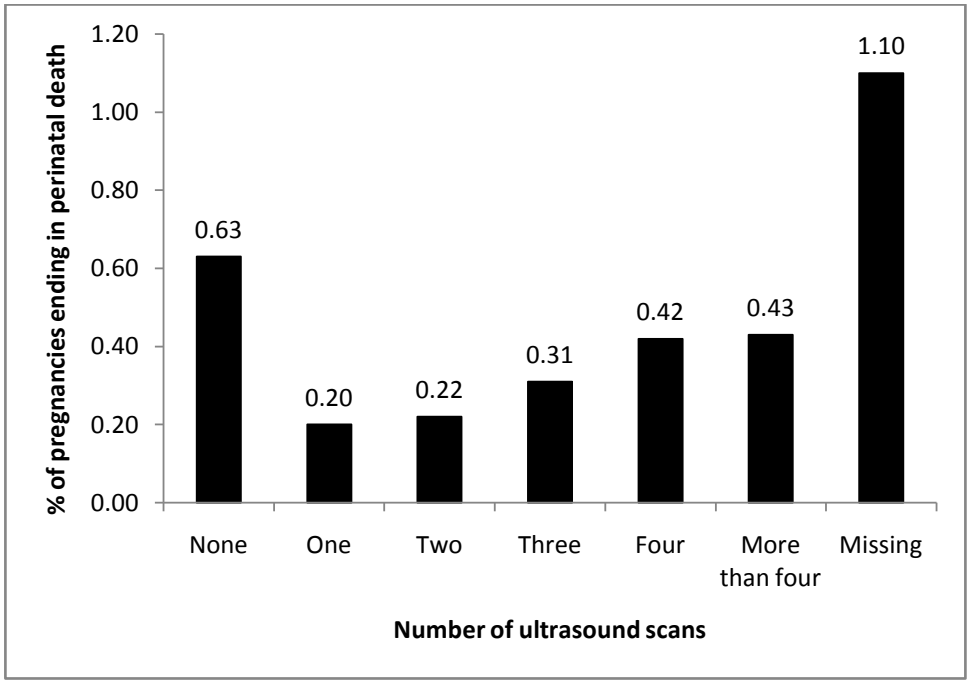
Condition	No of cases in SMMIS eligible for inclusion in this analysis	% of eligible cases ending in perinatal death
Placental abruption	2,167	4.52
Tuberculosis	41	2.44
Suspected congenital abnormality	10,893	2.30
Oligo/polyhydramnios	985	1.93
Malpresentation	27,141	1.55
Preterm labour	60,935	1.53
Multiple pregnancy	13,263	1.27
Previous stillbirth/neonatal death	8,207	0.85
Placenta praevia	2,222	0.81
Gestational hypertension/pre-eclampsia	1,395	0.79
Kidney disorder	2,003	0.65
Pre-existing diabetes	2,056	0.54
Recurrent antepartum haemorrhage	3,247	0.46
BMI 35+	118,472	0.36
Previous Caesarean section	36,113	0.32

7.5.2 Amount of medical attention received

Number of ultrasound scans

Figure 7.12 illustrates how having no ultrasound scans and having three or more were associated with a higher incidence of perinatal death (p=0.000). This pattern is to be expected, since women having no scans at all were likely to be those who were disengaged from the maternity care system and/or late bookers, and those having several scans tended to have high-risk pregnancies. If these are the sole explanations, we would expect 'number of scans' to become a non-significant covariate once late booking and pregnancy risk status are included in the models; but it does not (see Section 7.8).

Figure 7.12: Incidence of perinatal death, by number of ultrasound scans



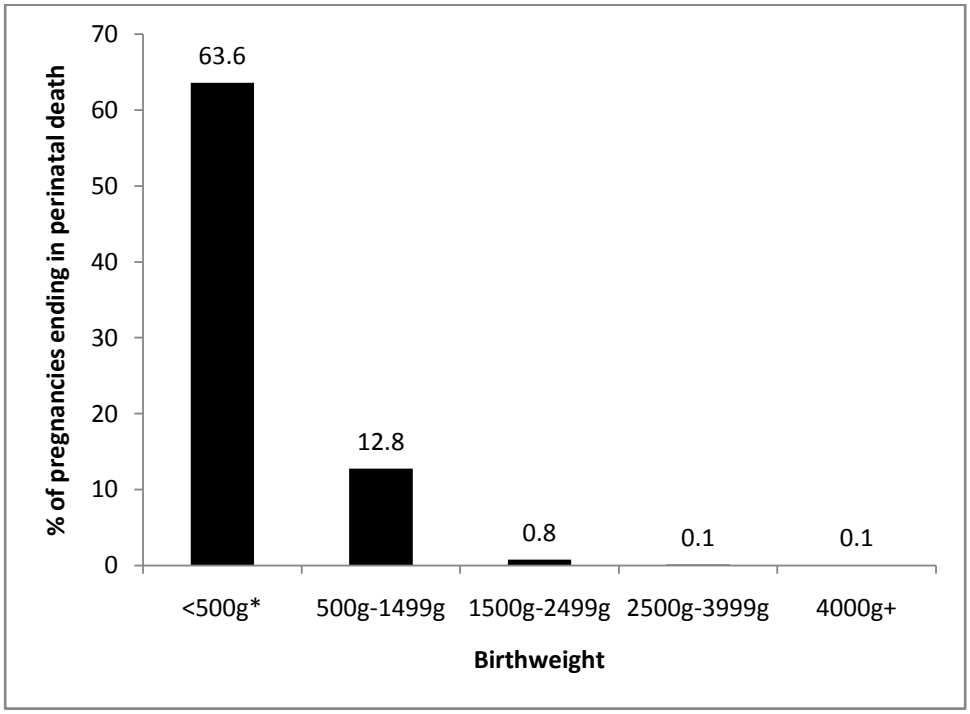
Amniocentesis / CVB

Incidence of perinatal death was higher if the mother had had an amniocentesis and/or chorionic villus biopsy in pregnancy (p=0.000 for both measures).

7.5.3 Maturity/size of foetus

Figure 7.13 shows that perinatal death occurred almost exclusively among low birthweight (<2500g), and especially very low birthweight (<1500g), babies (p=0.000).

Figure 7.13: Incidence of perinatal death, by birthweight



* The perinatal death figure is shown for the <500g group, but note that this group was excluded from the modelling of perinatal death (see Section 5.3.2).

It was also decided to include a covariate indicating whether or not the baby was post-term (gestation >41 weeks), because the incidence of perinatal death was relatively high in this group at 0.16%, compared with 0.10% among term babies (37-41 weeks of gestation). This did not introduce a major bias in relation to place of birth, because the incidence of post-maturity was similar among those intending a home birth and those intending a hospital birth (3.7% and 4.2% respectively).

7.5.4 Sex of baby

Incidence of perinatal mortality was higher for boys than for girls (p=0.000).

7.5.5 Congenital abnormalities

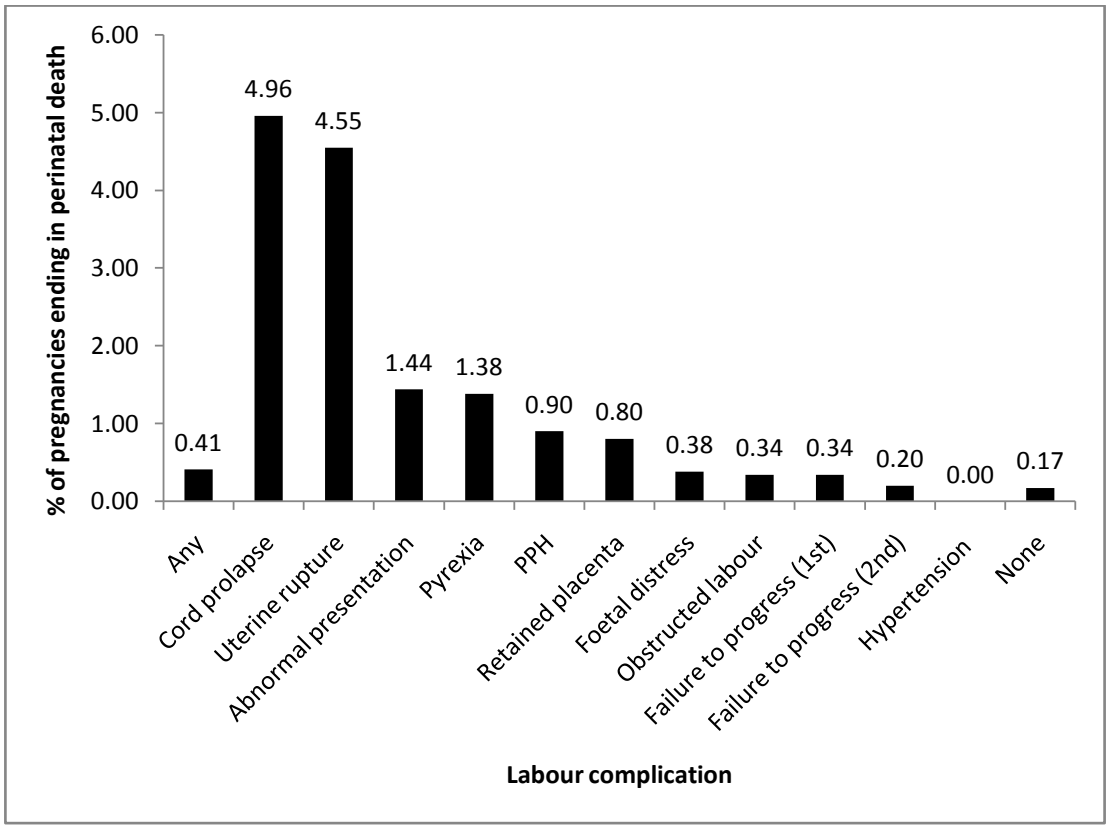
Babies born with abnormalities that are always or nearly always fatal were excluded from the analysis (see Section 5.3.2). Babies born with other congenital abnormalities (defined as in Section 6.5.5) were three times more likely than those without to suffer perinatal death (p=0.000). However, among babies with congenital abnormalities, there was no significant variation in incidence of perinatal death according to intended/actual place of birth (p=0.225).

7.6 Descriptive analysis: characteristics of labour/delivery associated with negative infant outcomes and/or place of birth

7.6.1 Labour complications

Figure 7.14 shows that, if there were labour complications, incidence of perinatal death was about twice as high as it was if labour was uncomplicated (p=0.000). Death was most likely to occur if labour was complicated by uterine rupture or cord prolapse. Incidence of perinatal death was similar in cases of failure to progress in stage 2 of labour and hypertension in labour as it was in cases of uncomplicated labour, which suggests that these two complications do not predict perinatal death.

Figure 7.14: Incidence of perinatal death, by type of labour complication



As explained in Section 7.2, labour complications were included in the perinatal death model only as part of interaction terms with intended place of birth.

7.6.2 Duration of labour

Longer labours (>18 hours) were associated with a higher incidence of perinatal death (p=0.000). Because 'failure to progress in stage 1 of labour' and 'failure to progress in stage 2 of labour' were both included as covariates and were strongly correlated with overall labour duration, it was judged to be unnecessary to include labour duration as a model covariate as well.

7.6.3 Mode of delivery

Although mode of delivery was associated with perinatal death (which was most common if the baby was born by emergency CS), it was not included as a covariate in the models because it was so strongly correlated with place of birth (see Section 6.6.3).

7.6.4 Type of pain relief used in labour

With the exception of general anaesthetic, babies born to women who used pharmacological pain relief in labour were less likely than those who did not to experience perinatal death (p=0.000). The 'no pharmacological pain relief' group contained a disproportionately high number of low birthweight and preterm babies, which may explain this. General anaesthetics were rarely used (0.2% of records), so it is reasonable to assume they were used only in the most complicated cases, which may explain the high incidence of negative outcomes in this group.

The use of pain relief was strongly correlated with place of birth, because certain types of pain relief (e.g. epidural) are available only in hospital. For this reason, it was not appropriate to consider pain relief as a predictor of perinatal death in this analysis.

7.6.5 Induction/augmentation of labour

Induction was not associated with perinatal death (p=0.573), but babies born after an augmented labour were less likely to die than those both after non-augmented labours (p=0.000). However, because induction and augmentation were both strongly correlated with place of birth (0.2% of planned home births were induced and 3.8% were augmented, compared with 18.0% and 20.6% respectively of planned hospital births;), it was inappropriate to include them as predictors of negative infant outcomes.

7.7 Statistical modelling: methods

7.7.1 Models required to answer the research questions

Research question 3: Were the babies of women who attempted a home birth less likely to die once other observed characteristics are held constant?

Research question 3 is answered using models with perinatal death as the outcome variable. 'Women who attempted a home birth' included all those who intended a home birth at the end of pregnancy, whether they gave birth at home or were transferred to hospital in labour. The following cases are excluded from the modelling as explained in Section 5.3.2: intended place of birth unknown, unplanned home births, antepartum stillbirths, lethal congenital anomalies, birthweight <500g, gestation <22 weeks. The model is run both with and without indeterminate stillbirths to assess the sensitivity of the results to their inclusion or exclusion.

As with the maternal outcomes (see Chapter 6), these models are an 'intention to treat' analysis, in which those intending a home birth at the end of pregnancy are treated as a single group, regardless of whether or not they actually gave birth at home. Thus, the complicated home birth cases are included as well as the straightforward ones.

The important question of whether home birth is safe for babies only if nothing goes wrong in labour is answered via the investigation of interactions between intended place of birth and labour complications (see Section 7.2). Additionally, in both models interactions between place of birth and: parity, pregnancy risk status, birthweight and congenital abnormalities are investigated, to establish whether the overall findings hold true for all groups, including those at higher risk of negative outcomes.

The models have a binary outcome variable, so binary regression models (BRMs) are used (see Section 3.3.2 for a detailed description of this type of model). All models used the logit link function.

7.7.2 Outcome variable and explanatory variables included in the model building process

The outcome variable is binary (yes or no). If indeterminate stillbirths were included, 1,356 of the 508,683 eligible records were coded as having experienced perinatal death (0.27%). If indeterminate stillbirths were excluded, 1,184 out of 508,511 (0.23%) ended in perinatal death.

The explanatory variables used in the model building process are detailed in Table E.9 in Appendix E. These were selected because previous research and commentary had either demonstrated or posited an association between the explanatory variable and either (a) perinatal death or (b) intended place of birth (see Table 6.2).

7.7.3 Model selection process

The model was selected using manual forward selection (see Table F.11 in Appendix F for a detailed account). Each explanatory variable was added individually, with two exceptions. The first was 'antenatal risk status'. As noted in Section 6.5.1, it was not appropriate to use the summary variable which classed each pregnancy as high-, medium- or low-risk because high-risk women having planned home births tended to have different high-risk conditions than high-risk women having planned hospital births. Therefore, each individual high- or medium-risk condition was treated as a separate covariate, with a few exceptions, all but one of which are described in Section 6.7.3. In addition, 'preterm birth' (<37 weeks) and 'post-term birth' (>41 weeks) were contained within a single 'gestation' variable (<37 weeks, 37-41 weeks, >41 weeks), because if they were included as separate covariates their coefficients became nonsensical and the coefficient for birthweight was much larger than if gestation was included as a single covariate. Five risk factors were excluded as individual covariates because there were no perinatal deaths among those who experienced them: chickenpox/rubella/herpes, hyperthyroidism, psychological problems, substance abuse and inflammatory bowel conditions. These five conditions were included in the 'other rare risk factor' category (see Section 6.7.3).

As part of the forward selection, the covariate (or block of covariates) yielding the highest $LR\chi^2$ value was selected to be included in the model, and was included in all models tested from that point on. This process was repeated with the remaining explanatory variables until Likelihood Ratio Tests (LRTs) showed that the addition of further explanatory variables did not make the model a significantly better fit overall (i.e. the p-value of the LRT was greater than 0.05).

The building of an additive model resulted in a model containing all except 13 of the covariates in Table E.9 in Appendix E. The covariates that were dropped during the model-building process were: "single, unsupported", previous terminations, smoking status, 'interpreter required', previous miscarriages, parity, congenital abnormalities, mother's age at delivery, Carstairs quintile, chorionic villus biopsy (CVB), amniocentesis, ethnic group and "patient category". All of these had a statistically significant association with perinatal death at the bivariate level (see Table F.11 in Appendix F). Eight of them ('single unsupported', ethnic group, 'interpreter required', previous miscarriages, smoking status, previous terminations, Carstairs quintile and amniocentesis) became non-significant once birthweight was held constant, indicating that their association was with low birthweight rather than with perinatal death *per se*. A further three (parity, congenital abnormalities and CVB) became non-significant once pregnancy risk status was held constant, indicating that their association was with being high- or medium-risk[58]. Mother's age became non-

[58] In the case of congenital abnormalities, this was almost certainly due to the inclusion of 'suspected congenital abnormality' in the 'antenatal risk status' block. Whilst it could be argued that actual congenital abnormality is a better covariate than suspected congenital abnormality, the latter was included in the model because it was evident before labour commenced and therefore of more use to pregnant women who are deciding where to plan their delivery.

significant once year of birth was held constant. "Patient category" became non-significant once hospital was held constant. It is interesting to note that relationship status and mother's age were both highlighted as being associated with infant mortality in England and Wales 2009 (Agarwal, 2010) – as indeed they were in the exploratory analysis in this chapter – but this analysis suggests that these associations may have resulted from age and relationship status being associated with other characteristics rather than having an independent association with mortality (although the difference may be accounted for by this analysis excluding cases in which the outcome was determined before the commencement of labour).

The final additive model also showed that most of the individual conditions making up the antenatal risk status block did not have a significant association with the outcome ($p>0.05$). A likelihood ratio test (LRT) showed that the model without these complications was not a significantly worse fit to the data than the model with them ($p=0.8008$). Furthermore, their removal made virtually no difference to the odds ratios for the remaining covariates[59], so the decision was taken to exclude them from the final model. Table 7.2 details the conditions that were excluded for this reason, and the p-values of their model coefficients.

Table 7.2: Pregnancy and labour complications excluded from final perinatal death model due to having no significant association with the outcome once other covariates were held constant, and the p-values of their model coefficients

Complication	p-value	Complication	p-value
Heart condition	0.452	Pre-existing hypertension	0.285
Asthma	0.622	Haemoglobinopathies	0.624
Atypical antibodies	0.696	Hepatitis B/C	0.679
Tuberculosis	0.315	Pre-existing diabetes	0.440
Kidney disorder	0.396	Epilepsy	0.209
Previous Caesarean section	0.663	Placenta praevia	0.107
Anaemia	0.728	Borderline anaemia	0.682
Gestational diabetes	0.594	Previous baby >4500g	0.328
Large for dates	0.872	Fibroids	0.377

The final additive model was re-run without indeterminate stillbirths, and this made hardly any difference to the odds ratio for 'intended place of birth' (with indeterminate stillbirths the OR was 1.58, and without them it was 1.70, and the p-value was greater than 0.05 whether or not they were included). Indeed, the exclusion of indeterminate stillbirths made very little difference to any of the ORs, with two exceptions: indeterminate sex (OR of 17.34 with indeterminate stillbirths and 20.99 without them; $p=0.000$ in either event) and birthweight <1500g (OR of 54.90 with indeterminate stillbirths and 56.33 without them; $p=0.000$ in either event). In neither case did the change in OR make any difference to the substantive conclusions of the model. This was a strong indication that

[59] The OR changed by more than 0.1 for only one covariate: very low birthweight (OR of 54.2 if all complications included; 54.3 if the non-significant ones were excluded). This would have made no difference to the model's substantive conclusions.

the overall results were not sensitive to the inclusion/exclusion of indeterminate stillbirths, so the analysis shown here only presents the results from the model including indeterminate stillbirths.

Once the final additive model had been built, interaction terms were added to assess whether or not they made a statistically and substantively significant improvement to the model. The addition of interaction terms was theory-driven, with a focus on interaction terms involving place of birth for the perinatal death model. The testing of such terms aimed to answer the question of whether the overall results on the safety of planned home birth were masking sub-groups of women for whom planning a home birth was less safe than planning a hospital birth. LRTs were used to assess whether interaction terms made a statistically significant improvement to the model ($p<0.05$). If they did, predicted probabilities and odds ratios were calculated to assess whether they made a substantive difference to the model interpretation. If they did, they were included in the final model.

A number of interaction terms were impossible to test because there were no cases in the 'intended a home birth' group which had that complication and ended in perinatal death, and these are shown in the first column of Table 7.3. For women with these conditions, therefore, we cannot make any statement about the relative safety of planning a home birth.

For the remaining interaction terms, LRTs were performed to see if their inclusion significantly improved the fit of the model. In many cases, the inclusion of the interaction term did not significantly improve the fit of the model once the other covariates were held constant, and these are shown in the second column of Table 7.3.

Table 7.3: Pregnancy and labour complications for which the interaction with intended place of birth was not included in the final perinatal death model, and reason why

No perinatal deaths in 'intended home birth' group	Interaction term did not significantly improve model fit (p>0.05)
Pyrexia in labour	Retained placenta
Postpartum haemorrhage	Low birthweight
Failure to progress in stage 1 of labour	Congenital abnormality diagnosed in pregnancy
Raised maternal BMI	Preterm labour
Obstructed labour	
Previous stillbirth/neonatal death	
Placental abruption	
Multiple pregnancy	
Malpresentation diagnosed in labour	
Recurrent antepartum haemorrhage	
Small-for-dates	
Oligo/polyhydramnios	
Gestation >41 weeks	
Gestational hypertension/pre-eclampsia	

Six interaction terms made a statistically significant improvement to the model fit (i.e. the p-value of the LRT and/or the interaction effect was <0.05), and these were the interactions between intended place of birth and: (1) foetal distress in labour, (2) infant resuscitation involving positive pressure/cardiac massage, (3) any infant resuscitation, (4) cord prolapse in labour, (5) failure to progress in stage 2 of labour and (6) malpresentation diagnosed before labour. In two of these cases (foetal distress and failure to progress in stage 2 of labour), the improvement in the model fit was due entirely to the inclusion of the main effect; the labour complication predicted perinatal death, but perinatal death was equally likely whether a home or a hospital birth had been intended (the p-value for the interaction term was <0.05). As explained in Section 7.2, labour complication main effects were excluded from this model on theoretical grounds, so these two interaction terms were not included in the final model.

The interactions between (1) intended place of birth and cord prolapse and (2) intended place of birth and infant resuscitation involving positive pressure/cardiac massage were also excluded because the confidence interval for the interaction term was extremely large due to tiny numbers of deaths in the 'intended a home birth' group (there was just one death following cord prolapse and just three following infant resuscitation involving positive pressure/cardiac massage). It should therefore be noted that it is possible that, if cord prolapse occurs during labour or the baby needs resuscitation involving positive pressure/cardiac massage, the baby may be more likely to die if a home birth is attempted than if it is a planned hospital birth. However, SMMIS is not a sufficiently large evidence base for us to be confident one way or the other. The cases of resuscitation involving positive pressure/cardiac massage were included in the interaction term for 'any resuscitation', and this is discussed further below.

This left two interaction terms for consideration: intended place of birth * any kind of infant resuscitation and intended place of birth * malpresentation diagnosed before labour. Once the former was included in the model, the latter did not make a significant improvement to the model fit, because infant resuscitation and malpresentation were confounded. This indicated that the final model should be the one which contained the interaction between intended place of birth and any infant resuscitation. As will be seen in Section 7.8, however the results of this model are questionable because (a) the confidence interval around the results is very large due to the small number of perinatal deaths in the 'intended a home birth' group, and (b) a high proportion of those who intended a home birth and needed resuscitation were actually born in hospital, which means we cannot tell whether the increased risk of perinatal death among those who intended a home birth and needed resuscitation was associated with having attempted a home birth or with the resuscitation received in hospital.

Section 7.8 shows that the results of the model containing the interaction between intended place of birth and malpresentation were also questionable because of a wide confidence interval due to small number of deaths in the 'intended a home birth' group. Given this level of uncertainty over the

models containing interactions, the Section 7.8 shows the results of three versions of the model: (1) no interactions, (2) the interaction between intended place of birth and any infant resuscitation and (3) the interaction between intended place of birth and malpresentation.

7.7.4 Reference categories

Table 7.4 details the reference categories selected for each categorical explanatory variable, and therefore describes a 'reference pregnancy' for the perinatal death models. In most cases, the reference category was the group with the lowest incidence of perinatal death, so that relative risks in the final model would be greater than one and thereby the model results would be easier to interpret. As with the 'labour complications' models, there were two main exceptions to this rule (1) if the group with the lowest incidence was too small to be a reference category, the largest group was selected instead, and (2) for variables with an inherent order (e.g. year of birth), where possible a category at one of the extremes was selected. However, in some cases (e.g. mother's age), the groups at either end of the continuum were too small to be used as reference categories. In these cases, the group with the lowest incidence of labour complications was selected instead.

Table 7.4: Characteristics of a reference pregnancy for perinatal mortality models

Explanatory variable	Reference category	Explanatory variable	Reference category
Intended place of birth at end of pregnancy	Hospital	Conditions making up antenatal risk status	No for each
Year of birth	2000	Gestation >41 weeks?	No
Month of birth	Mar-Dec	Number of ultrasound scans	1-4
Time of birth	08:00-19:59	Sex of baby	Female
Hospital providing care	Watford	Birthweight	2500+g
Late booker?	No	Individual labour complications	No for each

7.8 Statistical modelling: results

Tables 7.5, 7.6 and 7.8 show the logs odds, standard errors, relative risks and 95% confidence intervals for the relative risks, for three versions of the models with perinatal death as the outcome. As explained in Section 7.7.3, three versions are shown because there are indications that there are some situations in which the overall pattern of there being no significant difference in the risk of perinatal death between those who intended a home birth and those who had a planned hospital

birth may not apply. These situations are (1) if the baby needed resuscitation after delivery and (2) if the foetus was malpresented[60].

The results for all three versions of the model are shown consecutively, and a description and discussion of the results follows. The relative risk is interpreted as the number of times by which a baby in that category was more or less likely to die in comparison with a 'reference baby', assuming all other covariates were the same. A relative risk greater than 1 indicates a higher likelihood of death in comparison to the reference group, and a relative risk of less than 1 indicates a lower likelihood.

Although some of the relative risks are large, it is important to bear in mind that the absolute risk of death was extremely small. Just 0.27%, or 1 in 370, of the eligible SMMIS records ended in perinatal death. A relative risk of 2 would therefore mean the risk going up to 1 in 185.

Model containing no interactions

Table 7.5: Results of model with perinatal death as the outcome and containing no interactions

	Log odds	Standard error	p-value of log odds	Relative risk	95% confidence interval for relative risk	
Intended place of birth (reference = hospital)						
Home	0.4502	0.2964	-	1.57	0.88	2.80
Year of delivery (reference = 2000)						
1988	0.7643	0.1632	***	2.15	1.56	2.95
1989	0.7210	0.1629	***	2.06	1.49	2.83
1990	0.5464	0.1662	***	1.73	1.25	2.39
1991	0.6954	0.1602	***	2.00	1.46	2.74
1992	0.5461	0.1645	***	1.73	1.25	2.38
1993	0.5350	0.1643	***	1.71	1.24	2.35
1994	0.6032	0.1622	***	1.83	1.33	2.51
1995	0.5561	0.1626	***	1.74	1.27	2.40
1996	0.2320	0.1723	-	1.26	0.90	1.77
1997	0.4654	0.1646	***	1.59	1.15	2.20
1998	0.0811	0.1751	-	1.08	0.77	1.53
1999	-0.0123	0.1766	-	0.99	0.70	1.40
Month of delivery reference = March-December)						
January	0.1942	0.0981	**	1.21	1.00	1.47
February	0.2560	0.1028	**	1.29	1.06	1.58

[60] The same was true of cord presentation/prolapse in labour, but this model is not shown because there was only one perinatal death after this complication in the 'intended a home birth' group, so the confidence interval around the results is extremely wide.

Table 7.5 (cont'd): Results of model with perinatal death as the outcome and containing no interactions

	Log odds	Standard error	p-value of log odds	Relative risk	95% confidence interval for relative risk	
Time of delivery (reference = 08:00-19:59)						
00:00-01:59	0.4415	0.1005	***	1.55	1.28	1.89
02:00-03:59	0.1232	0.1171	-	1.13	0.90	1.42
04:00-05:59	0.2921	0.1097	***	1.34	1.08	1.66
06:00-07:59	0.2433	0.1184	**	1.28	1.01	1.61
20:00-21:59	0.2511	0.1023	**	1.29	1.05	1.57
22:00-23:59	0.2064	0.1047	**	1.23	1.00	1.51
Hospital providing care (reference = Watford)						
Ashford	0.2843	0.2564	-	1.33	0.80	2.20
Bedford	0.4727	0.1911	**	1.60	1.10	2.33
Central Middlesex	0.4181	0.2100	**	1.52	1.01	2.29
Chelsea & Westminster	0.1993	0.1725	-	1.22	0.87	1.71
Ealing	-0.0836	0.2309	-	0.92	0.58	1.45
Edgware	0.3816	0.1742	**	1.46	1.04	2.06
Hemel Hempstead	0.5453	0.1877	***	1.72	1.19	2.49
Hillingdon	0.6082	0.1678	***	1.84	1.32	2.55
Luton & Dunstable	0.2920	0.1652	*	1.34	0.97	1.85
Northwick Park	0.3525	0.1661	**	1.42	1.03	1.97
St Mary's	0.2643	0.1711	-	1.30	0.93	1.82
Stevenage	0.2400	0.1920	-	1.27	0.87	1.85
Welwyn Garden City	0.4505	0.1893	**	1.57	1.08	2.27
West Middlesex	0.3257	0.1958	*	1.38	0.94	2.03
Late booker? (reference = no)						
Yes	0.3009	0.0804	***	1.35	1.15	1.58
Missing	0.2332	0.0877	***	1.26	1.06	1.50
Suspected congenital abnormality? (reference = no)						
Yes	2.2669	0.0840	***	9.63	8.18	11.34
Oligo/polyhydramnios? (reference = no)						
Yes	1.3344	0.2786	***	3.80	2.20	6.54
Weeks of gestation (reference = 37-41)						
<37	1.0585	0.1160	***	2.88	2.30	3.61
>41	0.5888	0.1725	***	1.80	1.28	2.53
Placental abruption? (reference = no)						
Yes	0.8670	0.1369	***	2.38	1.82	3.11
Malpresentation diagnosed before labour? (reference = no)						
Yes	0.7101	0.0714	***	2.03	1.77	2.34

Table 7.5 (cont'd): Results of model with perinatal death as the outcome and containing no interactions

	Log odds	Standard error	p-value of log odds	Relative risk	95% confidence interval for relative risk	
Gestational hypertension/pre-eclampsia? (reference = no)						
Borderline	0.4744	0.3409	-	1.61	0.82	3.13
Yes	-0.6434	0.1016	***	0.53	0.43	0.64
Recurrent antepartum haemorrhage? (reference = no)						
Yes	0.4443	0.1495	***	1.56	1.16	2.09
Previous stillbirth/neonatal death? (reference = no)						
Yes	0.3994	0.1414	***	1.49	1.13	1.97
BMI (reference = <30)						
30-34	0.3733	0.1176	***	1.45	1.15	1.83
35+	0.0066	0.0725	-	1.01	0.87	1.16
Multiple pregnancy? (reference = no)						
Yes	-0.3053	0.0973	***	0.74	0.61	0.89
Small for dates? (reference = no)						
Yes	-0.6304	0.2825	**	0.53	0.31	0.93
Number of ultrasound scans (reference = 1-4)						
0	0.2695	0.1632	*	1.31	0.95	1.80
>4	-0.3382	0.1089	***	0.71	0.58	0.88
Missing	0.6301	0.1477	***	1.88	1.41	2.51
Birthweight (reference = 2500+g)						
500g-1499g	3.7776	0.1284	***	43.30	33.82	55.22
1500g-2499g	1.3490	0.1160	***	3.85	3.07	4.83
Sex of baby (reference = girl)						
Boy	0.2156	0.0587	***	1.24	1.11	1.39
Indeterminate	2.8756	0.4745	***	17.67	6.99	44.31
Constant	-8.4104	0.2012	***	n/a	n/a	n/a

*** p<0.01 / ** p<0.05 / * p<0.1

In the unadjusted data, those who intended a hospital birth were slightly (but not significantly) more likely to experience perinatal death than those who intended a home birth. Table 7.5 shows that, after adjustment for the other model covariates, the opposite pattern applied, i.e. those who intended a home birth were slightly (but not significantly) more likely to experience perinatal death than those who intended a hospital birth. This was due to low-birthweight babies being born in hospital in disproportionately high numbers; low-birthweight babies made up the majority (67%) of stillbirths/neonatal deaths, and the mothers of low birthweight babies were much less likely to

intend a home birth than mothers of babies weighing 2500g or more (0.2% did, compared with 1.4% overall).

The finding that the risk of perinatal death is not significantly different for those who intended a home birth compared with those who intended a hospital birth echoes that of most previous studies in developed countries (see Section 2.4.2), but it is striking that most of those previous studies focused solely on low-risk pregnancies, whereas this study found the same result despite including high-risk pregnancies (11% of planned home maternities in SMMIS would have been classed as 'high-risk' according to the current NICE guideline) and excluding lethal congenital abnormalities and extremely low birthweight babies, which will have been mainly born in hospital.

This result indicates that, at the population level, planning a home birth is not associated with a significantly higher risk of perinatal death than planning a hospital birth. However, the question 'what if something goes wrong?' is not answered satisfactorily by the model described above. As noted in Section 7.7.3, there are a few situations in which the safety of planned home birth is called into question: (1) if the baby needs resuscitation, (2) if the baby is malpresented and (3) if there is umbilical cord prolapse in labour. The results pertaining to these situations are set out below.

As can be seen in Table 7.5, three 'high-risk' conditions were associated with a significantly *lower* risk of perinatal death: gestational hypertension/pre-eclampsia, multiple pregnancy and being 'small for dates'. In the observed data, these conditions were associated with a relatively high risk of perinatal death. The change is due to all three conditions being confounded with birthweight (and in the case of gestational hypertension/pre-eclampsia with preterm labour); once birthweight was held constant, the relative risk fell below zero. Therefore, their association with perinatal death was through their association with low birthweight/preterm labour rather than being associated with perinatal death in their own right.

Model containing the interaction between intended place of birth and infant resuscitation

Table 7.6: Results of model with perinatal death as the outcome and containing the interaction between infant resuscitation and intended place of birth

	Log odds	Standard error	p-value of log odds	Relative risk	95% confidence interval for relative risk	
Intended place of birth main effect (reference = hospital)						
Home	0.0681	0.3839	-	1.07	0.50	2.27
Infant resuscitation main effect (reference = no)						
Yes	0.4952	0.0711	***	1.64	1.43	1.89
Intended place of birth * resuscitation interaction effect						
Home * resuscitation	1.8439	0.6118	***	11.08	1.37	87.33

Table 7.6 (cont'd): Results of model with perinatal death as the outcome and containing the interaction between infant resuscitation and intended place of birth

	Log odds	Standard error	p-value of log odds	Relative risk	95% confidence interval for relative risk	
Year of delivery (reference = 2000)						
1988	0.7200	0.1634	***	2.05	1.49	2.83
1989	0.6959	0.1629	***	2.01	1.46	2.76
1990	0.5153	0.1664	***	1.67	1.21	2.32
1991	0.6701	0.1603	***	1.95	1.43	2.67
1992	0.5013	0.1648	***	1.65	1.20	2.28
1993	0.5142	0.1643	***	1.67	1.21	2.31
1994	0.5800	0.1624	***	1.79	1.30	2.45
1995	0.5362	0.1627	***	1.71	1.24	2.35
1996	0.2148	0.1725	-	1.24	0.88	1.74
1997	0.4626	0.1647	***	1.59	1.15	2.19
1998	0.0771	0.1752	-	1.08	0.77	1.52
1999	-0.0151	0.1769	-	0.99	0.70	1.39
Month of delivery (reference = March – December)						
January	0.1932	0.0982	**	1.21	1.00	1.47
February	0.2556	0.1029	**	1.29	1.06	1.58
Time of delivery (reference = 08:00-19:59)						
00:00-01:59	0.4475	0.1005	***	1.56	1.28	1.90
02:00-03:59	0.1137	0.1175	-	1.12	0.89	1.41
04:00-05:59	0.2951	0.1096	***	1.34	1.08	1.66
06:00-07:59	0.2518	0.1183	**	1.29	1.02	1.62
20:00-21:59	0.2479	0.1023	**	1.28	1.05	1.57
22:00-23:59	0.2094	0.1048	**	1.23	1.00	1.51
Hospital providing care (reference = Watford)						
Ashford	0.3040	0.2567	-	1.36	0.82	2.24
Bedford	0.5041	0.1906	***	1.66	1.14	2.40
Central Middlesex	0.4077	0.2097	*	1.50	1.00	2.27
Chelsea & Westminster	0.1664	0.1723	-	1.18	0.84	1.66
Ealing	-0.1017	0.2309	-	0.90	0.57	1.42
Edgware	0.3656	0.1738	**	1.44	1.03	2.03
Hemel Hempstead	0.5324	0.1874	***	1.70	1.18	2.46
Hillingdon	0.5943	0.1676	***	1.81	1.30	2.51
Luton & Dunstable	0.2932	0.1649	*	1.34	0.97	1.85
Northwick Park	0.3316	0.1659	**	1.39	1.01	1.93
St Mary's	0.2263	0.1709	-	1.25	0.90	1.75
Stevenage	0.2397	0.1916	-	1.27	0.87	1.85
Welwyn Garden City	0.4243	0.1891	**	1.53	1.06	2.21
West Middlesex	0.3255	0.1954	*	1.38	0.94	2.03
Late booker? (reference = no)						
Yes	0.2948	0.0804	***	1.34	1.15	1.57
Missing	0.2330	0.0877	***	1.26	1.06	1.50
Suspected congenital abnormality? (reference = no)						
Yes	2.2807	0.0836	***	9.76	8.30	11.49

Table 7.6 (cont'd): Results of model with perinatal death as the outcome and containing the interaction between infant resuscitation and intended place of birth

	Log odds	Standard error	p-value of log odds	Relative risk	95% confidence interval for relative risk	
Oligo/polyhydramnios? (reference = no)						
Yes	1.3101	0.2781	***	3.70	2.15	6.38
Weeks of gestation (reference = 37-41)						
<37	0.9960	0.1170	***	2.71	2.15	3.40
>41	0.5548	0.1726	***	1.74	1.24	2.44
Placental abruption? (reference = no)						
Yes	0.8427	0.1363	***	2.32	1.78	3.03
Malpresentation diagnosed before labour? (reference = no)						
Yes	0.6527	0.0715	***	1.92	1.67	2.21
Gestational hypertension/pre-eclampsia? (reference = no)						
Borderline	0.4467	0.3411	-	1.56	0.80	3.05
Yes	-0.6345	0.1014	***	0.53	0.43	0.65
Recurrent antepartum haemorrhage? (reference = no)						
Yes	0.4222	0.1493	***	1.53	1.14	2.04
Previous stillbirth/neonatal death? (reference = no)						
Yes	0.3931	0.1417	***	1.48	1.12	1.96
BMI (reference = <30)						
30-34	0.3574	0.1177	***	1.43	1.14	1.80
35+	0.0010	0.0725	-	1.00	0.87	1.15
Multiple pregnancy? (reference = no)						
Yes	-0.2855	0.0972	***	0.75	0.62	0.91
Small for dates? (reference = no)						
Yes	-0.5552	0.2812	**	0.57	0.33	1.00
Number of ultrasound scans (reference = 1-4)						
0	0.2562	0.1633	-	1.29	0.94	1.78
>4	-0.3331	0.1090	***	0.72	0.58	0.89
Missing	0.6081	0.1477	***	1.84	1.38	2.45
Birthweight (reference = 2500+g)						
500g-1499g	3.5567	0.1325	***	34.79	26.93	44.79
1500g-2499g	1.2890	0.1168	***	3.63	2.89	4.56
Sex of baby (reference = girl)						
Boy	0.2061	0.0587	***	1.23	1.10	1.38
Indeterminate	2.8183	0.4718	***	16.69	6.64	41.66
Constant	-8.4287	0.2010	***	n/a	n/a	n/a

*** p<0.01 / ** p<0.05 / * p<0.1

When the other covariates were held constant, this model showed that, if the baby did not need to be resuscitated on delivery, there was no significant difference between those who intended a home birth and those who intended a hospital birth in terms of the risk of perinatal death. If, however, the baby did need resuscitation, the risk of death was higher if a home birth was attempted. Because there were so few deaths in the home birth group (n=12, of which just 5 occurred after resuscitation – see Table 7.7), we cannot accurately estimate the magnitude of the increased risk; the 95% confidence interval is very wide at 1.37 – 87.33.

Table 7.7 shows that, among those who needed positive pressure/cardiac massage (i.e. the most serious cases), about one in five babies died perinatally. This group included just three babies whose mothers intended a home birth; one who was born at home and two who were born after a transfer to hospital in labour. Among those who had any kind of resuscitation, there were just five cases of perinatal death among those who had intended a home birth (three born at home and two born in hospital). Out of these five deaths, three (60%) were cases requiring positive pressure/cardiac massage. By contrast, out of the 693 deaths among those who had a planned hospital birth and needed resuscitation, 111 (16%) were cases requiring positive pressure/cardiac massage. This suggests that it was the more serious cases which were responsible for the elevated risk among the 'intended a home birth' group. This theory is supported by the fact that the inclusion of the interaction between intended place of birth and positive pressure/cardiac massage resulted in by far the largest improvement to the model fit (see Table F.11 in Appendix F). However, there were not enough deaths in the 'intended a home birth' group who had positive pressure/cardiac massage to allow this interaction term to be included in the final model; the confidence interval around the relative risk calculation was too large (15.30 - 1,254.46). Furthermore, of the three deaths among those who intended a home birth and had positive pressure/cardiac massage, two were babies who were born in hospital and presumably had access to the same resuscitation skills as planned hospital births, which makes it impossible to judge whether or not the death was associated with the fact that a home birth was attempted.

Table 7.7: Number and percentage of cases involving resuscitation which ended in perinatal death, by place of birth

	Positive pressure/cardiac massage		Any resuscitation		No resuscitation	
	N	%	N	%	N	%
Planned home birth	1	20.00	3	1.70	4	0.07
Planned hospital birth	111	18.72	693	1.23	651	0.15
Transferred in labour	2	33.33	2	1.59	3	0.38
All	114	18.87	698	1.23	658	0.15

Model containing the interaction between intended place of birth and malpresentation

Table 7.8: Results of model with perinatal death as the outcome and containing the interaction between malpresentation and intended place of birth

	Log odds	Standard error	p-value of log odds	Relative risk	95% confidence interval for relative risk	
Intended place of birth main effect (reference = hospital)						
Home	0.2973	0.3236	-	1.35	0.71	2.54
Malpresentation main effect (reference = no)						
Yes	0.7019	0.0715	***	2.02	1.75	2.32
Intended place of birth * malpresentation interaction effect						
Intended home birth * malpresentation	1.8359	0.8000	**	16.97	1.64	167.49
Year of delivery (reference = 2000)						
1988	0.7627	0.1632	***	2.14	1.56	2.95
1989	0.7187	0.1629	***	2.05	1.49	2.82
1990	0.5451	0.1662	***	1.72	1.25	2.39
1991	0.6941	0.1602	***	2.00	1.46	2.74
1992	0.5434	0.1645	***	1.72	1.25	2.38
1993	0.5334	0.1642	***	1.70	1.24	2.35
1994	0.6018	0.1622	***	1.83	1.33	2.51
1995	0.5558	0.1626	***	1.74	1.27	2.40
1996	0.2304	0.1723	-	1.26	0.90	1.76
1997	0.4650	0.1645	***	1.59	1.15	2.20
1998	0.0808	0.1751	-	1.08	0.77	1.53
1999	-0.0118	0.1766	-	0.99	0.70	1.40
Month of delivery (reference = March – December)						
January	0.1933	0.0980	**	1.21	1.00	1.47
February	0.2567	0.1028	**	1.29	1.06	1.58
Time of delivery (reference = 08:00-19:59)						
00:00-01:59	0.4418	0.1005	***	1.56	1.28	1.89
02:00-03:59	0.1234	0.1171	-	1.13	0.90	1.42
04:00-05:59	0.2900	0.1097	***	1.34	1.08	1.66
06:00-07:59	0.2432	0.1184	**	1.28	1.01	1.61
20:00-21:59	0.2514	0.1023	**	1.29	1.05	1.57
22:00-23:59	0.2058	0.1047	**	1.23	1.00	1.51

Table 7.8 (cont'd): Results of model with perinatal death as the outcome and containing the interaction between malpresentation and intended place of birth

	Log odds	Standard error	p-value of log odds	Relative risk	95% confidence interval for relative risk	
Hospital providing care (reference = Watford)						
Ashford	0.2837	0.2564	-	1.33	0.80	2.19
Bedford	0.4724	0.1911	**	1.60	1.10	2.33
Central Middlesex	0.4194	0.2100	**	1.52	1.01	2.29
Chelsea & Westminster	0.1977	0.1725	-	1.22	0.87	1.71
Ealing	-0.0835	0.2309	-	0.92	0.59	1.45
Edgware	0.3808	0.1742	**	1.46	1.04	2.06
Hemel Hempstead	0.5438	0.1877	***	1.72	1.19	2.49
Hillingdon	0.6069	0.1678	***	1.83	1.32	2.55
Luton & Dunstable	0.2922	0.1652	*	1.34	0.97	1.85
Northwick Park	0.3517	0.1661	**	1.42	1.03	1.97
St Mary's	0.2638	0.1711	-	1.30	0.93	1.82
Stevenage	0.2387	0.1920	-	1.27	0.87	1.85
Welwyn Garden City	0.4510	0.1893	**	1.57	1.08	2.27
West Middlesex	0.3215	0.1959	-	1.38	0.94	2.02
Late booker? (reference = no)						
Yes	0.3006	0.0803	***	1.35	1.15	1.58
Missing	0.2336	0.0877	**	1.26	1.06	1.50
Suspected congenital abnormality? (reference = no)						
Yes	2.2647	0.0840	***	9.61	8.16	11.31
Oligo/polyhydramnios? (reference = no)						
Yes	1.3345	0.2786	***	3.80	2.20	6.54
Weeks of gestation (reference = 37-41)						
<37	1.0580	0.1159	***	2.88	2.29	3.61
>41	0.5864	0.1725	***	1.80	1.28	2.52
Placental abruption? (reference = no)						
Yes	0.8672	0.1369	***	2.38	1.82	3.11
Gestational hypertension/pre-eclampsia? (reference = no)						
Borderline	0.4726	0.3408	-	1.60	0.82	3.13
Yes	-0.6439	0.1016	***	0.53	0.43	0.64
Recurrent antepartum haemorrhage? (reference = no)						
Yes	0.4436	0.1495	***	1.56	1.16	2.09
Previous stillbirth/neonatal death? (reference = no)						
Yes	0.3968	0.1414	***	1.49	1.13	1.96
BMI (reference = <30)						
30-34	0.3740	0.1176	***	1.45	1.15	1.83
35+	0.0060	0.0725	-	1.01	0.87	1.16

Table 7.8 (cont'd): Results of model with perinatal death as the outcome and containing the interaction between malpresentation and intended place of birth

	Log odds	Standard error	p-value of log odds	Relative risk	95% confidence interval for relative risk	
Multiple pregnancy? (reference = no)						
Yes	-0.3043	0.0973	***	0.74	0.61	0.89
Small for dates? (reference = no)						
Yes	-0.6291	0.2824	**	0.53	0.31	0.93
Number of ultrasound scans (reference = 1-4)						
0	0.2715	0.1632	*	1.31	0.95	1.81
>4	-0.3393	0.1089	***	0.71	0.58	0.88
Missing	0.6292	0.1476	***	1.88	1.40	2.50
Birthweight (reference = 2500+g)						
500g-1499g	3.7815	0.1284	***	43.46	33.95	55.42
1500g-2499g	1.3512	0.1160	***	3.86	3.08	4.84
Sex of baby (reference = girl)						
Boy	0.2160	0.0587	***	1.24	1.11	1.39
Indeterminate	2.8792	0.4749	***	17.73	7.01	44.50
Constant	-8.4072	0.2011	***	n/a	n/a	n/a

*** p<0.01 / ** p<0.05 / * p<0.1

When the other covariates were held constant, this model showed that, if malpresentation had not been diagnosed before labour commenced, there was no significant difference between those who intended a home birth and those who intended a hospital birth in terms of the risk of perinatal death. If, however, malpresentation had been diagnosed, the risk of death was higher if a home birth was attempted. Because there were so few deaths in the home birth group (n=12, of which just two occurred after a diagnosis of malpresentation), we cannot accurately estimate the magnitude of the increased risk; the 95% confidence interval is very wide at 1.64 – 167.49.

7.9 Summary and discussion

In the SMMIS dataset, just 0.27%, or 1 in 370, of the eligible records[61] ended in perinatal death. Since that time, the perinatal death rate has fallen steadily[62] (Agarwal, 2010), so the risk of death in the present day will be even smaller than this.

Numerous covariates were significantly associated with perinatal death, and as indicated by the exploratory analysis (Sections 7.3-7.6), the main predictors were very low birthweight, indeterminate sex[63] and congenital abnormalities[64]. Intended place of birth, on the other hand, was not significantly associated with perinatal death overall; the risk was 1.57 times higher if a home birth was intended than if it was a planned hospital birth, but the 95% confidence interval was 0.88-2.80, making the difference non-significant at the 95% level.

Several pregnancy and labour complications were associated with perinatal death. For most of them there were no perinatal deaths in the 'intended a home birth' group, so we do not know whether or not these complications are more likely to be associated with perinatal death if a home birth is intended than if a hospital birth is intended. Three labour complications (foetal distress, failure to progress in stage 2 of labour and retained placenta) were associated with a higher risk of perinatal death overall, but this was true regardless of the intended place of birth.

However, in three situations (malpresentation, cord presentation/prolapse and infant resuscitation) there is some indication that perinatal death may be more likely if a home birth is attempted than if there is a planned hospital birth. Because of the small number of perinatal deaths after an attempt at a home birth, it is impossible to estimate accurately the magnitude of the increased risk in these three situations. It could be extremely small (e.g. a relative risk of 1.6 would raise the risk of perinatal death from 1 in 370 to 1 in 240 – i.e. still extremely unlikely to happen) or it could be extremely large (e.g. a relative risk of 85.8 would raise the risk from 1 in 370 to 1 in 4 – i.e. quite likely to happen). Despite SMMIS containing details of over half a million maternities, there are simply not enough perinatal deaths involving these situations in the 'intended a home birth' group for us to be sure of the size of the increased risk.

---

[61] Unplanned home births, antepartum stillbirths, lethal congenital anomalies, birthweight <500g, gestation <22 weeks and cases in which the intended place of birth was unknown were excluded.

[62] In 2009 the perinatal death rate was 7.5 per thousand live births, but these figures included the groups excluded from this analysis (see previous footnote).

[63] It is impossible to tell whether the sex was simply not recorded, or whether it was not possible to determine the sex due to deformity. Of the 75 cases recorded as being of indeterminate sex, just 12 had an ICD code for indeterminate sex as a congenital abnormality, 36 were stillborn and 10 were perinatal deaths.

[64] Low birthweight and congenital abnormalities continue to be major contributors to the perinatal mortality rate in England and Wales (Agarwal, 2010). To some extent, low birthweight and congenital abnormalities are predictable before the onset of labour, but as things currently stand, methods of predicting these two outcomes are far from 100% reliable. However, in many cases they will be predicted, and it is reasonable to suppose that, when they are predicted, women tend to be advised to plan a hospital birth. If so, low birthweight and congenital abnormalities will be endogenous to intended place of birth.

The vast majority of previous research on this subject has made the assumption that only women with 'low-risk' pregnancies should attempt a home birth, without attempting to provide evidence that outcomes of 'high-risk' pregnancies are better if a hospital delivery is planned. This analysis provides no support for this assumption, except in cases of malpresentation. Unfortunately, however, neither cord presentation/prolapse nor infant resuscitation is possible to predict with any certainty before labour commences (e.g. Ezra et al, 2003). It is likely that 'high-risk' pregnancies are more likely to experience these complications than 'low-risk' pregnancies, in which case it could be argued that current advice regarding place of birth should still stand.

On the other hand, cord presentation/prolapse is extremely rare (it was recorded in just 0.19% of eligible SMMIS cases and just 0.06% of those who intended a home birth). Murphy and MacKenzie (1995) noted that most deaths in cases of cord prolapse were attributable to congenital abnormalities and prematurity than to birth asphyxia, indicating that a death following cord prolapse cannot be assumed to be associated with the birth setting. The one perinatal death following cord prolapse in the 'intended a home birth' group in SMMIS did not have a congenital abnormality and was not premature, so it was likely to have been a case of birth asphyxia. However, because there was only one case in this group, it was not possible to model perinatal death whilst including the interaction between cord prolapse and intended place of birth as a covariate. We therefore are unable to investigate whether the higher risk of perinatal death after cord prolapse in the 'intended a home birth' group still stood if the other observed covariates were held constant. Furthermore, it would be unwise to draw firm conclusions on the basis of a single case.

Infant resuscitation is more common than cord prolapse; it was recorded in 11.1% of SMMIS cases and therefore has the potential to affect a lot of babies. The 95% confidence interval around the relative risk of perinatal death if a home birth was attempted and the baby needed resuscitation was extremely wide (1.37-87.33). If the relative risk is at the lower end of this range, it is not much different from the risk if a hospital birth was intended and the baby needed resuscitation. If it is at the higher end of this range, home birth could reasonably be described as less safe for babies than hospital birth. As noted in Section 7.8, however, there are indications that only the more 'serious' infant resuscitation cases (i.e. those requiring positive pressure/cardiac massage which represented 0.12% of the total) were at higher risk of perinatal death if a home birth had been attempted. Given that two of the three deaths after positive pressure/cardiac massage in the 'intended a home birth' group were babies who were born in hospital after intrapartum transfer from home, questions remain over whether the higher risk of perinatal death in the home birth group had anything to do with the fact that a home birth was attempted.

7.10 Chapter 7 key points

This chapter makes a novel contribution to existing knowledge in three main ways:

1. Through the use of multivariate modelling techniques and application of the knowledge gained in Chapter 4 of this thesis, it makes a very good attempt to control for selection effects. Few, if any, previous studies have been able to control for such a large number of potential confounders.

2. This study includes high-risk pregnancies, whereas the norm is to restrict such analyses to low-risk pregnancies. In all developed countries which have a policy on place of birth, hospital birth is deemed to be safer than home birth for high-risk pregnancies, yet this assumption appears not to be based on solid research evidence. In most developed countries all – or nearly all – high-risk pregnancies have planned hospital births, so in those countries it would not be possible to include high-risk pregnancies in a comparison of the safety of different birth settings. However, 11% of the planned home births in the SMMIS dataset were to women who would have been classed as 'high-risk' in the present day, which means this study is able to consider the safety of home birth for high-risk as well as low-risk pregnancies.

3. Through the use of interaction terms, the thesis is able to address the question: "is home birth safe when there are unforeseen complications?" This question represents the central objection to planned home birth as a safe option, yet it has not been directly addressed in any of the previous quantitative comparisons of the relative risk of perinatal mortality by birth setting.

The key messages of this chapter are as follows:

- If the foetus is not malpresented, there is no cord prolapse in labour and no need for infant resuscitation on delivery, the risk of perinatal death is not significantly different whether a home birth or a hospital birth is intended.

- If, however, one or more of these complications does arise, there is weak evidence to indicate that the risk of perinatal death is higher if a home birth is intended than if a hospital birth is intended. The number of cases of death in the 'intended a home birth' group was, however, too small to permit an accurate estimate of the magnitude of the increased risk.

- Malpresentation is detectable before the commencement of labour, so there is an argument for women with malpresented foetuses being advised to plan a hospital birth for the safety of the baby and/or for midwives being trained to deliver malpresented foetuses vaginally. Cord prolapse and infant resuscitation, tend not to be predictable in advance of labour, indicating that midwives attending planned home births should be fully competent to deal with these types of emergency.

8 Discussion and conclusions

8.1 Summary of key findings and implications

Who plans/has a home birth?

The analysis of the types of women who plan/have a home birth found that key variables robustly predict: a woman's intended place of birth at booking, her propensity to change intention during pregnancy, and her chances of achieving a planned home birth. Most of these key predictors have also been identified by previous research in the UK and other countries, e.g. parity (first-time mothers tend not to plan a home birth), age (those who intend a home birth tend to be older), pregnancy risk status (higher-risk women tend not to plan a home birth) and ethnic group (certain minority ethnic groups tend not to plan a home birth). It will be important for future research which seeks to compare pregnancy outcomes for home births with those for hospital births, to control for these key predictors.

In addition to the individual-level predictors, the hospital which provides maternity care predicts: intended place of birth, a change in intention during pregnancy, and the achievement of a planned home birth. This holds true even when variations in a hospital's casemix are held constant. Whilst we cannot infer from this analysis that the policies and practices of individual hospitals influence women's choices about place of birth, the possibility that they do cannot be discounted. This presents a challenge for the research community, to find out if hospital policies/protocols or individual members of staff do influence the choices that women make, and if so, in what ways. If it is the case that not all women have access to free and informed choice, this presents a challenge for maternity service management, to design a maternity care service which fosters and encourages free and informed choice for all.

To date, very little quantitative analysis to describe the types of women who plan and have a home birth has been done, and none has been published in the UK since Chamberlain et al in 1997. Of the quantitative analysis that has been done using UK data, none has ever attempted to use a multivariate method to control for confounding. Thus, the analysis described in Chapter 4 of this thesis makes a novel contribution to what was previously known. Furthermore, these analyses use a pathway as a framework for understanding the types of women who plan and have a home birth, in recognition of the fact that decisions about place of birth can be made over a period of time, particularly if circumstances change during the pregnancy.

The safety of planned home birth

From the perspective of the pregnant woman, in most cases planned home birth can be considered to be safer than planned hospital birth. More specifically:

- Even after adjustment for characteristics such as pregnancy risk status and parity, intending a hospital birth was associated with a 2.5-times higher risk of PPH (loss of >1000ml of blood), compared with intending a home birth. It is possible that part of this difference can be explained by the fact that the model did not control for previous PPH, which is known to be a strong predictor of PPH in the current pregnancy, and which would be likely to lead a woman to choose hospital birth in subsequent pregnancies. However, PPH is a rare event, so it is unlikely that this omission is fully responsible for the large difference between home and hospital birth.
- Similarly, compared with intending a home birth, intending a hospital birth is associated with approximately double the risk of: pyrexia in labour, failure to progress in stage 2 of labour, and retained placenta, even when potential confounders are held constant. There is no obvious reason to suppose that these complications were more likely to be recorded in hospital than at home.
- If the mother does not have asthma and the foetus is not malpresented, the risk of foetal distress in labour (as measured by abnormal foetal heart rate and/or meconium-stained liquor) is also significantly higher if a hospital birth is intended than if a home birth is intended. However, given that foetal heart rate monitoring is more common in hospital than at home, it is possible that all or some of this difference is due to an abnormal heart rate being more likely to be noticed in hospital than at home.

The implications of these results are that the onus is on hospitals to defend their safety record from the point of view of pregnant women. It is possible that some of the heightened risk of labour complications is due to differences in practices between home and hospital (e.g. some labour complications might be more likely to be noticed/recorded in the hospital setting), or there may be other unobserved variables which explain some or all of the difference. Further research is required to ascertain this. If it confirms that there is something about hospital practices and protocols which increases the risk of labour complications, the challenge for the NHS is to make changes to these practices and protocols so that women are not subjected to avoidable complications.

From the perspective of the baby, the comparison of the safety of planned home birth and planned hospital birth is less clear-cut. If the foetus is not malpresented, there is no cord prolapse in labour and no need for infant resuscitation on delivery, the risk of perinatal death is slightly (but not significantly) higher if a home birth is intended than if there is a planned hospital birth. If, however, one or more of these complications does arise, there is weak evidence to indicate that the risk of perinatal death is significantly higher if a home birth is intended than if a hospital birth is intended. The number of cases of death in the 'intended a home birth' group was, however, too small to permit an accurate estimate of the magnitude of the increased risk.

Malpresentation is detectable before the commencement of labour, so there is an argument for women with malpresented foetuses being advised to plan a hospital birth for the safety of the baby

and/or for midwives being trained to deliver malpresented foetuses vaginally. Cord prolapse and infant resuscitation, on the other hand, tend not to be predictable in advance of labour. Given this, it could be argued that all women should be advised to plan a hospital birth just in case these complications arise. However, because these two complications are relative uncommon and home birth is associated with a more positive birth experience for the mother, perhaps are more reasonable response would be to ensure that midwives attending planned home births are fully competent to deal with these types of emergency. If all midwives were fully competent to deal with these situations, it may be that the heightened risk associated with planning a home birth would cease to exist.

The 'safety' analysis makes a novel contribution to existing knowledge in five main ways:

1. Through the use of multivariate modelling techniques and application of the knowledge gained in Chapter 4 of this thesis, it makes a very good attempt to control for selection effects. Few, if any, previous studies of the safety of home birth have been able to control for such a large number of potential confounders.
2. The question of safety is considered from the perspective of the mother as well as the baby; the majority of existing published research considers the question solely from the perspective of the baby.
3. The large number of observations in the dataset used for the statistical modelling has permitted the modelling of a number of relatively rare outcomes, e.g. postpartum haemorrhage (PPH) and perinatal death, rather than having to use composite measures of negative pregnancy outcomes, which are controversial.
4. This study includes high-risk pregnancies, whereas the norm is to restrict such analyses to low-risk pregnancies. In all developed countries which have a policy on place of birth, hospital birth is deemed to be safer than home birth for high-risk pregnancies, yet this assumption appears not to be based on solid research evidence. In most developed countries all – or nearly all – high-risk pregnancies have planned hospital births, so in those countries it would not be possible to include high-risk pregnancies in a comparison of the safety of different birth settings. However, 11% of the planned home births in the SMMIS dataset were to women who would have been classed as 'high-risk' in the present day, which means this study is able to consider the safety of home birth for high-risk as well as low-risk pregnancies.
5. Through the use of interaction terms, the thesis is able to address the question: "is home birth safe when there are unforeseen complications?" This question represents the central objection to planned home birth as a safe option, yet it has not been directly addressed in any of the previous quantitative comparisons of the relative risk of perinatal mortality by birth setting.

8.2 Discussion

Planned home birth can bring about considerable benefits to the labouring woman, because she may find it easier to relax in familiar surroundings and she is likely to feel more in control of her labour and delivery. Indeed, it has been Government policy in England and Wales since 1993 that pregnant women should be given an informed choice about where to give birth, with the caveat that women who are at higher risk of negative pregnancy outcomes due to pre-existing medical conditions or pregnancy complications should be advised to plan a hospital birth.

The fact that fewer than 3% of maternities in England and Wales take place at home (including unplanned home births) is an indication either that women are not routinely offered the option of a planned home birth, or that they do not want to give birth at home. The results of this and previous research suggest an element of both. Several studies quoted in Section 1.1 suggest that a significant minority of women are never offered the option of a home birth, and even among those who are, there is very often a perceived lack of the information required in order to make a sensible choice about place of birth. Studies also show that the majority of women would not consider a home birth because hospital birth is the norm, and they think it is intrinsically safer. However, this attitude appears not to be based on solid research evidence of the sort presented in this thesis. If this evidence was better understood, it is possible that more women would opt for home birth.

Study of the recent history of home birth in the UK (see Section 2.1.1) reveals that it is a highly emotive and political subject, involving power struggles, gender politics and workplace politics. Therefore, women's decisions about place of birth are made in a far-from-neutral environment, with their main sources of information (GPs, midwives and obstetricians) subject to professional, financial and political pressure from their colleagues and paymasters, which can be at odds with the concerns and preferences of the individual woman. Added to this is the problem that previous research looking at the comparative safety of home and hospital birth (see Section 2.4.2) has never satisfactorily addressed the main objection to home birth, i.e. that at the level of the individual pregnancy, it can be declared safe only after the event. The result is that decisions about place of birth tend to be made on the basis of subjective opinion, highly influenced by professions who have an interest in maintaining the *status quo*.

In such an environment, it is reasonable to speculate that certain types of women are more likely (a) to be aware that home birth is an option for them, and (b) to have the confidence and resources to argue for a home birth if that is what they want. Previous research did indeed show that older, middle-class women were more likely to have a planned home birth, but this type of analysis tells only part of the story. The analyses presented in Chapter 4 of this thesis were based on the theory that pregnant women and their partners may make the decision about place of birth over a period of time, and even if there is a definite decision early in pregnancy, this decision can be changed in response to circumstances that arise as pregnancy progresses, e.g. the development of obstetric risk

factors. In this thesis, we gain an understanding not only of the type of woman who decides in early pregnancy that she would like a home birth, but also the factors that are associated with a change in intention during the course of the pregnancy, and the factors associated with being transferred to hospital during labour after attempting a home birth.

Backing up the findings of earlier research, this study finds that women planning a home birth tend to be older, from relatively affluent areas, partnered and white. These are statistical associations only, so we can only speculate about whether these groups are more likely to want home birth in the first place, or are more likely to have the confidence and resources to fight for it. However, the fact that there are (or have been) some very deprived areas in the UK with unusually high planned home birth rates (e.g. Leap, 1996; Sandall et al, 2001a) suggests that the skew towards older, middle-class women having home birth is not solely due to their being more likely to want home birth.

Independently of all other observed characteristics, including pregnancy risk status, parity is a very important factor in the decision-making process, with first-time mothers tending not to express an intention to give birth at home, and first-time mothers who did express this intention being more likely to transfer to hospital-based care during either pregnancy or labour, *whether or not they developed pregnancy or labour complications*. This may be an indication that first-time mothers and their care-givers tended to lack confidence in their ability to give birth without medical assistance. The independent association between the hospital providing maternity care and a woman's propensity to plan a home birth may be an indication that some hospitals are more 'pro home birth' than others and/or that some midwifery teams are more confident/competent at handling home births than others, and that these factors influence women's decisions about place of birth.

The above research findings contribute in their own right to the debate about home birth, particularly in relation to the choice agenda (see Section 8.3.1), but they are also allow us to understand and control for many of the selection effects that have traditionally dogged the study of the relative safety of home birth. The main objection to planned home birth is that the woman and her baby are not close to emergency medical facilities, so if there are complications during labour or delivery, access to emergency medical care will be slower, with potentially tragic consequences. Accurate prediction of such complications is currently impossible, and is likely to remain so. Previous research has not addressed this central concern; it has tended to assess the *overall* safety of planned home birth at a population level, without satisfactorily addressing the question of whether there are specific situations in which planned home birth is riskier than planned hospital birth. This means that there are lingering doubts over whether home birth is as safe as hospital birth 'when things go wrong'.

From the perspective of the mother, this research suggests that that planned home birth may be associated with a lower risk of 'things going wrong' in the first place – if a hospital birth is intended,

the risk of foetal distress, failure to progress in labour, postpartum haemorrhage, pyrexia or retained placenta is double the risk if a home birth is intended, even after adjustment for factors such as pregnancy risk status, parity and social deprivation. There are three exceptions to this general rule:

- If the mother has asthma, the baby is just as likely to become distressed in labour whether she intends a home birth or a hospital birth.
- If malpresentation has been diagnosed before labour commences, foetal distress is more likely to occur if a home birth is attempted than if there is a planned hospital birth.
- If the woman is having her first baby, she is more likely to be diagnosed with failure to progress in stage 1 of labour if she attempts a home birth than if she intends a hospital birth.

However, in cases of foetal distress or failure to progress in stage 1 of labour, perinatal death is no more likely to occur if a home birth is intended than if a hospital birth is intended, so even if these complications do arise, there is no evidence to indicate that the baby will be less likely to die if a hospital birth is planned.

These results suggest that there are questions to be answered by hospitals about why the risk of labour complications and the potentially life-threatening postpartum haemorrhage is so much higher for planned hospital births, even after adjustment for the differing characteristics of those intending home birth and those intending a hospital birth. Given that infant mortality rates in the UK are so low, women are not always satisfied simply for them and their babies to have lived through the process of childbirth; there is increasing demand for the experience to be a positive one from other perspectives.

From the perspective of the baby, the overall risk of perinatal death is slightly, but not significantly, higher among those who intended a home birth than those who intended a hospital birth. Previous research has found no significant difference among low-risk pregnancies (see Section 2.4.2). The analysis presented in this thesis includes high-risk pregnancies as well, yet draws the same conclusion.

Looking specifically at complications of pregnancy and labour (i.e. when 'things go wrong'), whilst this study shows that most such complications are associated with a higher risk of perinatal death, there is no evidence from this research to indicate that perinatal death is more likely if a home birth is attempted than if there is a planned hospital birth, with three exceptions: (1) malpresentation of the foetus, (2) cord presentation/prolapse during labour and (3) infant resuscitation. In these three situations, there is weak evidence to suggest that perinatal death is more likely if the mother intended a home birth than if she had a planned hospital birth. Unfortunately, even though the SMMIS database contained over half a million records, the small number of perinatal deaths in the

'intended a home birth' group (n=12) makes it impossible to estimate the magnitude of the increased risk of perinatal death in these three situations with any confidence.

This makes it difficult to give individual pregnant women actionable, relevant information about their risk of a negative pregnancy outcome if they make particular decisions about place of birth. Malpresentation was the most common of the three conditions under which home birth may be less safe than hospital birth; incidence in SMMIS was 5.4%[65]. On the basis of this research, there is a reasonable argument for cases of malpresentation being advised to plan a hospital birth, although some would argue that an equally reasonable response would be to give midwives better training and experience in delivering breech babies vaginally (see Section 8.3.1).

Unlike malpresentation, however, cord prolapse and infant resuscitation cannot be predicted reliably in individual cases, which brings us back to the argument that home birth is only safe if these things do not happen, i.e. at the individual level, it can only be declared safe in retrospect. The question is: does this mean that all women should be advised to plan a hospital birth 'just in case'?

Cord prolapse is a rare complication, with incidence estimated at 0.1%-0.6% of pregnancies, and over 1% of breech presentations[66] (Siassakos et al, 2008), i.e. between 700 and 4,000 cases would be expected per year in England and Wales. In SMMIS, cord prolapse was recorded in 0.2% of the cases eligible for inclusion in the modelling of perinatal death. The Royal College of Obstetricians and Gynaecologists takes the view that perinatal death in cases of cord prolapse "has been described with normally formed babies, particularly with planned home birth" (Siassakos et al, 2008), but does not provide compelling evidence that the risk of death is higher for planned home births than for planned hospital births. As noted in Section 7.9, the small number of deaths after cord prolapse in SMMIS prevents the investigation of whether the higher risk of perinatal death after cord prolapse in the 'intended a home birth' group still stood if prematurity and congenital abnormalities – which are known to be associated with cord prolapse (Murphy & MacKenzie, 1995) - were held constant.

Infant resuscitation is more common than cord prolapse (11.1% of SMMIS cases were recorded as having had any type of resuscitation), but the more serious cases involving positive pressure/cardiac massage made up a smaller proportion at 0.1%. As noted in Section 7.8, it is highly likely that these more serious cases were responsible for the risk of perinatal death after resuscitation being higher if a home birth was planned than if a hospital birth was planned, so it is appropriate to focus on these cases. Once again the small number of deaths following positive pressure/cardiac massage in the 'intended a home birth' group and the fact that most of the cases in the 'intended a home birth'

[65] The incidence of breech presentation at term (the most common form of malpresentation) is estimated to be 3-4% (Hofmeyr & Impey, 2006), which indicates that the recording of incidence of malpresentation in SMMIS was broadly accurate.
[66] This could be considered as further evidence in support of cases of malpresentation being advised to plan a hospital birth.

group were babies born in hospital (see Section 7.8) means that we cannot have full confidence in the finding that planned home birth was associated with a higher risk of perinatal death if the baby needed resuscitation.

If we accept the weak evidence of a higher risk of perinatal death if a home birth is attempted and the baby needs resuscitation, in order to state that home birth is intrinsically more risky than hospital birth, we would have to assume all midwives who attended the home births in the SMMIS database were fully qualified to carry out infant resuscitation. There is, however, reason to doubt that this was the case. Although regular resuscitation training for midwives has been considered 'best practice' for many years, Gnanalingham et al (2001) found that it was not compulsory for all midwives in the UK, and that even in maternity units where it was compulsory, the training programmes had been in existence for a mean of less than four years. Furthermore, two-thirds of the units with resuscitation training programmes had set no standards of achievement from the training, which calls into question its effectiveness. Since 2003, under the Clinical Negligence Scheme for Trusts (CNST), there has been an incentive for NHS Trusts to ensure that midwives are able to perform neonatal resuscitation; Trusts that adhere to this requirement are eligible for a significant discount in their insurance premiums (Bush & Arulkumaran, 2006). However, a national review of maternity services in 2007 found that there was much room for improvement in core skills training; just 15 out of 148 NHS Trusts ensured that all midwives were trained in all four core areas (cardiotocography, adult resuscitation, neonatal resuscitation and obstetric 'skills and drills'). A snapshot of eight NHS Trusts in the former North Thames RHA area revealed scores ranging from 51% to 89% (Care Quality Commission, 2008).

Singh et al (2006) and Draycott et al (2006) found that training in neonatal resuscitation brought about positive results, which indicates that the resuscitation skills of clinicians attending births are an important factor in the outcome. Aubrey and Yoxall (2001) found that resuscitation teams led by trained "advanced neonatal nurse practitioners" achieved excellent outcomes in comparison to resuscitation teams led by medical doctors, which led them to conclude that infant resuscitation skills "are not the exclusive domain of doctors".

If neonatal resuscitation skills among midwives in the North West Thames region in 1988-2000 were not as good as they could have been, then the relatively high perinatal mortality among those who needed infant resuscitation after attempting a home birth may have been due to this rather than to the home environment *per se* being less safe than the hospital environment. The UK Resuscitation Council produces guidance on best practice in neonatal resuscitation (Richmond & Wyllie, 2010), and none of the techniques described require specialist equipment that is available only in hospitals. CNST has probably brought about better resuscitation skills among present-day midwives, so it cannot be assumed that the same pattern of results would appear if the analysis were to be repeated on current data. However, the Care Quality Commission data indicate that midwifery resuscitation skills training still left something to be desired even as recently as 2007.

8.3 Policy implications

8.3.1 Choice of birth setting

The analysis presented in this thesis provides clear support for the current Government policy in England and Wales, i.e. that women and their partners should be allowed to choose where they would like to give birth without being pressured in one direction or the other. Clinically, there is no need for this decision to be taken at the booking appointment, yet this seems to be the norm. There may be benefits to the pregnant woman and her partner in leaving this decision until later in pregnancy, and NHS Trusts should build in systems to allow preferences expressed at the beginning of pregnancy to be revisited before labour commences.

Given the lack of reliable research evidence about the safety of different birth settings in the UK, women – and particularly first-time mothers - are currently at the mercy of the subjective opinions of the medical profession, the media and their family and peers. If childbirth is presented as an inherently risky and frightening event that should be conducted in a clinical environment in order to be safe, any choice made by a woman will not be an informed one. To allow a truly informed choice, attention must be paid to the implicit and explicit messages that women receive from maternity services and other sources, so that women have a realistic idea of what labour is like and the level of risk it entails.

Furthermore, the evidence presented in this thesis may be an indication that some hospitals are more 'pro home birth' than others. Equality of access to choice will be achieved only if hospitals follow the same protocol in terms of encouraging and accepting women who show an interest in home birth. Some (e.g. Lavender & Chapple, 2004; Kirkham & Stapleton, 2004) argue that this is unlikely to be achieved within the current hierarchical structure of NHS maternity services, because midwives tend to be more 'pro home birth' than obstetricians, but are relatively lowly in the 'pecking order' (see Section 8.3.3).

The research presented in this thesis indicates that the principle of informed choice should be extended to all, and not restricted to those with uncomplicated pregnancies. There is very little evidence to suggest that 'high-risk' pregnancies are at higher risk of negative outcomes if a home birth is planned than if a hospital birth is planned, with the exception of pregnancies affected by malpresentation[67]. Malpresentation is detectable during pregnancy and it has been shown in this

[67] For a number of other pregnancy complications, it was impossible to assess whether planning a home birth was associated with a higher risk of perinatal death than planning a hospital birth, because there were no perinatal deaths in the 'intended a home birth' group. These complications were: previous stillbirth/neonatal death, raised maternal BMI, placental abruption, multiple pregnancy, recurrent antepartum haemorrhage,

thesis to be associated with a slightly higher risk of negative maternal and infant outcomes if a home birth is attempted, so there is a strong argument for advising women with malpresented foetuses to plan a hospital birth. At the same time, it could be argued that there should be more midwives who specialise in delivering malpresented foetuses vaginally in low-technology settings. If all midwives had the requisite skills/experience to cope with vaginal deliveries of malpresented foetuses, we could speculate that the risk of adverse outcomes with a planned home birth would *not* be higher than with a planned hospital birth. Until this option has been fully explored, it is premature to state that home birth is intrinsically less safe than hospital birth in cases of malpresentation; it appears to be less safe under the current system of care in the UK, and women should be advised as such, but under a different system of care this may not apply.

There were a few cases in SMMIS of malpresentation not being diagnosed until after labour had commenced. Given its importance as a predictor of negative outcomes, the NHS should work towards ensuring that as many cases of malpresentation as possible are diagnosed in time to ensure that the woman is attended in labour by people with the requisite skills to maximise the chances of a positive outcome to the pregnancy.

There is weak evidence that there is a higher risk of perinatal death in planned home births than in planned hospital births if labour and delivery are complicated by the unpredictable problems of cord prolapse or infant resuscitation requiring positive pressure/cardiac massage. This evidence is, however, not strong enough to justify a policy of all women being advised to plan a hospital birth 'just in case' these problems arise. Rather, women and their partners should be advised of the likelihood of them/their babies developing these complications, and that if they do develop them, the risk of perinatal death *may* be higher if a home birth is attempted, but that we do not know how much higher. They should then be left to make their own decision without being pressured into giving birth in any particular setting.

The same advice should apply to four other unpredictable labour complications, for which there were no cases of perinatal death in the 'intended a home birth' group in SMMIS and which therefore remain unevaluated in terms of the relative risk associated with planning a home birth. These complications are: pyrexia in labour, postpartum haemorrhage, obstructed labour and failure to progress in stage 1 of labour. When giving women information on the incidence of these complications, it should be pointed out to them that the risk of postpartum haemorrhage is lower if a home birth is intended than if a hospital birth is intended, and the same is true of failure to progress in stage 1 of labour if the woman has given birth before. For primiparae, on the other hand, the risk of failure to progress in stage 1 of labour is higher if a home birth is intended.

'small-for-dates', oligo/polyhydramnios, gestation > 41 weeks and gestational hypertension/pre-eclampsia. Women with these conditions should therefore be advised that there is currently no reliable evidence about whether the risk of perinatal death is higher if they plan a home birth.

8.3.2 Allocating a risk status to a pregnancy

There is some evidence from this analysis that the current NICE guideline which covers the advice that should be given to women regarding place of birth (National Collaborating Centre for Women's and Children's Health, 2007) should be revised. Unless evidence can be provided that heart conditions, previous episode(s) of hypertension, bleeding/coagulation disorders, atypical antibodies, hepatitis B/C, chicken pox/rubella/herpes, hyperthyroidism, kidney disorders, epilepsy, psychiatric disorders or substance misuse are independently associated with a higher risk of one or more specific negative pregnancy outcomes, they should be removed from the list of conditions that suggest a hospital birth should be planned. Whilst these conditions may require additional care during pregnancy to avoid miscarriage or damage to the foetus, and therefore merit the label 'high-risk', if the pregnancy has gone to term there does not seem to be any reason why a hospital birth is more advisable than a home birth.

This is one example of why the NICE guideline on this subject is too blunt an instrument to be of much assistance to the pregnant woman trying to establish whether home birth is a safe choice for her. It needs to be made clearer to service users with 'high-' or 'medium-risk' conditions exactly what they are at higher risk of, and the magnitude of the increased risk. At the level of the individual woman making a decision about place of birth, there is a big difference between a condition which is associated with a higher risk of perinatal death if she plans a home birth and condition which is associated with a raised risk of preterm labour. In the former scenario, it would be reasonable for the woman to avoid planning a home birth. In the latter scenario, if the pregnancy does go to full term, in the absence of other contraindications a planned home birth would be a perfectly reasonable choice. Armed only with a label of 'high-risk', a woman cannot be expected to make a truly informed choice about place of birth.

It is possible that the information necessary to produce a NICE guideline which clarifies the exact nature and magnitude of the increased risk does not currently exist. If so, the wisdom of issuing any guideline at all is questionable. While it is true that the current guideline is not a set of 'rules' and is open about the fact that it is not based on research evidence, the reality is that, in a litigious society such as the UK, maternity care providers will treat it as a set of 'rules', to ensure that they can robustly defend their actions in the event of litigation following a negative outcome to a pregnancy. The result is that women and their partners who have conditions on the 'high-risk' list are likely to be denied the same level of choice about place of birth, without any evidence to suggest that this is to their benefit.

Finally, there needs to be a change in the way that the risk status of pregnancies is labelled. Although the NICE guideline does not use the term 'high-risk' to describe pregnancy, this term is commonly used by clinicians (e.g. Queenan et al, 2010; University College London Hospitals NHS Foundation Trust, 2009). With access to high-quality maternity care, the risk of serious negative

outcomes to pregnancy in the UK is extremely low; most of the negative outcomes covered by this analysis were experienced in less than 4% of cases, and the really serious negative outcomes - perinatal death and postpartum haemorrhage - by 0.3% and 1.8% respectively. Whilst there is always a degree of risk attached to pregnancy, and it would be disingenuous to lead people to believe that pregnancy is risk-free, it is more accurate to say that all pregnancies are low-risk and most are very low-risk. It is possible that the use of the term 'high-risk' leads women to be more fearful of negative outcomes than is justified by the actual level of risk. If it is true that a woman's psychological state is directly linked to the physiology of her birth, we could speculate that entering labour in a state of fear due to a belief that there is a high risk of a negative outcome could actually make a negative outcome more likely.

Rather than using the term 'high-risk' to describe a pregnancy, therefore, it would almost certainly be beneficial to users of maternity services if they were told that pregnancies affected by specific condition *x* are at higher risk of negative outcome *y*, but that most pregnancies do not experience this outcome. This would help to keep the level of risk in perspective, and enable women to make a more informed choice about aspects of their maternity care such as place of birth. It would also be helpful if clinicians and the media stopped using the term 'high-risk pregnancy' in headlines and the titles of books and web pages.

The advice that home birth is safe for women with low-risk pregnancies but not for those with high-risk pregnancies is also questionable. Of the 12 perinatal deaths in SMMIS following an attempt at a home birth, just 3 followed high-risk pregnancies. This suggests that 'high-' versus 'low-risk' is too blunt a distinction when it comes to making decisions about birth setting. Perinatal death is more common following a high-risk pregnancy, but it still occasionally happens after a low-risk pregnancy. Again, it would be helpful to women if they were given the available figures relating to their risk of a negative outcome, and supported and encouraged to come to their own decision about where to give birth.

8.3.3 The role and training of midwives

There is evidence from other research to suggest that the positive maternal outcomes for planned home births are due at least partly to these deliveries being midwife-led rather than to their taking place at home (Hatem et al, 2008). Midwives are supposed to be the experts in providing maternity care for uncomplicated pregnancies. However, the history of maternity services in the 20th and early 21st century has resulted in a system under which midwives are subordinate to obstetricians, and have relatively little power in deciding on policies and practices relating to maternity care. In the few areas of the UK where home birth rates are relatively high, unusually strong midwifery leadership and relative autonomy are hallmarks of the local service (e.g. Leyshon, 2004; Sandall et

al, 2001a). Policy-makers wishing to facilitate informed choice should pay attention to the extent to which the structure of NHS maternity services is a barrier to such choice.

A system under which midwives operate more autonomously – such as that in operation in the Netherlands - may bring about benefits for pregnant women in terms of their ability to exercise free and informed choice about place of birth and other aspects of their care. The Dutch midwifery profession is currently under attack (Royal College of Midwives, 2010b) due to the Netherlands' relatively high perinatal mortality rate (see Section 2.1.2), despite the fact that there is no evidence to link this mortality rate with the activities of its midwives (de Jonge et al, 2009).

A change to the structure of maternity services is not something that could be achieved overnight, since the midwifery workforce has been trained under the current system, and has gained its early work experience in high-technology settings, thus normalising the medical model of care for them, and resulting in their not feeling fully confident to operate in low-technology settings such as the home (Healthcare Commission, 2008). This lack of confidence must be addressed through changes to midwifery training and work experience patterns. Particular attention needs to be paid to ensuring that midwives are fully trained, competent and confident to treat newborn babies requiring resuscitation.

8.3.4 Access to data

The publication of *Maternity Matters* (Department of Health, 2007) should have given NHS maternity services fresh impetus to deliver on the recommendations of *Changing Childbirth* (Department of Health, 1993) with regard to offering women a real choice about where they give birth. Analysis based on more recent data would provide information about the extent to which it has done so. Similarly, access to recent data on cases of pregnancy and labour complications for which this thesis was unable to provide concrete answers in terms of the relative safety of home birth would enable the research community confidently to answer the question 'is planned home birth safe?' Nationally, there would be enough cases of these rare complications to answer fully the research questions posed in this thesis. Because NHS maternity records are routinely maintained on computer, in theory such analysis should be possible. However, it would be extremely difficult to access these data because of the culture within the NHS of preserving patient confidentiality at all costs. The central collation of SMMIS data was halted in 2000 due to this culture – there were concerns that women who had not given their permission for their data to be released for analysis may object to their data being used for this purpose.

Furthermore, because different NHS Trusts use different computer systems, in practice it would be difficult to produce a single database. Because there are relatively few maternity care computer systems in use in the UK (Steer, 2008a), one solution would be to pool the information from trusts

which use the same system. However, even this may be problematic, due to technical difficulties in accessing data from the systems (Options UK, 2009; Healthcare Commission, 2008).

A surmountable, but still notable, barrier to conducting analysis on more recent data is the system for gaining ethical approval for research involving NHS records. My own experience indicates that this system is designed to ensure that the highest ethical standards are applied to clinical research involving human subjects. This means that much of the process is not relevant to secondary data analysis of the type described in this thesis. This results in the process being extremely – and unnecessarily - lengthy and resource-intensive, which is a barrier to further research. This is unfortunate, given the number of unanswered questions on the subjects of access to and the safety of home birth in the UK.

Given these barriers to accessing the data required to answer the research questions posed in this thesis, which certainly also apply to other important issues of public health, questions should be asked at the highest levels of Government and the NHS over whether concerns over patient confidentiality should over-ride concerns over ensuring that NHS users are enabled to make free and informed choices about important issues such as place of birth, and whether it is necessary for secondary data analysis to be subject to the same rigorous system for gaining ethical approval as clinical research directly involving human subjects. The medical and academic research communities tend to be scrupulous over the protection of data; surely a system could be designed under which access to data could be made easier without endangering the protection of individuals' privacy.

8.4 Study advantages and limitations

Statistical modelling permits the identification of associations between outcomes and explanatory variables, but does not generally permit conclusions to be drawn about causal relationships. For example, the fact that women who had more ultrasound scans were more likely to change their intention from home to hospital does not necessarily mean that the scans were a contributory factor to the decision to change the intended place of birth. It is possible that the change to hospital-based care resulted in more ultrasound scans being given. However, for most of the explanatory variables in these models, there is a clear chronological order to the events, which lends greater weight to the hypothesis that the explanatory variables caused the outcomes rather than the other way round. What we cannot tell is whether other, unmeasured, variables in fact caused both the explanatory variables and the outcome.

Notwithstanding this limitation, overall, this research ticks nearly all of the boxes on Vedam's (2003) checklist of what makes up a good study of the comparative safety of different birth settings, and therefore represents a significant improvement on previous UK studies:

- It distinguishes between planned home births and unplanned out-of-hospital births, and does so more effectively than many studies because it was possible to derive intended place of birth at the end of the pregnancy rather than having to rely on intended place of birth at booking to work out which home births were planned and which were unplanned.
- There were relevant and consistent inclusion criteria across comparison groups (see Section 5.2); it was possible to identify and exclude irrelevant cases, and the criteria for exclusion were the same whether a home birth or a hospital birth was intended.
- Similarly, the selected outcome measures were clearly defined, relevant to the research question, and the definitions applied equally whether a home birth or a hospital birth was intended.
- Adjustment was made for differences in selection criteria for home birth (while this adjustment cannot claim to have compensated fully for selection effects – see below – the number of covariates in the dataset and our ability to assign pregnancies to a standard risk status means the compensation was more comprehensive than in most other studies of the subject).
- It allows discrimination between different care providers (at the hospital level).
- It was possible to identify cases which were transferred to hospital in labour and assess their contribution to the overall pattern of results, and to control for differences in transfer criteria and method (to the extent that these were consistent within hospitals).

Additionally, the size of the dataset means that several rare pregnancy outcomes could be modelled. For these reasons, and because it is rare for a single study to be able to make all of the above claims, the results of this analysis deserve to be taken very seriously by pregnant women, policy-makers and maternity care providers. However, it is important to note a number of limitations, which are described below.

In Chapters 6 and 7, the use of individual negative outcomes rather than composite negative outcomes has restricted the analytical possibilities, because there were relatively few planned home births, of which very few experienced negative pregnancy outcomes (e.g. there were only 12 perinatal deaths in the 'intended a home birth' group). For this reason, the confidence intervals around the results, especially those involving interaction effects, are wide. One possible solution to this problem would have been to use composite outcome measures, but this was not done because composite outcome measures can produce misleading results. For example, the descriptive analysis in Chapter 6 shows that the relationships between the explanatory variables and the various labour complications were quite different. Because foetal distress was so much more common than the other labour complications, had a composite 'any labour complication' outcome variable been used, the statistical associations between covariates and the outcome would have been driven largely by the relationships between the covariates and foetal distress. Questions would have been raised about whether the associations applied to all labour complications, or just to foetal distress, and it

would be have been virtually impossible for clinicians to make informed decisions based on the results.

As noted elsewhere, some potentially useful explanatory variables were not included in the SMMIS database. The ideal dataset would have included full information on the following:

For all models:

- Mother's educational qualifications or other measure of social class
- Distance and/or travel time from the woman's home to the nearest hospital maternity unit
- Whether the labour/delivery was midwife-led throughout, consultant-led throughout, or changed from being midwife-led to being consultant-led part-way through
- A measure of the skill/experience of the attending midwife/ves
- Local midwifery staffing level
- Housing type
- Complete information on the mother's obstetric history (e.g. there is evidence to suggest that previous postpartum haemorrhages were not routinely recorded for the current pregnancy – see Section 6.8.4)

For the 'who plans/has a home birth?' models:

- Whether place of birth was discussed at the initial consultation with the GP, and if so, the extent to which this affected the woman's stated intention at booking
- Mother's height (this was included in SMMIS, but with a high level of missing data, making it unusable for this analysis)
- Mother's country of birth
- Whether transfers to hospital during labour were at the mother's request or on the midwife's advice
- What, if anything, the mother was told about the baby's likely birthweight before labour commenced
- Attitudinal data

Had all these variables been present in the dataset without significant amounts of missing data, it is possible that some of the associations identified in the modelling would have been weaker or non-existent. Social class is probably the most important omission for the 'who plans/has a home birth' models, since previous research has suggested that a desire for a home birth is far more common among middle-class women, and middle-class women tend to have relatively positive birth outcomes. SMMIS contained a measure of area deprivation, which will have compensated for the lack of social class variable to some extent, but the two do not measure exactly the same thing. It is, however, worth noting that even in deprived areas it is possible to have a relatively high home maternity ratio (Nove et al, 2008), indicating that factors external to the mother (e.g. the ease of

access to a high-quality home birth service) can be more important than social class in explaining why people choose home birth.

Although the inclusion of social class as a covariate would almost certainly have made the associations between intended place of birth and the outcomes weaker, it is unlikely that this would have changed the substantive conclusions drawn about the safety of home birth for the mother. For five of the six negative maternal outcomes, the risk of the outcome was roughly double if a hospital birth was intended, compared to if a home birth was intended. The inclusion of social class as a covariate would be highly unlikely to cancel out or reverse a difference of this magnitude. Because there was no significant difference between intending a home birth and intending a hospital birth in terms of the risk of perinatal death, however, we cannot make the same claim about the safety of home birth from the point of view of the baby.

Previous research (Hatem et al, 2008) has found that many of the benefits that are attributed to home birth have more to do with the intrapartum care at home being midwife-led than with the home environment *per se*. Because it was not possible to distinguish between midwife-led and obstetrician-led hospital births in SMMIS, a comparison could not be made between the outcomes of planned home births and the outcomes of planned hospital births that were midwife-led. Had this comparison been made, it is possible that the differences between planned home birth and planned hospital birth would have been smaller or even non-existent.

The SMMIS database was collated over the period 1988-2000, so its applicability to the present day is questionable. Since the publication of *Maternity Matters* (Department of Health, 2007), NHS trusts have been under more pressure to offer women a real choice about where they give birth, and if this analysis were repeated in the present day, it is possible that external factors such as hospital would be less strongly associated with intended and actual place of birth. This said, there is evidence from more recent data (National Childbirth Trust, 2009a; Healthcare Commission, 2007b) to suggest that significant variations by trust still exist. Similarly, the incidence and management of labour complications and perinatal death may have changed since 2000.

The SMMIS data are also specific to one region of England: the former North West Thames Regional Health Authority area, so care should be exercised when generalising these results to the rest of the UK. For example, women giving birth in the South-east of England tend to be older than average (Tromans et al, 2008) and the population of this area is more ethnically diverse than in most parts of the UK. This having been said, the North West Thames region was large and diverse, so there is no reason to suppose that these results are completely atypical of the rest of the UK.

Because the SMMIS database covered a 13-year period, some women will have been included in the database more than once, due to having more than one pregnancy during those 13 years. There will therefore be clustering effects that were not controlled for in the analysis. The extent to which this

is a problem depends on the extent to which women have an underlying propensity towards experiencing the outcomes modelled herein. If they do, then this underlying propensity will carry through all their pregnancies. It is reasonable to suppose that a woman's underlying attitudes towards childbirth will influence the decisions she makes about place of birth for all her pregnancies, but on the other hand, her experiences in a previous pregnancy are likely to affect her underlying propensity, e.g. if she had a negative experience of a hospital birth, she may be more likely to explore the possibility of a home birth next time round. Similarly, if a woman has an underlying medical or obstetric condition that predisposes her to experience labour complications and negative pregnancy outcomes, this will not have been adequately controlled in the models described in Chapters 6 and 7. It will be controlled to some extent, because SMMIS contained fairly detailed information about pre-existing medical and obstetric conditions, but there is evidence to indicate that this information was not complete in all cases (see Section 6.8.4).

This analysis does not take into account the heterogeneity of hospital birth, which covers a range of facilities from high-technology consultant-led units to the home-like surroundings of midwife-led birth centres. Ideally, this study would have compared midwife-led births in hospital with planned home births, but it was not possible to identify from SMMIS which hospital births were midwife-led and which were consultant-led.

The Healthcare Commission (2008) noted that, in 2007, many NHS trusts in England kept very poor records of indicators of neonatal morbidity such as Apgar score at 5 minutes after birth, the use of newborn intubation, meconium aspiration and neonatal encephalopathy, so it is possible that the SMMIS data on these outcomes is incomplete. There is certainly evidence to suggest that some or all of the maternity units featured in this analysis kept incomplete records of maternal outcomes. The Healthcare Commission (2008) estimated the incidence of significant postpartum haemorrhage (1000ml+) at 27 per 1,000 births in England, major postpartum haemorrhage (2500ml+) at 1.9 per 1,000 and eclampsia at 0.4 per 1,000 live births. The SMMIS incidence figures were 18.4, 1.0 and 0.1 respectively. In interpreting these results, therefore, it must be borne in mind that some cases of each outcome were probably misclassified as not having experienced the outcome.

Despite the number of records in the dataset, the small number of cases of negative outcomes among those who intended a home birth means that it was not possible to include all the desired interaction effects in the model-building process. For some complications of pregnancy and labour, therefore, we cannot make any evidence-based statement about the relative safety of home and hospital birth.

The results of the national Birthplace in England study (National Perinatal Epidemiology Unit, 2008) are due to be published in the summer of 2011. There is a great deal of overlap between the Birthplace study and this thesis, in that both studies aimed to evaluate the relative safety of different birth settings, including planned home birth. The Birthplace study has some advantages over this

thesis, including: (a) the use of a national, up-to-date dataset which was designed with this specific analysis in mind and (b) the ability to compare home, midwifery units and obstetric units, thus partly overcoming the issue of the heterogeneity of hospital births (National Perinatal Epidemiology Unit, 2007b). Notwithstanding this, this thesis makes a useful addition to the debate due to its: (a) quantitative evidence on factors predicting birthplace choices (which is not attempted as part of the Birthplace study), (b) use of individual outcome measures rather than the composite measure used by the Birthplace study, and (c) inclusion of high-risk, multiple and preterm births, all of which were excluded from the Birthplace study.

8.5 Future research: recommendations and implications

Future research should focus on the questions of whether perinatal death more common if a home birth was intended and the pregnancy or labour is complicated by malpresentation, cord prolapse or infant resuscitation. This thesis provides weak evidence that home birth is less safe for the baby than hospital birth under these circumstances. More evidence is needed to either support or challenge the evidence from this analysis. As noted in Section 8.3.1, the relative safety of home and hospital birth in the event of certain other pregnancy and labour complications is unevaluated due to there being no perinatal deaths in the 'intended a home birth' group in SMMIS, so these complications are also worthy of further investigation. Such investigation should take into account whether hospital births were midwife-led or consultant-led, to test the hypothesis that the variations in risk for home births are due simply to the fact that they were all midwife-led.

Chapter 6 reports that the risk of a number of labour complications (including the potentially fatal postpartum haemorrhage) is much higher if a hospital birth is intended than if a home birth is intended, even if key confounders are held constant. More research needs to be done if we are to understand *why* the risk is so much higher for planned hospital births. It is possible that there are medical or physiological reasons why women who choose hospital birth tend to be more pre-disposed to these labour complications, but the onus should be on hospitals to defend their safety record from the perspective of the mother.

A number of other maternal and infant outcomes could have been investigated if there had been time, and these are described in Appendix H. In particular, given the finding that in most cases the risk of perinatal death is not significantly higher for home births, a comparison of the incidence of infant morbidity between home and hospital births would be enlightening.

To answer the question about whether socio-demographic variations in accessing home birth are due to certain types of women being more likely to want home birth or to their being more able to fight for it, longitudinal data analysis would be required. This question may become irrelevant if the NHS is able to deliver on the choice agenda. However, if service providers operate under the belief

that there is no point offering home birth to certain groups because they will not want it, then existing biases will be perpetuated. The ideal such study would recruit women before pregnancy, and learn about their attitudes towards different birth settings, then follow them through key encounters with maternity care providers in pregnancy, identifying the points at which decisions are made (and changed), and on what bases.

Given the significantly lower incidence of labour complications, instrumental deliveries and operative deliveries for planned home births, it would be interesting for a health economist to do some investigation of the impact on NHS costs of different levels of home maternity ratios in the present day. NHS Trusts are often quoted as saying that they cannot afford to provide a home birth service for anyone who wants a home birth. A comparison of the overall costs to a Trust of a home birth compared with a comparable hospital birth (taking into account the higher risk of labour complications and/or operative delivery) may demonstrate that Trusts would save money in the long run if they invested in setting up a more widely accessible home birth service.

Finally, questions should be asked about whether multi-country meta-analysis is a suitable tool for making comparisons between home and hospital births. It is reasonable to postulate that the safety of home birth is largely dependent on whether (a) the attending midwife/ves is/are competent to operate in the home setting and (b) there is quick and easy access to emergency medical care should the need arise. The extent to which these two conditions apply varies depending on the system of care in place in that country, and the geographical conditions that prevail there. Pooling the data from countries which have little in common on these two measures therefore makes very little sense from a theoretical point of view, particularly if, out of the studies selected for inclusion, there is a skew towards particular countries.

The most recently-published meta-analysis (Wax et al, 2010a) was used by the American College of Obstetricians and Gynecologists to justify its position that hospital birth is safer than home birth (American College of Obstetricians and Gynecologists Committee on Obstetric Practice, 2011), despite the fact that the study's methodology has been strongly criticised (e.g. Gyte et al, 2010) to the extent that the journal in which it was published conducted an investigation into the validity of the study (Hayden, 2011). This investigation concluded that there were errors in the calculations used, but that these errors did not affect the overall conclusions. It did not, however, address one of the central concerns about the meta-analysis, which was that, without adequate justification, it excluded high-quality studies which would have changed the study's conclusions had they been included. This debate will no doubt continue for some time.

Appendix A: Glossary of terms, acronyms and abbreviations

Agenesis	Absence or incomplete development of an organ or body part
Amenity patient	Woman receiving NHS (qv) postpartum (qv) care in hospital who opts to pay directly for a private room rather than being allocated a bed according to need/availability
Amniocentesis	Removal and analysis of a sample of amniotic fluid (qv) with a view to detecting chromosomal abnormalities in the developing foetus (qv)
Amniotic fluid	Liquid surrounding the foetus (qv) which provides nourishment and protection
Anaemia	Condition that occurs when there is a reduced number of red blood cells or concentration of haemoglobin (qv)
Anencephaly	A fatal open neural tube defect, affecting the development of the brain and spinal cord with associated congenital problems, including significant abnormalities to the face and neck. The skull vault is absent and a severely abnormal brain structure is exposed
Antenatal/antepartum	During pregnancy, before the commencement of labour
Apgar score	A system of evaluating a newborn's physical condition by assigning a value (0, 1, or 2) to each of five criteria: heart rate, respiratory effort, muscle tone, response to stimuli, and skin colour. The maximum possible score is 10, and the minimum is 0. Apgar score is usually assessed at 1 minute after birth and 5 minutes after birth.
ARM	Artificial Rupture of Membranes. Puncture of the membranes containing amniotic fluid (qv) via the vagina, used to induce or speed up labour
Assisted delivery	Baby is born vaginally with the assistance of forceps (qv) or ventouse (qv)
Augmentation of labour	Action taken to speed up labour, e.g. ARM (qv) or intravenous administration of Syntocinon (qv)
Bilateral kidney agenesis	Neither kidney forms in the foetus (qv)
Birth pool	Large pool containing warm water, in which the labouring woman immerses herself
BMI	Body Mass Index (weight in kilograms divided by height in metres squared) – a measure of obesity
Booking	Antenatal (qv) appointment (usually with midwife in first trimester (qv) of pregnancy) at which details of full medical and obstetric history should be taken
Brachial plexus	Nerve network controlling movement and sensation in the arm
Breech presentation	Foetus (qv) is positioned such that its buttocks will be the first part of its body to enter the mother's pelvis during labour
Caesarean section	Extraction of the baby from the uterus (qv) via a surgical incision in the abdominal and uterine walls
Cardiac	Relating to the heart
Caseload midwifery	Model of care maternity care under which a midwife is personally responsible for the provision of midwifery care to a number of women
Cephalic presentation	Foetus (qv) is positioned such that any part of its head will be the first part of its body to enter the mother's pelvis during labour
Cephalohaematoma	Collection of blood under the scalp (usually a result of birth trauma)

Cerebral	Relating to the brain
Cerebrovascular accident	Stroke
Cervical	Relating to the cervix (qv)
Cervical suture	Surgical procedure designed to prevent a weak cervix (qv) from dilating before the foetus (qv) reaches full term
Cervix	Lowest part of the uterus (qv) which dilates to allow the baby to pass out of the uterus
Chorionic villus biopsy	The removal and analysis of a sample of cells from the placenta (qv), with a view to detecting serious genetic defects in the foetus (qv)
Clavicle	Collar-bone
CNST	Clinical Negligence Scheme for Trusts; designed to provide a means for NHS (qv) Trusts to fund the cost of clinical negligence litigation, and to encourage effective risk management
Colitis	Inflammation of large intestine
Colostrum	Substance produced by the breasts during pregnancy and in the first days after delivery, before the breasts start producing breastmilk
Congenital	Existing at the time of birth
Contractions	Contractions of muscles in the uterus (qv), designed to help the baby move down from the uterus to the vagina
Cord prolapse	See 'umbilical cord prolapse'
Crohn's disease	Inflammation of the lining of the digestive system
CS	Caesarean section (qv)
CVB	Chorionic villus biopsy (qv)
Diastolic blood pressure	Minimum pressure in the arteries between heartbeats when the heart relaxes to fill with blood
Dystocia	Difficult or abnormal labour
Eclampsia	Convulsions/coma during late pregnancy or early puerperium (qv)
Ectopia cordis	Congenital (qv) anomaly whereby the baby is born with its heart in the wrong place, often outside the body
Ectopic pregnancy	Fertilised egg implants outside the uterus (qv) and embryo develops, rendering pregnancy non-viable
Edwards syndrome	See Trisomy 18
Elective Caesarean section	The baby is delivered by Caesarean section (qv), performed as a planned procedure before the onset of labour
Emergency Caesarean section	The baby is delivered by Caesarean section (qv) after an attempt at delivering vaginally, when circumstances during labour call for urgent delivery of the baby
Encephalopathy	Neurological abnormality such as lethargy, coma, impaired respiration, seizures
Endorphins	A group of chemicals manufactured within the brain, which relieve pain and have other regulatory effects on the mind, body and other hormones
Epidemiology	Study of causes, transmission and treatment of diseases

Epidural / epidural anaesthesia	Injection of a local anaesthetic into the epidural space in order to block the spinal nerves and cause total numbness of the lower torso and limbs
Episiotomy	Surgical cut in perineum (qv) performed immediately before a vaginal birth
Foetal	Relating to the foetus (qv)
Foetal distress	Indication of potentially harmful environment in the womb, most commonly abnormal heart rate/rhythm and/or meconium (qv)-stained liquor
Foetal manipulation	Attempted conversion of breech (qv) or other malpresentation (qv) to vertex presentation (qv) by manipulation of the foetus (qv) through the maternal abdomen
Foetus	Unborn baby
Forceps delivery	Forceps (two spoon-like instruments that fit together and are placed on each side of the baby's head so that the baby can be pulled out) are inserted into the vagina to assist delivery if the mother is unable or unwilling to push the baby out unaided, or if there is a perceived need to birth the baby quickly
Fibroids	See 'myoma'
Gestation	Period of development in the uterus (qv) from conception until birth
Gas and air	See 'inhalational pain relief'
GOR	Government Office Region
GRO-S	General Register Office for Scotland
Haematoma	Swelling containing blood
Haemoglobin	Protein that carries oxygen in the blood
Haemoglobinopathy	Genetic deficit affecting haemoglobin (qv)
Haemolytic disease of the newborn	Autoimmune condition that develops when antibodies produced by the mother and passed to the foetus (qv) through the placenta (qv) include ones which attack the foetus' red blood cells
Haemorrhage	Excessive blood loss, or blood loss causing internal damage
HBV	Hepatitis B virus
HELLP-syndrome	Combination of hypertension (qv) and proteinuria (qv)
HIV	Human Immunodeficiency Virus
HMR	Home Maternity Ratio. The percentage of maternities (qv) that take place at home
Humerus	Upper arm bone
Hydramnios	Amount of amniotic fluid (qv)
Hypertension	Diastolic blood pressure above 89 mmHg
Hyperthyroidism	Overproduction of thyroid hormones
Hysterectomy	Surgical removal of the uterus (qv)
Iatrogenic	Caused by medical diagnosis or treatment
ICD	International Classification of Diseases
IM	Independent Midwife, i.e. not employed by the NHS (qv)
Induction of labour	Process by which contractions (qv) are initiated artificially

Infant mortality rate	In the UK this is defined as: $\frac{\text{Deaths under the age of 1 year after live birth (qv) x 1,000}}{\text{Live births}}$
Inhalational pain relief	Anaesthesia administered through a breathing tube, made up of half oxygen and half nitrous oxide. Also known as 'gas and air'
Instrumental delivery	The baby is delivered vaginally, with the use of forceps (qv) or ventouse (qv)
Intrapartum	During labour
Intubation	A method of resuscitation used if a newborn baby fails to start breathing; the giving of air or oxygen via a tube inserted into the baby's trachea (qv)
Item non-response	If someone has taken part in a survey, but not answered every question, those questions with no answer are classified as 'item non-response'
Jaundice	Condition whereby the liver is not fully functioning
Kernicterus	Severe form of jaundice (qv) of the newborn
LA	Local Authority
Live birth	A child which has been born and either breathed or shown other sign of life, e.g. heartbeat, pulsating umbilical cord (qv)
Local infiltration	Injection of local anaesthetic into perineum (qv)
Macrosomia	Abnormally large foetus (qv), often as a result of maternal diabetes
Malpresentation	Unborn baby is not in the vertex presentation (qv) position
Maternity	Pregnancy resulting in the birth of one or more children. A pregnancy resulting in the birth of more than one child counts as a single maternity, but a multiple birth
Meconium	Thick substance found in the intestine of a full-term foetus (qv) and excreted shortly before or after birth
Miscarriage	Spontaneous termination of pregnancy
Morbidity	Disease or abnormality
MROP	Manual removal of placenta (qv) after delivery of the baby
Multipara	Woman having her second or subsequent child
Multiple birth	Single pregnancy resulting in the birth of more than one child
Myasthenia gravis	Condition causing voluntarily-controlled muscles to become weak and easily tired
Myoma	Non-cancerous tumour of the uterus (qv); also known as fibroids
Myomectomy	Surgical removal of myoma
NCCWCH	National Collaborating Centre for Women's and Children's Health
NCT	National Childbirth Trust
Neonatal	Within the first 28 days of life
Neonatal mortality rate	In the UK this is defined as: $\frac{\text{Deaths at 0-27 days after live birth (qv) x 1,000}}{\text{Live births}}$
Neurological deficit	Defect or absence of function of a nerve or a nervous system
NHS	National Health Service

NICE	National Institute for Health and Clinical Excellence
NISRA	Northern Ireland Statistics and Research Agency
Non-instrumental delivery	The baby is born vaginally without the use of forceps (qv) or ventouse (qv)
Normal birth	Spontaneous vaginal delivery without the aid of an epidural (qv), spinal (qv) or general anaesthesia, forceps (qv) or ventouse (qv)
NS-SEC	National Statistics Socio-Economic Classification
Obstetrics	Medical/surgical specialty concerned with pregnancy, delivery and the puerperium (qv)
Oedema	Fluid retention in the body, leading to swelling
Oligohydramnios	Insufficient amniotic fluid (qv)
ONS	Office for National Statistics
Operative delivery	Caesarean section (qv)
Oxytocin	The hormone secreted by the pituitary gland which stimulates labour contractions (qv) and controls bleeding
Paediatrics	Medical specialty concerned with care of babies/children
Parity	The number of viable children already born to an individual woman (including live births (qv) and stillbirths (qv), but not terminations (qv) or miscarriages (qv)). Thus, a woman of parity 0 has never given birth before the current pregnancy, parity 1 has given birth once before, and so on
Perinatal	Within the first 7 days of life
Perineal suturing	Surgical stitching of an episiotomy (qv) wound or tear to the perineum (qv) after delivery
Perineum	Area of pelvic floor between vagina and anus
Pethidine	Opioid pain-relieving drug usually administered via injection
Pharmacological	Involving the use of drugs
Physiological	Consistent with an organ or organism's normal functioning
Physiological third stage of labour	During third stage of labour (qv), the placenta is left to detach naturally, without the use of drugs
Placental abruption	Partial or complete detachment of placenta (qv) during pregnancy
Placenta	Organ which is attached to the lining of the uterus (qv) during pregnancy, linking mother's blood supply with that of the foetus (qv)
Placenta praevia	Placenta (qv) is attached over or close to the cervical (qv) opening
Planned HMR	The percentage of maternities that were intended to take place at home and did so
Platelet	Blood particle necessary for clotting
PMR	Perinatal Mortality Rate. In the UK this is defined as: $\frac{\text{(stillbirths (qv) + deaths at 0-6 days after live birth) x 1,000}}{\text{Live births (qv) + stillbirths}}$
Polyhydramnios	Excess of amniotic fluid (qv)
Postpartum	Following birth

PPH	Postpartum haemorrhage
Pre-eclampsia	Problem with the placenta (qv) which can lead to hypertension (qv), proteinuria (qv) and/or oedema (qv) in the pregnant woman, and/or growth problems in the unborn baby. If left untreated pre-eclampsia can develop into eclampsia (qv)
Premature rupture of membranes	Amniotic fluid (qv) is contained within a membrane, which usually ruptures shortly before or during labour. The rupture is premature if it occurs more than 24 hours before the establishment of labour
Preterm labour	Labour commencing before the completion of the 37th week of gestation (qv)
Primipara	Woman having her first child
Prostaglandins	Chemicals used to make the cervix (qv) softer and thinner allowing it to open (dilate). Used as a method of induction of labour (qv)
Proteinuria	Excess protein in the urine
Puerperium	Period after delivery during which the mother's body adjusts to the end of pregnancy
Pyelonephritis	Infection of the kidneys
Pyrexia	Raised body temperature
RCM	Royal College of Midwives
RCOG	Royal College of Obstetricians and Gynaecologists
Renal	Relating to the kidneys
RHA	Regional Health Authority
SCBU	Special Care Baby Unit
Scleroderma	Autoimmune disease that affects the blood vessels and connective tissue; fibrous connective tissue is deposited in the skin
Singleton birth	Pregnancy resulting in the birth of one child
SLE	Systemic lupus erythematosus
SMMIS	St Mary's Maternity Information System
Spinal or spinal block	Injection of a local anaesthetic into the sac of fluid surrounding the spinal cord/nerves in order to block the spinal nerves and cause total numbness of the lower torso and limbs. Similar to an epidural (qv) but cannot be topped up
Stages of labour	Labour is typically experienced in three stages: (1) dilation of the cervix (qv), (2) the baby is pushed down the vagina and born and (3) the placenta (qv) detaches from the uterus (qv) and is pushed out of the vagina
Stillbirth	A baby which is born dead after 24 completed weeks of pregnancy
Syntocinon	Artificial form of oxytocin (qv)
Systolic blood pressure	Maximum pressure in the arteries when the heart contracts and pushes blood out into the body
TENS	Transcutaneous Electrical Nerve Stimulation. Non-pharmalogical method of pain relief
Termination	Induced termination of pregnancy
Thromboembolic disorder	Obstruction of artery or vein by a blood clot
Trachea	Windpipe (pipe joining the throat to the lungs, used for breathing)

Transverse presentation	Foetus (qv) lying at right angles to the cervix (qv), i.e. head pointing sideways rather than up or down
Trimester	Pregnancy is divided into three roughly equal time periods, known as trimesters
Triploidy	Chromosomal abnormality in which three, rather than two, sets of 23 chromosomes combine to form the embryo
Trisomy 18	Chromosomal abnormality in which there are three, rather than two, number 18 chromosomes in every cell (aka Edwards syndrome)
Umbilical cord	Cord containing blood vessels which connects the foetus (qv) to its mother via the placenta (qv)
Umbilical cord prolapse	Umbilical cord (qv) comes through the cervix (qv) before the baby
Unplanned HMR	The percentage of maternities (qv) that were intended to take place in hospital but took place at home
Uterus	Womb
Ventouse delivery	A suction cup is inserted into the vagina and attached to the top of the unborn baby's head to assist delivery if the mother is unable or unwilling to push the baby out unaided, or if there is a perceived need to birth the baby quickly
Vertex presentation	Foetus (qv) is positioned such that the crown of its head will be the first part of its body to enter the mother's pelvis during labour. This is the ideal presentation for a vaginal delivery
Vulva	Female external genital parts

Appendix B: Data sources considered but rejected

Avon Longitudinal Study of Parents & Children (ALSPAC)

Pregnant women living in one of three Bristol-based health districts in the former County of Avon with an expected delivery date between April 1991 and December 1992 were eligible to be enrolled in this cohort study. Around 14,000 pregnant women were initially recruited. Information was collected using self-administered questionnaires, data extraction from medical notes, linkage to routine information systems and at research clinics. Data collection began as soon as the woman presented for antenatal care.

The study was designed to allow assessment of the interaction of genes and environment on a child's health and development (Golding et al, 2001). Place of birth was not therefore a central concern, so whereas actual place of delivery was recorded for all study participants, intended place of delivery was only recorded for a sub-sample. Both variables were collected in relation to 8,250 women, of whom only 63 intended a home birth, of whom only 46 had one. A further 149 women had an unintended home birth, bringing the total number of home births to 195. However, the crucial figure was the number of *intended* home births, and 46 was insufficient to allow reliable conclusions to be drawn about how these 46 women compared to those giving birth in hospital.

Birthplace: UK National Cohort Study

Birthplace is a large-scale research programme, designed to compare outcomes of home births, births in midwifery units and births in obstetric units. It is co-ordinated by the National Perinatal Epidemiology Unit (NPEU) at Oxford University and funded by the Department of Health and the National Institute for Health Research (NPEU, 2007a).

The Birthplace programme consists of six inter-related studies, of which one is a prospective cohort study. This collected data on planned place of birth and key clinical outcomes for 'low risk' women and babies. A feasibility study ran from July-December 2007, and then the main stage of data collection was scheduled to continue for a further 14 months, with a view to recruiting 17,000 women. In the event, the data collection period was extended still further. Therefore, the data from this study were not available for secondary analysis in time for inclusion in this thesis.

Born in Bradford

All pregnant women attending Bradford Royal Infirmary from Spring 2007 were invited to join this cohort study, and it was anticipated that recruitment would continue for two years until the target number of 10,000 births was achieved (Centre for Longitudinal Studies, 2006a). The data from this study would therefore be available too late for use in this thesis.

Gateshead Millennium Study

All babies born in one of 34 'recruiting weeks' between 1 June 1999 and 31 May 2000 to women resident in Gateshead were eligible for recruitment to this cohort study. From the 1,270 eligible births, just over 1,000 were recruited (Centre for Longitudinal Studies, 2006b). A sample of this size would not have yielded very many planned home births, so this study was not investigated further.

Isle of Wight Birth Cohort Study

Just under 1,500 babies born on the Isle of Wight between January 1989 and February 1990 were recruited to this study, with the intention to study their development of asthma and allergy, and identify risk factors for these conditions (Centre for Longitudinal Studies, 2006d). The sample was too small for the separate analysis of children born at home, and the focus was very much on allergy rather than more general wellbeing outcomes.

Millennium Cohort Study (MCS)

This study recruited the parents of nearly 19,000 babies born in the UK over a 12-month period in the year 2000 and who were resident in selected areas of the UK when they were 9 months old. The first round of interviews took place between June 2001 and January 2003 (Centre for Longitudinal Studies, 2005).

Although the dataset contained a lot of potentially useful information, it was not used for the following reasons:

- Intended place of birth was not recorded
- The mother's feelings about labour and delivery were not recorded
- Only live births were included, so outcomes such as stillbirth and neonatal death could not have been analysed

National Birthday Trust Fund 1994 Confidential Enquiry into Home Births

Pregnant women were recruited to this study at 37 weeks' gestation. The sample contained information on almost 4,000 planned home births and almost 2,000 unplanned home births. The planned home births were compared with a matched sample of 3,300 comparable planned hospital births. The research team estimated that 61% of all home births in the UK in 1994 were included in the study.

As noted in Section 2.4.2, the official report of this study (Chamberlain et al, 1997) described a number of ways in which the outcomes of planned home births were different from those of planned hospital births. All the analysis in the report was based on the examination of bivariate associations between intended place of delivery and outcomes; no statistical modelling was carried out to control for the contribution of factors such as the mother's socio-economic background, reproductive

history or level of education. It was therefore not possible to assess the extent to which the differences in outcomes were associated with place of birth *per se*, or just due to the fact that the kind of women who opt for home birth were the kind of women who had those outcomes.

Extensive efforts were made to locate the original 1994 dataset so that such analysis could be carried out, but none of the lines of enquiry was successful:

- The National Birthday Trust Fund (NBTF) is now administered by the charity Wellbeing of Women (WoW). WoW's Research Grants Manager confirmed that the data were not held in its archives.
- The UK Data Archive at the University of Essex was interested in finding out where the data were held, but could not help locate them.
- The Wellcome Library in London holds a number of NBTF archival records, but nearly all pre-dated the 1994 study. Wellcome's Archives Team Leader checked their catalogue, but found no reference to this study.
- The University of London Computer Centre (ULCC) held the data from at least one earlier NBTF study, but their Archives Assistant confirmed that they did not have the 1994 dataset.
- Two of the report's authors (Geoffrey Chamberlain and Ann Oakley) were contacted, but neither of them knew where the data were archived.
- The 1994 study team was based at St George's Hospital in Tooting, London, but the St George's Librarian confirmed that the data were not stored there.

Regretfully, therefore, the data from this important study were not included in the analysis in this thesis.

Scottish Morbidity Record SMR02: Maternity Inpatient & Day Case

Under this scheme, information on births in Scotland has been routinely collected since 1975, including: mother's age, height, smoking history and previous obstetric history; outcome of pregnancy, mode of delivery, induction and analgesia; and baby's birthweight, gestation, Apgar score and gender. SMR02 claims to achieve national coverage of 98% of all births and pregnancies (Scottish Public Health Observatory, 2007).

The main difficulty with this dataset was patchy coverage of home births. In October 2007, Dr James Chalmers (Consultant in Public Health Medicine, NHS National Services Scotland) confirmed that until recent years, the scheme covered only hospital births. He noted that, although there have been recent attempts to include home births, there appears to be a high degree of non-random under-reporting (i.e. some midwives were better than others at completing and returning the relevant forms). Even where home births were included in the data, intended place of delivery was rarely noted, so this option was not pursued further.

Southampton Women's Survey (SWS)

From April 1998 to October 2002, 12,500 women aged between 20 and 34 years were recruited into this cohort study. Those who became pregnant before May 2007 were re-interviewed, and their children followed up at intervals (MRC Epidemiology Resource Centre, 2006).

The aim of the study was to assess the effect of the mother's lifestyle, size, shape and diet (both before and during pregnancy) on her child's health. It also considered how a woman's social life, level of fitness and exercise, food intake, family life and housing arrangements affect her health, and that of her children.

Place of birth was recorded in the dataset, but numbers were too small for separate analysis (just 6 home births in the cohort), so this dataset was not used.

South-east Thames Case Control Study of Severe Obstetric Morbidity

Almost 50,000 women who were resident in the South-east Thames region and gave birth between 1 March 1997 and 28 February 1998 were recruited to this study (Waterstone et al, 2001). The main focus of the study, however, was severe obstetric morbidity, so detailed information was collated only for about 600 cases and about 2,400 controls. In personal communication, Mark Waterstone estimated in November 2007 that there were only about a dozen home births within this sub-sample, so this option was not pursued.

Appendix C: Classification of level of risk in pregnancy

Shaded rows represent conditions that could be considered as risk factors but it has not been possible to quantify them because the database did not have a field for this condition and it was not possible to find an ICD code for it in the ICD coding manuals.

Where an ICD code is not shown but an incidence figure is recorded, this indicates a condition that was recorded on the SMMIS database separately from the ICD codes.

Indication	ICD-10 code(s) starting with:	ICD-9 code(s) starting with:	Incidence per 1,000 pregnancies resulting in live or stillbirth (SMMIS)
Medical conditions indicating increased risk suggesting planned birth at an obstetric unit			
Confirmed cardiac disease	I01; I02.0; I05-09; I20-28; I30-52	391-398; 410-429	7.9
Hypertensive disorders	I10-15	401-405	3.8
Asthma requiring an increase in treatment or hospital treatment[68]	J45-46	493	9.4
Cystic fibrosis	E840, E841, E848, E849	277.0	0.02
Haemoglobinopathies – sickle cell disease, beta-thalassaemia major	D51-64	281-285	8.2
History of thrombo-embolic disorders	I74	444	0.006
Immune thrombocytopenia purpura or other platelet disorder or platelet count below 100,000	M311; N085	446.6	0
Bleeding disorder in woman or unborn baby, including Von Willebrand's disease	D65-69	286-287	1.1
Atypical antibodies which carry a risk of haemolytic disease of the newborn	O36.0-1	656.1-2	14.0
Risk factors associated with group B streptococcus whereby antibiotics in labour would be recommended	Z22.3	V02.51	0.06

[68] SMMIS did not record whether or not the asthma required an increase in treatment or hospital treatment, so for the purposes of this analysis all women with asthma are coded as 'high-risk'.

Indication	ICD-10 code(s) starting with:	ICD-9 code(s) starting with:	Incidence per 1,000 pregnancies resulting in live or still birth (SMMIS)
Hepatitis B/C with abnormal liver function tests[69]	B16; B17.0-1; B18.0-2	571.4, 573.1-3	3.3
Carrier of / infected with HIV[70]	B20-24; Z21	No code	0.03
Toxoplasmosis – women receiving treatment	B58	130	0.02
Current active infection of chicken pox / rubella / genital herpes in the woman or baby	A60; B01-02; B06; O26.4	052-053; 054.1; 056; 647.5	0.6
Tuberculosis under treatment	A15-19; B90; P37.0	010-018	0.08
Systemic lupus erythematosus (SLE)	L93; M32	695.4	0.04
Scleroderma	L94.0-1	701.0	0.004
Hyperthyroidism	E05	242-244	0.7
Diabetes	E10-14	250	4.1
Abnormal renal function / renal disease requiring supervision by a renal specialist	N10-19; N20.0; N20.2; N23; N25-29	580-589; 592.0; 593.0-2; 593.9	3.9
Epilepsy	G40-41	345	3.6
Myasthenia gravis	G70.0	358.0	0.01
Previous cerebrovascular accident (stroke)	I61; I63	436	0
Liver disease associated with current abnormal liver function tests	K70; K73-74	571	0.01
Psychiatric disorder requiring current inpatient care[71]	F03-09; F12-13; F17; F20-52; F53.2-F89	290; 293-301; 307.1; 308-312; 317-319	0.6
Other factors indicating increased risk suggesting planned birth at an obstetric unit			
Unexplained neonatal death/stillbirth or previous death related to intrapartum difficulty			16.2
Previous baby with neonatal encephalopathy Pre-eclampsia in previous pregnancy requiring preterm birth Placental abruption in previous pregnancy with adverse outcome			

[69] SMMIS did not record whether or not the hepatitis was accompanied by abnormal liver function tests, so for the purposes of this analysis all cases of hepatitis B or C are coded as 'high-risk'

[70] The ICD-9 coding system (used until 1994/5) did not have a code for HIV, so this was coded only when the ICD-10 system was introduced. This means that HIV will be under-reported

[71] SMMIS did not record whether or not current inpatient care was required, so all women with psychiatric disorders have been coded as 'high-risk'

Indication	ICD-10 code(s) starting with:	ICD-9 code(s) starting with:	Incidence per 1,000 pregnancies resulting in live or still birth (SMMIS)
Eclampsia in previous pregnancy			
Uterine rupture in previous pregnancy			
Primary postpartum haemorrhage in previous delivery requiring additional treatment or blood transfusion	O72	666	0.03
Retained placenta in previous delivery, requiring manual removal in theatre	O73	667	0.0000002
Caesarean section in previous delivery			70.7
Shoulder dystocia in previous delivery			
Multiple pregnancy	O30	651	26.4
Placenta praevia	O44	641.0-1; 762.0	4.4
Pre-eclampsia or pregnancy-induced hypertension	O13-15	642	90.5
Preterm labour or preterm prelabour rupture of membranes	O42; O60	644; 658.1	123.4
Placental abruption	O45	641.2	4.7
Anaemia (Hb<8.5g/dl) at onset of labour[72]			64.4
Confirmed intrauterine death			4.1
Induction of labour[73]			163.4
Substance misuse	F11; F14-16; F18-19	304	0.3
Alcohol dependency requiring assessment or treatment	F10	303	0.03
Onset of gestational diabetes	O24	648	76.7
Malpresentation – breech or transverse lie	O32	652.0-4; 652.6-9	54.0
Body mass index at booking of greater than 35 kg/m^2			
Recurrent antepartum haemorrhage	O46	No code	10.0
Small for gestational age in this pregnancy (less than fifth centile or reduced growth velocity on ultrasound)	O36.5	656.5	6.4
Abnormal fetal heart rate (FHR) / Doppler studies	O36.3	659.7; 763.81	0.008
Ultrasound diagnosis of oligo-/polyhydramnios	O40-41.0	657, 658.0	2.0
Previous myomectomy			
Previous hysterectomy	Q07-08	68.3-5; 68.9	0.002

[72] Haemoglobin level at onset of labour was not routinely recorded, so any woman whose lowest haemoglobin level in pregnancy was below 8.5 g/dl has been coded as 'high-risk'

[73] Induction via artificial rupture of membranes (ARM) was excluded

Indication	ICD-10 code(s) starting with:	ICD-9 code(s) starting with:	Incidence per 1,000 pregnancies resulting in live or still birth (SMMIS)
Medical conditions indicating individual assessment when planning place of birth			
Cardiac disease without intrapartum complications			
Atypical antibodies not putting the baby at risk of haemolytic disease Sickle-cell trait Thalassaemia trait			
Anaemia (Hb 8.5-10.5g/dl) at onset of labour[74]			
Hepatitis B/C with normal liver function tests Non-specific connective tissue disorders			
Unstable hypothyroidism such that a change in treatment is required			
Spinal abnormalities / previous fractured pelvis / neurological defects	M43; M47-8; Q76.2; S327-8	721; 756.11; 808, 344	
Liver disease without current abnormal liver function			
Crohn's disease / ulcerative colitis	K50-52	555-558	
Other factors indicating individual assessment when planning place of birth			
Previous stillbirth/neonatal death with a known non-recurrent cause			
Pre-eclampsia developing at term in previous pregnancy Placental abruption in previous pregnancy with good outcome			
History of previous baby more than 4.5kg[75]			
Extensive vaginal, cervical, or 3rd- or 4th-degree perineal trauma as a result of previous delivery	O70.2-3	664.2-3	0
Previous term baby with jaundice requiring exchange transfusion			
Antepartum bleeding in current pregnancy of unknown origin (single episode after 24 weeks of gestation)			

[74] Haemoglobin level at onset of labour was not routinely recorded, so any woman whose lowest haemoglobin level in pregnancy was in the range 8.5-10.5g/dl has been coded as 'medium-risk'

[75] The birthweight of the most recent baby only was recorded on SMMIS. If the woman had had a baby weighing more than 4.5kg but her most recent baby was below this weight, she will not have been classed as medium risk in the absence of other risk factors.

Indication	ICD-10 code(s) starting with:	ICD-9 code(s) starting with:	Incidence per 1,000 pregnancies resulting in live or still birth (SMMIS)
Body Mass Index at booking of 30-34 kg/m^2			
Blood pressure of 140 mmHg systolic or 90 mmHg diastolic on two occasions[76]			
Clinical or ultrasound suspicion of macrosomia	O33.5; O36.6	653.5; 656.6	1.1
Para 6 or more			
Recreational drug use			
Under current outpatient psychiatric care			
Age over 40 at booking			
Foetal abnormality			6.8
Major gynaecological surgery			
Cone biopsy or large loop excision of the transformation zone			
Fibroids	O34.1	218	0.3

[76] The number of occasions of raised blood pressure was not recorded on SMMIS, so a woman was classed as 'medium risk' if her highest diastolic blood pressure in pregnancy was 90-94 mmHg

Appendix D: Missing data

As explained in Section 3.3.3, the general approach to dealing with missing data was as follows:

- If fewer than 0.1% of records had data missing on a variable, those records were deleted, because it was judged that the number of observations with missing data was sufficiently small for these deletions not to affect the conclusions of the modelling process.
- If 0.1% or more of records had data missing on a variable, a 'missing' category was created and included as a measure within the model.
- If more than 12% of records had missing data on an explanatory variable, that variable was not included as a covariate.

Intended place of birth at booking model

Table D.1 shows the explanatory variables with missing data. Records with missing data for 'single, unsupported', parity, previous termination(s), previous miscarriage(s) and/or mother's age at delivery were deleted. In total, 1,757 records were deleted (0.3% of the total), leaving 514,020 to be used in this stage of the modelling.

Table D.1: Missing data for 'intended place of birth at booking' model

Variable	Missing observations N	%
Mother's height	88,392	17.1
Carstairs quintile	46,229	9.0
Mother's ethnic group	14,328	2.8
Single, unsupported?	437	0.1
Parity	84	<0.1
Previous termination(s)?	84	<0.1
Previous miscarriage(s)?	83	<0.1
Mother's age at delivery	6	<0.1

For the remaining three explanatory variables with missing data, exploratory analysis found that 'missingness' was not randomly distributed (see Sections 4.4.6, 4.4.7 and 4.4.9). For Carstairs quintile and mother's ethnic group, a 'missing' category was created so that those with missing data would be included in the model. The modelling found that missing ethnic group was not significantly associated with the outcomes of interest, so it was judged to be unnecessary to take further action on this covariate. Missing Carstairs quintile, on the other hand, was significantly associated with intention at booking, so ideally attempts would have been made to impute this information, e.g. by taking the mean of women using the same hospital. However, each hospital served a large and demographically diverse area, which would have made the mean Carstairs index largely meaningless.

For mother's height, 'missingness' was strongly associated with giving birth at home, so the inclusion of 'missing' as a category of mother's height would probably be a highly significant factor,

yet one that would not help to answer the research question. Imputation was considered, but given the amount of variation in human height, it was felt that any attempt at imputation would be severely flawed. For these reasons, and the high proportion of missing data for this variable, it was decided not to include mother's height in the modelling process. It should, however, be noted that it seems to be strongly associated with propensity to intend/have a home birth.

Changes in intended place of birth models

Figure 4.1 shows that:

- 507,574 women were recorded as intending a hospital birth at booking, of whom 1,005 (0.2%) changed their intention during pregnancy, and
- 6,882 women were recorded as intending a home birth at booking, of whom 795 (11.6%) changed their intention during pregnancy.

Table D.2 shows the explanatory variables with missing data for these two models.

Table D.2: Missing data for 'changing intended place of birth' models

	Changing from hospital to home model		Changing from home to hospital model	
Variable	N	%	N	%
Carstairs quintile	45,067	8.9	697	10.1
Mother's ethnic group	14,067	2.8	174	2.5
Number of antenatal clinic visits	8,404	1.7	487	7.1
Number of ultrasound scans	6,180	1.2	168	2.4
Single, unsupported?	425	0.1	4	<0.1
Mother's age at delivery	4	<0.1	0	0.0
Previous termination(s)?	3	<0.1	0	0.0

Because 'number of antenatal visits' and 'number of ultrasound scans' were slightly positively correlated (see Section 4.3.5) and 'number of antenatal clinic visits' had more missing data, it was decided to use solely 'number of ultrasound scans' as an indicator of the amount of medical attention received during pregnancy.

Observations with data missing for 'single, unsupported', mother's age and previous terminations were deleted. This resulted in the deletion of 432 observations from the 'changing from hospital to home' model, and 4 from the 'changing from home to hospital' model.

For some records it was not possible to establish whether or not the woman's intention had changed between booking and the end of pregnancy. These records were also deleted (655 from the 'changing from hospital to home' model and 13 from the 'changing from home to hospital' model). This left a total of 506,487 to be used in the 'changing from hospital to home' model and 6,865 in the 'changing from home to hospital' model. For the remaining explanatory variables with missing data, a 'missing' category was created.

'Who achieves a planned home birth' model

7,079 records (1.4%) were classed as having intended a home birth at the end of pregnancy, and this stage of modelling was based on this sub-group.

All of those intending a home birth at the end of pregnancy had their actual place of delivery recorded: 6,154 (86.9%) gave birth at home and 925 (13.1%) in hospital.

Table D.3 shows the explanatory variables with missing data.

Table D.3: Missing data for 'achieving a planned home birth' model

	Missing observations	
Variable	N	%
Carstairs quintile	675	9.5
Duration of labour	379	5.4
Pain relief used in labour	281	4.0
Mother's ethnic group	167	2.4
Number of ultrasound scans	164	2.3
Interpreter needed?	38	0.5
Single, unsupported?	4	0.1

Observations with data missing for 'interpreter needed' and 'single, unsupported' were deleted. This resulted in the deletion of 42 observations, leaving 7,037 to be used in the model. For the remaining variables with missing data, a 'missing' category was created.

'Duration of labour' was recorded in four fields: (1) length of 1st stage of labour, (2) length of 2nd stage of labour, (3) length of 3rd stage of labour and (4) total duration. As noted in Table D.3, total duration was missing in 379 cases, but 'length of 1st stage' was missing in only 208 cases. The two variables were found to be almost perfectly correlated (correlation coefficient = 0.99), so 'length of 1st stage' was used in the modelling as an indicator of labour duration, with a 'missing' category created so as not to lose the 208 observations with missing data on this variable.

'Labour complications' models

Once cases for which the intended place of birth was unknown (n=1,994) and unplanned home births (n=2,771) were excluded, 511,012 records were eligible for inclusion in these models. For all labour complications models except those with foetal distress and PPH as outcome, elective Caesareans were also excluded, leaving 480,635.

The outcome variables were derived from ICD codes and other fields (see Table 5.2), and it was assumed that each labour complication did not occur if it was not recorded in the database. Thus, there were no missing data for the outcome variables. Several of the explanatory variables had missing data, as detailed in Table D.4 (variables with no missing data are not shown).

Table D.4: Missing data for 'labour complications' models (including elective Caesareans)

	Missing observations			Missing observations	
Variable	**N**	**%**	**Variable**	**N**	**%**
Late bookers	62,874	12.3	"Patient category"	39	<0.1
Carstairs quintile	45,426	8.9	Sex of baby	11	<0.1
Mother's ethnic group	14,144	2.8	Mother's age	4	<0.1
Chorionic villus biopsy	13,409	2.6	Parity	3	<0.1
Amniocentesis	10,434	2.0	Number of previous miscarriages	2	<0.1
Number of ultrasound scans	6,222	1.2	Number of previous terminations	3	<0.1
Smoking status	2,616	0.5	Month of birth	1	<0.1
Interpreter required	2,615	0.5	Time of day of birth	1	<0.1
Single, unsupported mother	421	0.1			

Records with missing data for the shaded cells in Table D.4 were deleted. This resulted in the deletion of 58 records, leaving 510,954 to be used for these models. For the other remaining covariates with missing data, 'missing' categories were created to assess the extent to which 'missingness' was associated with the outcome.

Perinatal death models

Once cases for which the intended place of birth was unknown, antepartum stillbirths, lethal congenital anomalies, cases with birthweight below 500g, babies born before 22 weeks of gestation and unplanned home births are excluded, 508,683 records were eligible for inclusion in the models with perinatal mortality as an outcome. If indeterminate stillbirths are also excluded, 508,511 records were eligible.

There were no missing data for the outcome variable. Several of the explanatory variables had missing data, as detailed in Table D.5 (those with no missing data are not shown).

Table D.5: Missing data for perinatal death models

	Missing observations			Missing observations	
Variable	**N**	**%**	**Variable**	**N**	**%**
Late bookers	62,504	12.3	Single, unsupported mother	419	0.1
Carstairs quintile	45,224	8.9	"Patient category"	38	<0.1
Mother's ethnic group	14,075	2.8	Sex of baby	11	<0.1
Chorionic villus biopsy	13,329	2.6	Number of previous terminations	3	<0.1
Amniocentesis	10,361	2.0	Parity	3	<0.1
Number of ultrasound scans	6,172	1.2	Number of previous miscarriages	2	<0.1
Interpreter required	2,598	0.5	Month of birth	1	<0.1
Smoking status	2,590	0.5	Time of day of birth	1	<0.1

Records with missing data for the shaded cells in Table D.5 (n=53) were deleted, leaving 508,630 to be used for this model. For the other remaining covariates with missing data, 'missing' categories were created.

Appendix E: Covariates considered for each model

'Intention at booking' model

Table E.1: Explanatory variables included in the 'intended place of birth at booking' model building process

Explanatory variable	Notes
Year of delivery	Initially, all 13 years were included separately. However, when it became clear that the model should include a 'hospital*year' interaction, year was collapsed into 6 groups (1988-90, 1991-2, 1993-4, 1995-6, 1997-8, 1999-2000) to simplify the model.
Hospital	All 15 hospitals were included
Pre-pregnancy risk status	The model was concerned with intention at booking, i.e. before most pregnancy-related complications would have become apparent, so the classification of pregnancies into high-, medium- or low-risk was based only on conditions that would usually be evident before conception (i.e. those coloured green in Tables 4.5-6).
Mother's age at delivery	Age was treated as a categorical variable because the relationship between age and place of birth was non-linear (see Figure 4.14). Six categories were used to ensure there were sufficient numbers in each age band.
Mother's parity	Initially, this ordinal variable was transformed into a categorical variable with 6 levels (0, 1, 2, 3, 4 and 5+). However, when interaction terms involving parity were included in the model, the main effect for pregnancies of parity 4 or more had a p-value of greater than 0.05, and the interaction effects for pregnancies of parity 2 or more also tended to be greater than 0.05. For these reasons, and to simplify the model, parity was collapsed into three groups (0, 1 and 2+).
Previous miscarriage(s)	Initially, this ordinal variable was transformed into a 3-factor categorical variable (0, 1 or 2, 3+) to reflect the results of the exploratory analysis (see section 4.4.3.2). The early stages of modelling, however, found that there was no significant difference between women who had had one or two miscarriages and those who had had more than two, so it was collapsed into a binary variable (any/none).
Birthweight of last baby	Figure 4.18 shows a distinction between those whose last baby was low birthweight (<2500g) and those whose last baby was not. This continuous variable was therefore re-coded to a binary variable (low birthweight / not low birthweight). This will not have captured all women who had previously given birth to a low birthweight baby, because birthweight was only recorded for the most recent birth. However, only 22% of observations were to women who had given birth more than once before.
Single	This was included as a binary variable, as in the original database.
Mother's ethnic group	Figure 4.22 shows that the Oriental, Mediterranean, Black African and South Asian groups had a similar profile in terms of place of birth. These four groups were therefore combined to simplify the model.
Previous termination(s)?	This was originally an ordinal variable, but exploratory analysis (Section 4.4.3.3) found that the distinction was between women who had had any termination(s) and those who had had none, so it was re-coded into a binary variable (any/none).
Carstairs quintile	Quintiles 1 and 2 were almost identical in terms of their relationship with place of birth. Quintiles 3 and 4 were also almost identical. For simplicity, therefore, this became a variable with 4 levels: 1-2, 3-4, 5 and missing.

Table E.2: Explanatory variables included in the 'changing from hospital to home' model building process

Explanatory variable	Notes
Year	All 13 years were included separately.
Hospital	All 15 hospitals were included
Overall antenatal risk status	Initially, this was included with all three levels: high-, medium- and low-risk. At the bivariate level, however, there was no significant difference between low- and medium-risk, so the variable was collapsed into a binary one: high/not high.
Number of ultrasound scans	The exploratory analysis suggested that it was appropriate to turn this ordinal variable into a categorical one with 4 levels: 0, 1, 2 and 3+. During the modelling process it became clear that those who had one scan were not significantly different from those who had two, so these two categories were combined.
Mother's age at delivery	Initially, the same 6 categories were used as for the 'intention at booking' model. However, as the modelling progressed it became clear that the 35-39 and 40+ age groups were not significantly different from the 30-34 age group, so the three were collapsed into a single '30+' category. Thus, age became a categorical variable with 4 levels: <20, 20-24, 25-29 and 30+.
Mother's parity	Initially, this ordinal variable was transformed into a categorical variable with 6 levels (0, 1, 2, 3, 4 and 5+). However, when interaction terms involving parity were included in the model, parity was collapsed into three groups (0, 1 and 2+) for simplicity.
Previous miscarriage(s)	Initially, this ordinal variable was transformed into a 3-factor categorical variable (0, 1 or 2, 3+) to reflect the results of the exploratory analysis. The early stages of modelling, however, found that there was no significant difference between women who had had one or two miscarriages and those who had had more than two, so it was collapsed into a binary variable (any/none).
Birthweight of last baby	There was a distinction between those whose last baby was low birthweight (<2500g) and those whose last baby was not. This continuous variable was therefore re-coded to a binary variable (low birthweight / not low birthweight).
Single	This was included as a binary variable, as in the original database.
Mother's ethnic group	The Oriental, Mediterranean, Black African and South Asian groups had a similar profile in terms of place of birth. These four groups were therefore combined to simplify the model.
Interpreter?	Included as a binary variable, as in the original database.
Previous termination(s)?	This was originally an ordinal variable, but exploratory analysis (Section 4.4.3.3) found that the distinction was between women who had had one or more termination(s) and those who had had none, so it was re-coded into a binary variable (any/none).
Carstairs quintile	Quintiles 1 and 2 were almost identical in terms of their relationship with place of birth. Quintiles 3 and 4 were also almost identical. For simplicity, therefore, this became a variable with 4 levels: 1-2, 3-4, 5 and missing. As the modelling progressed, there was no significant difference between quintiles 1/2 and quintiles 3/4, so these were collapsed into a single category. Thus, Carstairs quintile became a variable with 3 levels: 1-4, 5 and missing.

Table E.3 details the explanatory variables included in the final model, and also explains why the others were excluded:

Table E.3: Explanatory variables included in, and excluded from, the 'changing from hospital to home' model

Included	Excluded (reason for exclusion)
Parity	Number of previous miscarriages (no association at the bivariate level)
Antenatal risk status	Last baby low birthweight (became non-significant once number of ultrasound scans and age were held constant)
Number of ultrasound scans	Carstairs quintile (became non-significant once age and 'single, unsupported' were held constant)
Year	Number of previous terminations (no bivariate association)
Ethnic group	Interpreter (became non-significant once ethnic group was held constant)
Hospital	
Age at delivery	
Single	

'Change from planned home birth to planned hospital birth' model

Table E.4: Explanatory variables included in the 'changing from home to hospital' model building process

Variable	Notes
Year	All 13 years were included separately.
Hospital	All 15 hospitals were included
Pre-pregnancy risk status	The model was concerned with intention at booking, so the classification of pregnancies into high-, medium- or low-risk was based only on conditions that would usually be evident before conception (i.e. those coloured green in Tables 4.5-6).
Risk factors developed during pregnancy	Initially, this was included with all three levels: high-, medium- and low-risk. However, the introduction of an interaction between this variable and hospital resulted in observations being dropped (see Table F.3). This was solved by collapsing this variable into a binary one (high risk factors / no high-risk factors).
Birthweight of current baby[77]	The initial stages of modelling indicated that only babies weighing less than 2500g were significantly different from the reference group, so this variable was collapsed into a binary one (low, not low)
No. of US scans	The exploratory analysis suggested that it was appropriate to turn this ordinal variable into a categorical one with 4 levels: 0, 1, 2 and 3+.
Mother's age at delivery	Age was treated as a categorical variable because the relationship between age and place of birth was non-linear. Six categories were used to ensure there were sufficient numbers in each age band.
Mother's parity	The key distinction for this stage of the decision-making process was between primiparae and multiparae, so this was collapsed into a binary variable (primip/not)
Previous miscarriage(s)	Initially, this ordinal variable was transformed into a 3-factor categorical variable (0, 1 or 2, 3+). The early stages of modelling found that there was no significant difference between women who had had one or two miscarriages and those who had had more than two, so it was collapsed into a binary variable (any/none).
Birthweight of last baby	There was a distinction between those whose last baby was low birthweight (<2500g) and those whose last baby was not. This continuous variable was therefore re-coded to a binary variable (low birthweight / not low birthweight).
Single	This was included as a binary variable, as in the original database.
Mother's ethnic group	The Oriental, Mediterranean, Black African and South Asian groups had a similar profile in terms of place of birth. These groups were combined to simplify the model.
Interpreter?	Included as a binary variable, as in the original database.
Previous termination(s)?	This was originally an ordinal variable, but exploratory analysis found that the distinction was between women who had had one or more termination(s) and those who had had none, so it was re-coded into a binary variable (any/none).
Carstairs quintile	Quintiles 1 and 2 were almost identical in terms of their relationship with place of birth. Quintiles 3 and 4 were also almost identical. Quintiles 1 and 2 were combined into a single category, as were quintiles 3 and 4.

[77] This was not included in the 'changing from hospital to home' model, on the assumption that the (predicted) size of the baby was unlikely to influence a decision to change from hospital to home, but it could well influence change from home to hospital.

Table E.5 details the explanatory variables included in the final model, and explains why others were excluded:

Table E.5: Explanatory variables included in, and excluded from, the 'changing from home to hospital' model

Included	Excluded (reason for exclusion)
Year	Previous miscarriage(s) (no bivariate association)
Hospital	Ethnic group (became non-significant once risk status, number of ultrasound scans, hospital and year were held constant)
Pre-pregnancy risk status	Interpreter needed (no bivariate association)
Risk factors developed during pregnancy	Previous termination(s) (no bivariate association)
Current baby low birthweight	Carstairs quintile (became non-significant once risk status was held constant)
Number of ultrasound scans	
Mother's age at delivery	
Primipara	
Last baby low birthweight	
Single	

Table E.6: Explanatory variables included in the 'who achieves a planned home birth?' model building process

Explanatory variable	Notes
Year	All 13 years were included separately.
Hospital	All 15 hospitals were included
Risk status at end of pregnancy	Pregnancies were classed as high-, medium- or low-risk based both on conditions that would usually be evident before conception and those that would have become apparent during pregnancy. During the modelling, medium-risk pregnancies were found not to be significantly different from low-risk pregnancies, so the variable was collapsed into a binary one (high/not high).
Complications during labour	Pregnancies were classed as having complications if one or more of the conditions listed in Table 4.8 were present during labour.
Duration of stage 1 of labour	This continuous variable was converted to a categorical one. Exploratory analysis suggested that the most appropriate bandings would be <3 hours, at least 3 but less than 6 hours, at least 6 but less than 9 hours, and 9 hours or longer.
Birthweight	Exploratory analysis suggested that 4 birthweight bands would be appropriate. The modelling process found that, once other factors were taken into account, there was no significant difference between those in the '4000-4499g' group and those in the '4500g+' group, so these two categories were collapsed in the final model.
Number of ultrasound scans	Exploratory analysis suggested that this ordinal variable should be categorical with 4 levels: 0, 1, 2 and 3+. During the modelling those who had 1 scan were not significantly different from those who had 2, so these categories were combined.
Mother's age at delivery	Age was treated as a categorical variable because the relationship between age and place of birth was non-linear. Six categories were used to ensure there were sufficient numbers in each age band.
Mother's parity	The key distinction was between primiparae and multiparae, so this was collapsed into a binary variable (primipara/not primipara)
Previous miscarriage(s)	Initially, this ordinal variable was transformed into a 3-factor categorical variable (0, 1 or 2, 3+). The modelling, however, found that there was no significant difference between women who had had 1-2 miscarriages and those who had had more than 2, so it was collapsed into a binary variable (any/none).
Birthweight of last baby	There was a distinction between those whose last baby was low birthweight (<2500g) and those whose last baby was not. This continuous variable was therefore re-coded to a binary variable (low birthweight / not low birthweight).
Single	This was included as a binary variable, as in the original database.
Mother's ethnic group	The Oriental, Mediterranean, Black African & South Asian groups had a similar profile in terms of place of birth. They were combined to simplify the model.
Interpreter?	Included as a binary variable, as in the original database.
Previous termination(s)?	This was originally ordinal, but the exploratory analysis found that the distinction was between women who had had one or more termination(s) and those who had had none, so it was re-coded into a binary variable (any/none).
Carstairs quintile	Quintiles 1 and 2 were almost identical in terms of their relationship with place of birth. Quintiles 3 and 4 were also almost identical. Quintiles 1 and 2 were combined into a single category, as were quintiles 3 and 4.

Table E.7 details the explanatory variables included in the final model, and explains why others were excluded:

Table E.7: Explanatory variables included in, and excluded from, the 'who achieves a planned home birth?' model

Included	Excluded (reason for exclusion)
Hospital providing care	Year of delivery (no significant bivariate association)
Risk status at end of pregnancy	Number of ultrasound scans (became non-significant once hospital was held constant)
Complications during labour	Mother's age at delivery (no significant bivariate association)
Duration of stage 1 of labour	Previous miscarriage(s) (no significant bivariate association)
Birthweight	Last baby low birthweight? (no significant bivariate association)
Primipara?	Single, unsupported (no significant bivariate association)
Mother's ethnic group	Previous termination(s) (became non-significant once birthweight was held constant)
Interpreter needed?	Carstairs quintile (became non-significant once mother's ethnic group was held constant)

'Labour complications' models

Table E.8: Explanatory variables included in the 'labour complications' model building process

Explanatory variable	Notes
Intended place of birth at end of pregnancy	Derived binary variable (see Section 4.1): home or hospital.
Year of birth	All 13 years were included separately. In the 'retained placenta' model, there was no significant difference between the years 1988-1991, so these years were collapsed into a single category (which became the new reference category), and 1996-2000 also became a single category.
Month of birth	All 12 months were included separately. In the 'failure to progress in stage 2 of labour' model, months were collapsed into 5 categories (Dec-Mar, Apr-Aug, Sep, Oct & Nov).
Time of birth	This was recorded to the nearest minute, and then transformed into a categorical variable with 12 levels (2-hour time slots). In the PPH model, all the time slots between 12:00 and 23:59 were collapsed into one category, because none was significantly associated with the outcome.
Hospital providing care	All 15 hospitals were included.
Parity	This ordinal variable was transformed into a categorical variable with 6 levels (0, 1, 2, 3, 4, 5+). In the 'failure to progress in stage 2 of labour' model, it was collapsed to 4 levels (0, 1, 2, >2).
Mother's age at delivery	Categorical variable with 8 levels (<16, 16-19, 20-24, 25-29, 30-34, 35-39, 40-44, 45+). In the 'failure to progress in stage 2 of labour' model, the '<20' groups were merged, as were the '40+' groups.

Table E.8 (cont'd): Explanatory variables included in the 'labour complications' model building process

Single, unsupported	Categorical variable (yes, no, missing).
"Patient category"	Categorical variable with 5 levels (normal, private, amenity, overseas visitor, missing).
Carstairs quintile	Categorical variable with 6 levels (1, 2, 3, 4, 5, missing).
Mother's ethnic group	Categorical variable with 7 levels (White European, Black African, Black Caribbean, South Asian, Oriental, Mediterranean, Other, missing).
Interpreter required?	Categorical variable (yes, no, missing).
Number of previous miscarriages	Continuous variable.
Number of previous terminations	Continuous variable.
Smoking status	Categorical variable with 5 levels (non-smoker, light (<10 per day), medium (10-19 per day), heavy (20+ per day), missing). In the PPH model, 'light', 'medium' and 'heavy' had similar coefficients so were collapsed into a single 'smoker' category.
Late bookers	Categorical variable with 3 levels (yes, no, missing), derived from weeks of gestation at booking.
Antenatal risk status	Of the 50 conditions coded as high- or medium- risk (see Tables 4.5 and 4.6), 35 were included as individual binary covariates (had condition, did not have condition). The others were combined into a binary 'other elevated risk' variable (yes, no) because there were hardly any cases with each individual condition (see Section 6.7.3).
Gestation >41 weeks?	Categorical variable (yes, no).
Number of ultrasound scans	Initially, this ordinal variable was transformed into a categorical variable with 7 levels (0, 1, 2, 3, 4, 5+, missing). In the 'foetal distress' model, it was reduced to 5 levels (0, 1, 2-4, 5+, missing) because the coefficients for 2, 3 and 4 were virtually identical and not significantly associated with the outcome.
Amniocentesis	Categorical variable with 3 levels (done, not done, missing).
Chorionic villus biopsy	Categorical variable with 3 levels (done, not done, missing).
Birthweight	This continuous variable was transformed into a categorical variable with 5 levels (<500g, 500-1499g, 1500-2499g, 2500-3999g, 4000g+). In the 'retained placenta' model, the 2500g-3999g and 4000g+ categories were combined into a 2500g+ category because the coefficients for the two were not significantly different. In the 'failure to progress in stage 1' model, the two smallest categories were combined because their coefficients were very similar and not significantly different from the reference group.
Sex of baby	Categorical variable with 3 levels (male, female, indeterminate).
Congenital abnormalities	Derived binary variable (see Section 6.5.5): yes or no.

Table E.9: Explanatory variables included in the model building process for perinatal death models

Explanatory variable	Notes
Intended place of birth at end of pregnancy	Derived binary variable: home or hospital.
Year of birth	All 13 years were included separately.
Month of birth	Initially, all 12 months were included separately. In the perinatal death model, March-December was treated as a single category because none of these months was significantly different from the reference month.
Time of birth	This was recorded to the nearest minute in the database, and was initially transformed into a categorical variable with 12 levels, i.e. 2-hour time slots starting at midnight. In the perinatal death model, the 8:00am-7:59pm slots were collapsed into a single category as none was significantly different from the reference category. In the infant resuscitation model, time of birth was collapsed to a binary variable (8:00am-9.59pm, 10:00pm-07:59am) because there was little variation in the coefficients between these two groups.
Hospital providing care	All 15 hospitals were included
Parity	This ordinal variable was transformed into a categorical variable with 6 levels (0, 1, 2, 3, 4, 5+). In the infant resuscitation model it was further collapsed to a binary variable (primipara, multipara) because the coefficients for parity 1 and over were very similar.
Mother's age at delivery	Categorical variable with 8 levels (<16, 16-19, 20-24, 25-29, 30-34, 35-39, 40-44, 45+). In the infant resuscitation model age was collapsed to four levels (<25, 25-34, 35-39, 40+).
Single, unsupported	Categorical variable (yes, no missing)
"Patient category"	Categorical variable with 5 levels (normal, private, amenity, overseas visitor, missing).
Carstairs quintile	Categorical variable with 6 levels (1, 2, 3, 4, 5, missing)
Mother's ethnic group	Categorical variable with 7 levels (White European, Black African, Black Caribbean, South Asian, Oriental, Mediterranean, Other, missing)
Interpreter required?	Categorical variable (yes, no, missing)
Number of previous miscarriages	Continuous variable, as its relationship with incidence of perinatal death was linear (see Section 6.4.8)
Number of previous terminations	Categorical variable with 4 levels (0, 1, 2, >2)
Smoking status	Categorical variable with 5 levels (non-smoker, light (<10 per day), medium (10-19 per day), heavy (20+ per day), missing)
Late bookers	Categorical variable with 3 levels (yes, no, missing)

Table E.9 (cont'd): Explanatory variables included in the model building process for perinatal death models

Explanatory variable	Notes
Antenatal risk status	Of the 54 conditions coded as high- or medium- risk, 24 were included as individual binary covariates (had condition, did not have condition). Six were combined into three categorical variables with three levels: haemoglobin level, BMI and blood pressure (see Section 6.7.3). Three (foetal abnormality, grand multiparity and being aged over 40) were excluded to avoid problems of collinearity with other covariates. The other 21 were excluded because none of the cases with the condition ended in perinatal death and therefore the model would not run.
Number of ultrasound scans	This ordinal variable was initially transformed into a categorical variable with 7 levels (0, 1, 2, 3, 4, 5+, missing). In the perinatal death model, it was collapsed to 4 levels (0, 1-4, >4, missing). In the infant resuscitation model it was collapsed to 5 levels (0, 1, 2-3, >3, missing).
Amniocentesis	Categorical variable with 3 levels (done, not done, missing)
Chorionic villus biopsy	Categorical variable with 3 levels (done, not done, missing)
Birthweight	Initially, this continuous variable was transformed into a categorical variable with 4 levels (<1500g (very low birthweight), 1500-2499g (low birthweight), 2500-3999g, 4000g+). In the perinatal death model, the results for the '4000g+' group were not significantly different from the '2500-3999g' group, so these two groups were merged, leaving 3 levels
Sex of baby	Categorical variable with 3 levels (male, female, indeterminate)
Congenital abnormalities	Derived binary variable: yes or no.
Labour complications	Each included as individual binary covariates (had complication, did not have complication).
Infant resuscitation: positive pressure/ cardiac massage	Derived binary variable: yes or no
Any infant resuscitation	Derived binary variable: yes or no

Appendix F: Model building

F.1 'Intended place of birth at booking' model

The building of an additive model resulted in all the explanatory variables being included in the model. Standardised residuals for the final additive model were calculated. Just 3.7% of observations had residuals outside the range -2 to 2, indicating that the overall fit of the model was good. Some groups were most likely to have large residuals:

- Those from non-white ethnic minority groups other than Black Caribbean
- Those receiving care from St Mary's Hospital
- Those aged under 20
- Those having their first baby
- Those giving birth before 1994

The exploratory analysis had already indicated that the explanatory variables in the above list may have interacted, so interactions were investigated as possible improvements to the additive model (see below full details). The addition of a 'year*hospital' interaction term improved the model more than any of the other two-way interactions tested. However, residual analysis showed that, after the addition of the 'year*hospital' interaction, the model fit remained relatively poor for the following groups:

- Those from non-white ethnic minority groups other than Black Caribbean
- Those aged under 20
- Those having their first baby

Further interactions involving the explanatory variables in this list were tested. The addition of a 'hospital*parity' interaction term made the biggest difference to the model. Further interactions involving hospital (e.g. with ethnic group and mother's age) were tested and found to improve the model, but they resulted in high levels of collinearity and observations being dropped due to predicting an intention to give birth in hospital perfectly, and so were not pursued. It should be noted, however, that hospital interacted with most of the other explanatory variables.

The addition of 'parity*ethnic group' and 'parity*age' interaction terms also improved the model. Likelihood Ratio Tests (LRTs) confirmed that these improvements were statistically significant ($p<0.001$).

Table F.1: Model selection for 'who intends a home birth at booking'

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Parity	3255.89	4	0.000	
Hospital	3255.42	14	0.000	
Ethnic group	2015.61	4	0.000	
Age	1586.24	5	0.000	
Year	1356.75	12	0.000	
Carstairs quintile	672.26	3	0.000	
Pre-pregnancy risk status	499.77	2	0.000	
Single?	221.20	1	0.000	
Last baby low birthweight?	90.88	1	0.000	
Previous termination(s)?	51.97	1	0.000	
Previous miscarriage(s)?	29.88	1	0.000	
Parity +				
Hospital	6487.43	18	0.000	
Ethnic group	5500.69	8	0.000	
Year	4639.22	16	0.000	
Pre-pregnancy risk status	4373.02	6	0.000	
Carstairs quintile	4122.78	7	0.000	
Age	3924.56	9	0.000	
Last baby low birthweight?	3507.99	5	0.000	
Single?	3343.23	5	0.000	
Previous termination(s)?	3305.74	5	0.000	
Previous miscarriage(s)?	3265.59	5	0.000	
Parity + hospital +				
Ethnic group	8354.54	22	0.000	
Year	7691.96	30	0.000	
Pre-pregnancy risk status	7633.46	20	0.000	
Carstairs quintile	7197.16	21	0.000	
Age	7162.74	23	0.000	
Last baby low birthweight?	6714.06	19	0.000	
Single?	6606.49	19	0.000	
Previous termination(s)?	6525.00	19	0.000	
Previous miscarriage(s)?	6495.92	19	0.000	
Parity + hospital + ethnic group +				W Middx went from OR <1 to OR >1 when parity and ethnic group added
Year	9666.94	34	0.000	
Pre-pregnancy risk status	9429.54	24	0.000	
Age	8964.31	27	0.000	
Carstairs quintile	8725.24	25	0.000	
Single?	8567.23	23	0.000	
Last baby low birthweight?	8532.22	23	0.000	
Previous termination(s)?	8416.62	23	0.000	
Previous miscarriage(s)?	8372.31	23	0.000	

Table F.1 (cont'd): Model selection for 'who intends a home birth at booking'

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Parity + hospital + ethnic group + year +				
Pre-pregnancy risk status	10797.46	36	0.000	
Age	10123.91	39	0.000	
Carstairs quintile	10100.95	37	0.000	
Single?	9863.66	35	0.000	
Last baby low birthweight?	9837.03	35	0.000	
Previous termination(s)?	9712.91	35	0.000	
Previous miscarriage(s)?	9692.48	35	0.000	
Parity + hospital + ethnic group + year + pre-pregnancy risk status +				
Age	11252.71	41	0.000	
Carstairs quintile	11202.21	39	0.000	
Single?	10994.41	37	0.000	
Last baby low birthweight?	10904.82	37	0.000	
Previous termination(s)?	10841.54	37	0.000	
Previous miscarriage(s)?	10814.38	37	0.000	
Parity + hospital + ethnic group + year + pre-pregnancy risk status + age +				
Carstairs quintile	11559.51	44	0.000	
Last baby low birthweight?	11348.00	42	0.000	
Single?	11340.06	42	0.000	
Previous termination(s)?	11297.16	42	0.000	
Previous miscarriage(s)?	11278.40	42	0.000	
Parity + hospital + ethnic group + year + pre-pregnancy risk status + age + Carstairs quintile +				
Last baby low birthweight?	11649.23	45	0.000	
Single?	11631.33	45	0.000	
Previous termination(s)?	11599.08	45	0.000	
Previous miscarriage(s)?	11583.39	45	0.000	
Parity + hospital + ethnic group + year + pre-pregnancy risk status + age + Carstairs quintile + last baby low birthweight? +				
Single?	11718.46	46	0.000	
Previous termination(s)?	11686.90	46	0.000	
Previous miscarriage(s)?	11671.97	46	0.000	
Parity + hospital + ethnic group + year + pre-pregnancy risk status + age + Carstairs quintile + last baby low birthweight? + single? +				
Previous termination(s)?	11747.93	47	0.000	
Previous miscarriage(s)?	11740.71	47	0.000	
Parity + hospital + ethnic group + year + pre-pregnancy risk status + age + Carstairs quintile + last baby low birthweight? + single? + previous termination(s)? +				
Previous miscarriage(s)?	11769.19	48	0.000	Final additive model

Table F.1 (cont'd): Model selection for 'who intends a home birth at booking'

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Final additive model +				
Year * hospital interaction	12531.65	201	0.000	46 levels p<0.05 – but a lot a dfs. Try collapsing year (88-90, 91-2, 93-4, 95-6, 97-8, 99-00)
Grouped year* hospital interaction	12308.48	104	0.000	18 levels p<0.05 All main effects for grouped year p=0 and LRχ^2 still higher than other interactions so use grouped year from now on
Hospital * parity interaction	12088.38	104	0.000	16 levels p<0.05, mostly involving parity 0 or parity 1 women. Main effect for parity 4+ non-significant. Try collapsing parity into 3 groups? (0, 1, 2+)
Hospital * grouped parity interaction	11990.49	74	0.000	16 levels p<0.05 i.e. same no as ungrouped parity (but higher proportion) so let's use this from now on
Hospital * ethnic group interaction	11999.74	101	0.000	16 levels p<0.05
Year * ethnic group interaction	11858.19	91	0.000	2 levels have p<0.05, both involving missing ethnicity (1990 & 2000). Not very enlightening…
Parity * Carstairs quintile interaction	11830.16	60	0.000	Several levels p<0.05
Hospital * age interaction	11824.94	115	0.000	11 levels p<0.05
Parity * ethnic group interaction	11820.11	64	0.000	The only level with p<0.05 is 'parity 0 / other nonwhite' (p=0.004)
Parity * age interaction	11814.43	67	0.000	Three levels p<0.05: 'parity 0/age <20' (p=0.000), 'parity 0/age 35-39 (p=0.005) and 'parity1/age <20' (p=0.000)
Carstairs quintile * ethnic group interaction	11808.99	60	0.000	4 levels p<0.05, but 3 of these involve cases with missing Carstairs quintile, so not very enlightening
Age * ethnic group interaction	11793.05	68	0.000	No levels p<0.05
Parity * pre-pregnancy risk status interaction	11789.80	56	0.000	The only significant level is 'parity 0/high risk' (p=0.002). Not very enlightening
Age * Carstairs quintile interaction	11786.28	63	0.000	The only level with p<0.05 is 'age <20 / most deprived quintile' (p=0.006). Not very enlightening
Age * risk status interaction	11778.86	58	0.000	No levels p<0.05
Parity * single? interaction	11776.17	52	0.000	No levels p<0.05
Year * age interaction				Exploratory analysis suggested no interaction
Year * parity interaction				Exploratory analysis suggested no interaction
Final additive model + grouped year*hospital +				
Hospital * grouped parity interaction	12554.06	130	0.000	16 levels p<0.05
Hospital * ethnic group interaction	12517.74	157	0.000	16 levels p<0.05, of which just 5 involve missing ethnic group
Hospital * age interaction	12346.68	171	0.000	9 levels p<0.05
Grouped parity * Carstairs quintile interaction	12321.21	108	0.000	4 levels p< 0.05
Grouped parity * ethnic group interaction	12316.88	110	0.000	5 levels p<0.05
Grouped parity * age interaction	12314.93	112	0.000	3 levels p<0.05

Table F.1 (cont'd): Model selection for 'who intends a home birth at booking'

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Final additive model + grouped year*hospital + grouped parity*hospital +				
Hospital * ethnic group interaction	12763.10	183	0.000	16 levels p<0.05 Lots of collinearity and 919 observations dropped due to predicting hospital birth perfectly. So decided not to pursue this
Hospital * age interaction	12620.19	197	0.000	12 levels p<0.05 Lots of collinearity and 3678 observations dropped due to predicting hospital birth perfectly. So decided not to pursue this
Grouped parity * ethnic group interaction	12588.37	138	0.000	4 levels p<0.05 LRT showed this to be significantly better model than the previous one (LR diff=34.31, 8dfs, p=0.000).
Grouped parity * age interaction	12583.39	140	0.000	2 levels p<0.05
Grouped parity * Carstairs quintile interaction	12564.85	136	0.000	3 levels p<0.05
Final additive model + grouped year*hospital + grouped parity*hospital + grouped parity*ethnic group +				
Grouped parity * age interaction	12619.14	148	0.000	2 levels p<0.05. LRT showed this to be significantly better than previous model (LR diff=30.77, 10dfs, p=0.0006).
Grouped parity * Carstairs interaction	12597.82	144	0.000	1 level p<0.05
Final additive model + grouped year*hospital + grouped parity*hospital + grouped parity*ethnic group + grouped parity*age group +				
Grouped parity * Carstairs interaction	12631.02	154	0.000	2 levels p<0.05, but LRT suggested not significantly better than previous model at 95% level (LR diff-11.88, 6 dfs, p=0.0648).

F.2 'Change from planned hospital birth to planned home birth' model

Standardised residuals were calculated for the final additive model, and just 3.2% were outside the range -2 to 2, indicating that the model fit was good overall. The following groups were most likely to have residuals outside of this range:

- Multiparae
- Low risk antenatally
- Received care from the Chelsea & Westminster or Stevenage units
- Delivered in 1993, 1998 or 1999
- White European
- One or two ultrasound scans during pregnancy
- Aged 30+
- Had a partner

Several two-way interactions were tested, mostly involving hospital (see below). However, due to the small number of women who changed their intention and the large number of hospitals, interactions tended to result in large numbers of observations being dropped due to predicting 'no change' perfectly. This pattern was evident for nearly all of the interaction terms tested. Only one was found to significantly improve the model without observations being dropped: hospital * parity. However, the predicted probabilities for this interaction showed that it did not contribute much to our understanding (see below). In the interests of parsimony, therefore, it was excluded from the final model.

Table F.2: Model selection for 'changing from hospital to home'

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Parity	504.18	2	0.0000	
Antenatal risk status	475.78	2	0.0000	Medium risk not sig diff from low risk. Combine into binary variable: high/not high
High risk antenatally	473.63	1	0.0000	Use this from now on
Hospital	441.91	14	0.0000	
Year	388.60	12	0.0000	94, 96, 97, 99, 00 not sig diff from 98 – possibly combine some years later
Ethnic group	305.67	4	0.0000	
Age	175.65	5	0.0000	35-39 not sig diff from 30-34 – possibly combine later
Number of ultrasound scans	156.68	4	0.0000	
Carstairs quintile	115.18	3	0.0000	
Single?	41.28	1	0.0000	
Interpreter required?	31.02	1	0.0000	
Last baby low birthweight?	4.73	1	0.0296	
Previous miscarriage(s)?	2.91	1	0.0881	Drop
Previous termination(s)?	0.14	1	0.7042	Drop
Parity +				
High risk antenatally	1031.84	3	0.0000	
Hospital	950.44	16	0.0000	
Year	898.79	14	0.0000	
Ethnic group	845.83	6	0.0000	
Number of ultrasound scans	658.92	6	0.0000	
Carstairs quintile	641.70	5	0.0000	
Age	565.96	7	0.0000	Less important once parity taken into account
Interpreter required	542.21	3	0.0000	
Last baby low birthweight	529.08	3	0.0000	
Single	521.36	3	0.0000	

Table F.2 (cont'd): Model selection for 'changing from hospital to home'

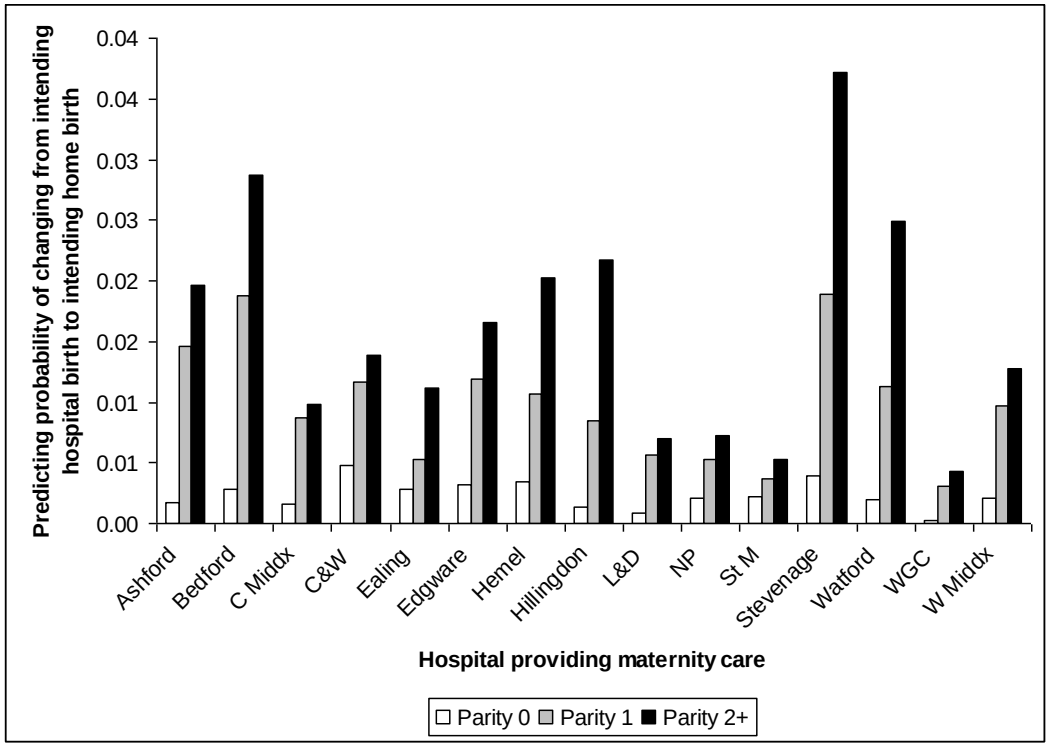
Explanatory variable(s) in model	LRχ^2	df	p	Notes
Parity + high risk antenatally +				
Hospital	1448.97	17	0.0000	
Year	1431.24	15	0.0000	
Ethnic group	1358.72	7	0.0000	'Other' not sig diff from W Euro
Carstairs quintile	1156.47	6	0.0000	
Number of ultrasound scans	1107.23	7	0.0000	
Age	1099.16	8	0.0000	
Interpreter required	1069.07	4	0.0000	
Single	1047.73	4	0.0000	
Last baby low birthweight	1045.37	4	0.0000	
Parity + high risk antenatally + hospital +				
Year	1826.56	29	0.0000	
Ethnic group	1670.27	21	0.0000	Just 'other nonwhite' sig diff from W Euro
Age	1511.33	22	0.0000	
Carstairs quintile	1500.84	20	0.0000	
Number of ultrasound scans	1497.72	21	0.0000	'2' not sig diff from '1' now – try collapsing into 0, 1/2, 3+
Grouped number of ultrasound scans	1494.58	20	0.0000	Use from now on
Interpreter required	1471.67	18	0.0000	
Last baby low birthweight	1460.99	18	0.0000	
Single	1460.45	18	0.0000	
Parity + high risk antenatally + hospital + year +				
Ethnic group	2055.24	33	0.0000	
Grouped number of ultrasound scans	1891.88	32	0.0000	
Carstairs quintile	1869.71	32	0.0000	
Age	1865.93	34	0.0000	
Interpreter required	1849.54	30	0.0000	
Last baby low birthweight	1836.91	30	0.0000	
Single	1834.90	30	0.0000	
Parity + high risk antenatally + hospital + year + ethnic group				
Grouped number of ultrasound scans	2125.80	36	0.0000	
Age	2087.57	38	0.0000	
Carstairs quintile	2070.92	36	0.0000	
Single	2070.36	34	0.0000	
Last baby low birthweight	2061.72	34	0.0000	
Interpreter required	2060.49	34	0.0000	P=0.068. Drop
Parity + high risk antenatally + hospital + year + ethnic group + grouped number of ultrasound scans +				
Age	2159.19	41	0.0000	Neither 35-39 nor 40+ sig diff from 30-34. Try collapsing 30+ into single category
Grouped age	2155.14	39	0.0000	Use from now on
Single	2141.53	37	0.0000	
Carstairs quintile	2140.58	39	0.0000	
Last baby low birthweight	2130.12	37	0.0000	P=0.051

Table F.2 (cont'd): Model selection for 'changing from hospital to home'

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Parity + high risk antenatally + hospital + year + ethnic group + grouped number of ultrasound scans + grouped age +				
Single	2163.17	40	0.0000	25-29 not sig diff from 30+ (p=0.054).
Carstairs quintile	2163.00	42	0.0000	Quintiles 3/4 not sig diff from 1/2 (p=0.097). Collapse into 3 groups: 1-4, 5, missing
Grouped Carstairs quintile	2160.23	41	0.0000	Use from now on
Last baby low birthweight	2158.85	40	0.0000	P=0.069. Drop
Parity + high risk antenatally + hospital + year + ethnic group + grouped number of ultrasound scans + grouped age + single +				
Grouped Carstairs quintile	2167.69	42	0.0000	LRT showed LR = 4.51 on 2 dfs, p=0.1047. Drop
Last baby low birthweight	2166.68	41	0.0000	P=0.8077. Drop
Parity + high risk antenatally + hospital + year + ethnic group + grouped number of ultrasound scans + grouped age + single+				
Hospital * parity	2202.99	68	0.0000	No interaction effects p<0.05. The parity pattern was similar in all hospitals (see graph below), so this interaction dropped.
Hospital * number of ultrasound scans	2202.06	67	0.0000	5,920 observations dropped due to predicting no change perfectly
Hospital * year	2096.11	160	0.0000	88,312 observations dropped due to predicting no change perfectly Try grouping year: 88-90, 91-92, 93-94, 95-96, 97-00
Hospital * grouped year	2197.03	81	0.0000	Still lost 23,259 observations due to predicting no change perfectly.
Parity * age	2171.92	45	0.0000	245 observations dropped due to predicting no change perfectly
Hospital * single	2168.19	52	0.0000	5,169 observations dropped due to predicting no change perfectly
Ethnic group * age	2167.24	50	0.0000	1,835 observations dropped due to predicting no change perfectly
High risk antenatally * ethnic group	2166.45	44	0.0000	None of the interaction effects had p<0.05. LRT showed no better than additive model (3.28(4) p=0.5128)
High risk antenatally * age	2166.21	43	0.0000	None of the interaction effects had p<0.05. LRT showed no better than additive model (3.04(3), p=0.3859)
Parity * ethnic group	2164.29	47	0.0000	5,975 observations dropped due to predicting no change perfectly
Parity * high risk antenatally	2163.51	42	0.0000	LR virtually identical to additive model
Hospital * age	2160.28	75	0.0000	9,907 observations dropped due to predicting no change perfectly

Hospital * ethnic group	2124.89	76	0.0000	28,172 observations dropped due to predicting no change perfectly
Hospital * high risk antenatally	2094.01	52	0.0000	23,348 observations dropped due to predicting no change perfectly

Figure F.1: Predicted probably of changing from hospital to home, by hospital providing care and parity



F.3 'Change from planned home birth to planned hospital birth' model

Standardised residuals were calculated for the final additive model, and 6.0% were outside the range -2 to 2, indicating that the model fit was less than ideal. The following groups were most likely to have large residuals:

- Those who did not develop risk factors during pregnancy
- Those receiving care from Chelsea & Westminster hospital
- Those giving birth in 1994

Most two-way interactions involving these variables improved the overall fit of the model, but resulted in observations being dropped due to predicting 'no change' perfectly (see below), and so were not included in the final model. A LRT found that one other interaction term made a significant improvement to the model: hospital * developed high-risk factors during pregnancy.

Table F.3: Model selection for 'changing from home to hospital'

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Developed risk factors during pregnancy	969.97	2	0.0000	
Number of ultrasound scans	195.42	4	0.0000	
Hospital	117.52	14	0.0000	
Birthweight	114.96	2	0.0000	4000g+ not sig diff from 2500-3999g. Collapse into binary variable: low b/w / not low b/w
Low birthweight	114.95	1	0.0000	Use from now on
Parity	39.14	2	0.0000	2+ not sig diff from 1. Collapse into binary variable: primip/not
Primipara	35.99	1	0.0000	Use from now on
Year	35.65	12	0.0004	
Pre-pregnancy risk status	30.32	2	0.0000	
Age	12.47	5	0.0289	
Ethnic group	11.88	4	0.0183	
Last baby low birthweight?	11.63	1	0.0007	
Single?	11.40	1	0.0007	
Carstairs quintile	8.20	3	0.0420	
Previous miscarriage(s)?	3.23	1	0.0723	Drop
Previous termination(s)?	1.05	1	0.3064	Drop
Interpreter required?	0.14	1	0.7054	Drop
Developed risk factors during pregnancy +				
Number of ultrasound scans	1072.36	6	0.0000	
Hospital	1059.62	16	0.0000	
Year	1035.86	14	0.0000	
Low birthweight	1020.66	3	0.0000	
Primipara	987.62	3	0.0000	
Age	984.24	7	0.0000	
Last baby low birthweight?	981.69	3	0.0000	
Pre-pregnancy risk status	979.51	4	0.0000	High risk now not sig diff from low risk, but medium risk is (?)
Single?	978.47	3	0.0000	
Ethnic group	977.20	6	0.0000	
Carstairs quintile	973.43	5	0.0000	Drop – no levels p<0.05
Developed risk factors during pregnancy + number of ultrasound scans +				
Hospital	1154.69	20	0.0000	
Low birthweight	1117.01	7	0.0000	
Year	1115.69	18	0.0000	
Primipara	1091.59	7	0.0000	
Age	1087.99	11	0.0000	
Single?	1082.42	7	0.0000	
Last baby low birthweight?	1081.92	7	0.0000	
Pre-pregnancy risk status	1080.66	8	0.0000	
Ethnic group	1080.58	10	0.0000	

Table F.3 (cont'd): Model selection for 'changing from home to hospital'

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Developed risk factors during pregnancy + number of ultrasound scans + hospital +				
Year	1210.56	32	0.0000	
Low birthweight	1196.40	21	0.0000	
Age	1173.52	25	0.0000	
Single?	1167.90	21	0.0000	
Ethnic group	1166.60	24	0.0000	
Primipara	1165.72	21	0.0000	
Pre-pregnancy risk status	1163.48	22	0.0000	
Last baby low birthweight?	1163.35	21	0.0000	
Developed risk factors during pregnancy + number of ultrasound scans + hospital + year +				
Low birthweight	1250.16	33	0.0000	
Age	1234.73	37	0.0000	
Single?	1224.59	33	0.0000	
Ethnic group	1220.33	36	0.0000	'Missing' is the only level with p<0.05. Drop
Pre-pregnancy risk status	1220.27	34	0.0000	
Last baby low birthweight?	1220.18	33	0.0000	
Primipara	1219.12	33	0.0000	
Developed risk factors during pregnancy + number of ultrasound scans + hospital + year + low birthweight +				
Age	1272.92	38	0.0000	
Single?	1262.90	34	0.0000	
Pre-pregnancy risk status	1261.10	35	0.0000	
Primipara	1258.57	34	0.0000	
Last baby low birthweight?	1257.12	34	0.0000	
Developed risk factors during pregnancy + number of ultrasound scans + hospital + year + low birthweight + age +				
Pre-pregnancy risk status	1286.23	40	0.0000	
Single?	1281.56	39	0.0000	
Last baby low birthweight?	1279.18	39	0.0000	
Primipara	1278.72	39	0.0000	
Developed risk factors during pregnancy + number of ultrasound scans + hospital + year + low birthweight + age + pre-pregnancy risk status +				
Single?	1294.55	41	0.0000	
Primipara	1292.95	41	0.0000	
Last baby low birthweight?	1292.62	41	0.0000	

Table F.3 (cont'd): Model selection for 'changing from home to hospital'

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Developed risk factors during pregnancy + number of ultrasound scans + hospital + year + low birthweight + age + pre-pregnancy risk status + single				
Primipara	1300.71	42	0.0000	
Last baby low birthweight?	1300.30	42	0.0000	
Developed risk factors during pregnancy + number of ultrasound scans + hospital + year + low birthweight + age + pre-pregnancy risk status + single + primip +				
Last baby low birthweight?	1307.51	43	0.0000	LRT: 6.80(1), p=0.0091
Final additive model +				
Hospital * year interaction	1374.75	160	0.0000	449 observations dropped due to predicting no change perfectly. Try grouping year
Hospital * grouped year interaction	1343.15	85	0.0000	50 observations dropped due to predicting no change perfectly
Hospital * developed risk factors during pregnancy	1368.88	68	0.0000	43 observations dropped due to predicting no change perfectly. Try risk as a binary variable (high/not high)
Hospital * developed high risk factors during pregnancy	1347.65	56	0.0000	LRT 40.15 (13), p=0.0001
Year * developed risk factors during pregnancy	1327.10	65	0.0000	72 observations dropped due to predicting no change perfectly. Try grouping year
Grouped year * developed risk factors during pregnancy	1309.63	43	0.0000	Not sig better than additive model

F.4 'Who achieves a planned home birth' model

Standardised residuals were calculated for the final additive model, and 6.1% were outside the range -2 to 2, indicating that the model fit could have been better. Those receiving care from Hillingdon hospital were most likely to have large residuals.

Several two-way interactions were tested, mostly involving hospital (see Table F.4). Most of these resulted in observations being dropped due to predicting home birth perfectly. LRTs showed that two made a significant improvement to the model: hospital * complications in labour and hospital * primipara. Once the former was added to the model, the latter became non-significant, so the final model contained just the interaction between hospital and complications in labour.

Table F.4: Model selection for 'who achieves a planned home birth?'

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Complications during labour	571.19	1	0.0000	
Duration of stage 1 of labour	470.96	4	0.0000	
Parity	389.75	2	0.0000	Parity 2+ not sig diff from Parity 1. Try collapsing to 2 groups: primip, not primip
Primip?	388.25	1	0.0000	Use this instead of parity from now on
Hospital	236.19	14	0.0000	6 hospitals p<0.05
Risk status at end of pregnancy	163.36	2	0.0000	Medium risk not sig diff from low risk. Collapse into high/not high?
High risk at end of pregnancy?	163.31	1	0.0000	Use this from now on instead of high/medium/low
Birthweight	41.53	3	0.0000	
Carstairs quintile	39.14	3	0.0000	
Number of ultrasound scans	24.15	4	0.0001	2 not sig diff from 1, so collapse into 0, 1-2, 3, missing
Grouped number of ultrasound scans	23.54	3	0.0000	Use this from now on
Ethnic group	20.87	4	0.0003	Just 'other nonwhite' p<0.05.
Previous termination(s)?	18.76	1	0.0000	
Interpreter needed?	10.59	1	0.0011	
Year	7.32	12	0.8360	Drop
Age	5.22	5	0.3893	Drop
Single?	3.74	1	0.0531	p<0.05 for coefficient
Last baby low birthweight?	3.20	1	0.0738	Drop
Previous miscarriage(s)?	0.26	1	0.6067	Drop
Complications during labour +				
Primip?	841.50	2	0.0000	
Duration of stage 1 of labour	817.95	5	0.0000	
Hospital	778.15	15	0.0000	9 hospitals p<0.05
High risk at end of pregnancy?	712.26	2	0.0000	
Birthweight	623.92	3	0.0000	
Carstairs quintile	601.75	4	0.0000	
Grouped number of ultrasound scans	597.63	4	0.0000	
Ethnic group	595.01	5	0.0000	
Previous termination(s)?	591.23	2	0.0000	
Interpreter needed?	581.47	2	0.0000	
Single?	577.04	2	0.0000	
Complications during labour + primip +				
High risk at end of pregnancy?	1002.22	3	0.0000	
Hospital	955.90	16	0.0000	7 hosps p<0.05
Duration of stage 1 of labour	948.28	6	0.0000	Less important once parity controlled for – primips tend to have longer labours so this makes sense
Birthweight	885.71	4	0.0000	
Carstairs quintile	866.61	5	0.0000	
Ethnic group	864.15	6	0.0000	
Grouped number of ultrasound scans	858.39	5	0.0000	
Interpreter needed?	852.60	3	0.0000	
Previous termination(s)?	851.85	3	0.0000	
Single?	843.26	3	0.0000	

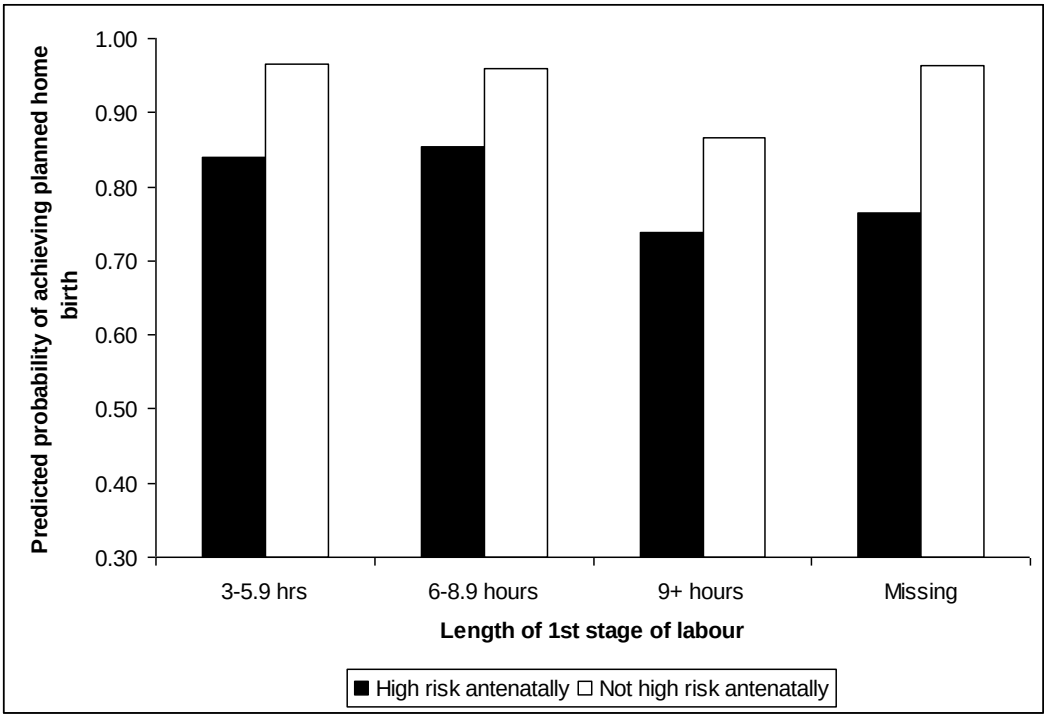
Table F.4 (cont'd): Model selection for 'who achieves a planned home birth?'

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Complications during labour + primip + high risk at end of pregnancy				
Duration of stage 1 of labour	1107.39	7	0.0000	
Hospital	1099.26	17	0.0000	
Birthweight	1040.30	5	0.0000	
Carstairs quintile	1022.85	6	0.0000	
Ethnic group	1022.25	4	0.0000	
Grouped number of ultrasound scans	1014.47	6	0.0000	
Interpreter needed?	1014.25	4	0.0000	
Previous termination(s)?	1010.72	4	0.0000	
Single?	1003.47	4	0.0000	
Complications during labour + primip + high risk at end of pregnancy + duration of stage 1 of labour +				
Hospital	1208.83	21	0.0000	
Carstairs quintile	1127.61	10	0.0000	
Birthweight	1151.06	9	0.0000	
Ethnic group	1127.49	11	0.0000	
Interpreter needed?	1119.59	8	0.0000	
Grouped number of ultrasound scans	1119.06	10	0.0000	
Previous termination(s)?	1115.54	8	0.0000	
Single?	1109.05	8	0.0000	p>0.05 - drop
Complications during labour + primip + high risk at end of pregnancy + duration of stage 1 of labour + hospital +				
Birthweight	1257.44	23	0.0000	4500+ not significant. Collapsed into 3 groups: <2500g, 2500-3999, 4000+. Made no difference to LR!
Ethnic group	1220.75	25	0.0000	
Interpreter needed?	1217.88	22	0.0000	
Grouped number of ultrasound scans	1214.37	24	0.0000	None p<0.05. Drop
Carstairs quintile	1214.35	24	0.0000	Less important once hospital controlled for – suggests hospital is stronger influence than socio-economic profile of user base
Previous termination(s)?	1213.04	22	0.0000	
Complications during labour + primip + high risk at end of pregnancy + duration of stage 1 of labour + hospital + birthweight +				
Ethnic group	1268.14	27	0.0000	
Interpreter needed?	1266.81	24	0.0000	
Carstairs quintile	1262.06	26	0.0000	
Previous termination(s)?	1260.53	24	0.0000	p>0.05. Drop.
Complications during labour + primip + high risk at end of pregnancy + duration of stage 1 of labour + hospital + birthweight + ethnic group +				
Interpreter needed?	1274.20	28	0.0000	
Carstairs quintile	1271.81	30	0.0000	None p<0.05. Drop.

Table F.4 (cont'd): Model selection for 'who achieves a planned home birth?'

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Complications during labour + primip + high risk at end of pregnancy + duration of stage 1 of labour + hospital + birthweight + ethnic group + interpreter needed +				
Hospital * labour length interaction	1330.20	80	0.0000	30 observations dropped due to predicting home birth perfectly.
Hospital * risk status during labour interaction	1294.47	42	0.0000	
Hospital * high risk at end of pregnancy? interaction	1293.74	41	0.0000	19 observations dropped due to predicting home birth perfectly
Hospital * ethnic group interaction	1292.20	65	0.0000	77 observations dropped due to predicting home birth perfectly
Hospital * primip interaction	1286.43	42	0.0000	
High risk at end of pregnancy * labour length interaction	1292.57	32	0.0000	LRT shows improvement on additive model. But the predicted probabilities resulting from this interaction were of no substantive interest (see Figure F.2). So not pursued
Risk status during labour * labour length interaction	1277.91	32	0.0000	LRT showed not significantly better than additive model (p=0.4467)
Final additive model + Hospital * risk status during labour interaction +				
Hospital * primip interaction	1306.13	56	0.0000	LRT showed not significantly better than model with one interaction (p=0.2508)

Figure F.2: Predicted probability of achieving a planned home birth, by duration of stage 1 of labour and pregnancy risk status



F.5 Foetal distress model

Table F.5: Model selection for foetal distress

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Parity	15693.39	5	0.0000	All sig diff from parity 2
Antenatal risk status [block]	4461.84	38	0.0000	18 conditions p<0.05
Hospital	3894.44	14	0.0000	All sig diff from Hillingdon bar 1
Gestation > 41 weeks?	2564.82	1	0.0000	P=0.000
Time of birth	1518.40	11	0.0000	All sig diff from 10:00-11:59
Ethnic group	1297.37	7	0.0000	All sig diff from W Eur bar Oriental
Intended place of birth	1215.16	1	0.0000	P=0.000. Home safer
Patient category	517.23	3	0.0000	All sig diff from 'normal' bar 'amenity'
No of US scans	402.40	6	0.0000	All sig diff from '1' except '2'
Single	333.43	2	0.0000	'Yes' & 'missing' sig diff from 'no'
Birthweight	255.95	4	0.0000	All sig diff from 2500-3999g
Sex of baby	236.18	2	0.0000	Male sig diff from female
Previous miscarriages	205.75	0	0.0000	P=0.000
Age	194.70	7	0.0000	16-19, 20-24, 25-29 & 40-44 sig diff from 30-34
Carstairs quintile	194.63	5	0.0000	All sig diff from '1'
Amniocentesis	167.94	2	0.0000	'Missing' sig diff from 'no'
CVB	147.03	2	0.0000	'Yes' &'missing' sig diff from 'no'
Year	116.77	12	0.0000	All years sig diff from 1988
Interpreter required	111.16	1	0.0000	P=0.000
Smoking status	98.04	4	0.0000	Light & medium sig diff from nonsmoker
Month	24.31	11	0.0115	Just 2 months sig diff from Sep
Late booker	20.33	2	0.0000	'Missing' sig diff from 'no'
Previous terminations	19.40	1	0.0000	P=0.000
Congenital abnormalities	11.73	1	0.0006	P=0.001
Parity +				
Hospital	19828.74	19	0.0000	All sig diff from Hillingdon bar 1
Antenatal risk status [block]	19536.16	43	0.0000	17 conditions p<0.05
Gestation > 41 weeks?	17718.67	6	0.0000	P=0.000
Ethnic group	17377.24	12	0.0000	All sig diff from W Eur
Time of birth	16832.17	16	0.0000	All sig diff from 10:00-11:59
Intended place of birth	16387.21	6	0.0000	P=0.000. Home safer
Age	16242.94	12	0.0000	All sig diff from 30-34 except 45+
Patient category	16216.83	8	0.0000	All sig diff from 'normal' bar 'amenity'
Birthweight	16119.07	9	0.0000	All sig diff from 2500-3999g
No of US scans	16104.59	11	0.0000	All sig diff from '1'
Carstairs quintile	15996.49	10	0.0000	All sig diff from '1' except 'missing'
Sex of baby	15933.93	7	0.0000	Male sig diff from female
Amniocentesis	15904.52	7	0.0000	'Yes' & 'missing' sig diff from 'no'
CVB	15835.70	7	0.0000	'Yes' & 'missing' sig diff from 'no'
Interpreter required	15835.33	6	0.0000	P=0.000
Year	15822.17	17	0.0000	All years sig diff from 1988
Smoking status	15815.37	9	0.0000	All sig diff from 'non' bar 'missing'
Single	15723.90	7	0.0000	'Yes' and 'missing' sig diff from 'no'
Month	15718.64	16	0.0000	7 months sig diff from Sep
Late booker	15713.93	7	0.0000	'Missing' sig diff from 'no'
Previous terminations	15708.41	6	0.0000	P=0.000
Congenital abnormalities	15699.97	6	0.0000	P=0.010
Previous miscarriages	15697.09	6	0.0000	P=0.054

Table F.5 (cont'd): Model selection for foetal distress

Explanatory variable(s) in model	$LR\chi^2$	df	p	Notes
Parity + hospital +				
Antenatal risk status [block]	23696.71	57	0.0000	18 conditions p<0.05
Gestation > 41 weeks?	21967.67	20	0.0000	P=0.000
Ethnic group	21025.79	26	0.0000	All sig diff from W Euro
Time of birth	20979.17	30	0.0000	All sig diff from 10:00-11:59
Intended place of birth	20438.08	20	0.0000	P=0.000. Home safer
Age	20413.72	26	0.0000	All sig diff from 30-34 except 45+
Patient category	20308.72	22	0.0000	Just 'private' sig diff from 'normal'
Birthweight	20299.17	23	0.0000	All sig diff from 2500-3999g except 500-1499g
No of US scans	20118.92	25	0.0000	'0', '5+' and 'missing' sig diff from '1'
Carstairs quintile	20114.79	24	0.0000	All sig diff from '1'
Sex of baby	20066.82	21	0.0000	Male sig diff from female
Amniocentesis	19989.50	21	0.0000	'Yes' and 'missing' sig diff from 'no'
Smoking status	19986.52	23	0.0000	All sig diff from 'non' bar 'missing'
Year	19972.97	31	0.0000	All years sig diff from 1988
Interpreter required	19941.32	20	0.0000	P=0.000
CVB	19898.41	21	0.0000	'Missing' sig diff from 'no'
Single	19856.91	21	0.0000	'Yes' and 'missing' sig diff from 'no'
Month	19852.29	30	0.0000	7 months sig diff from Sep
Late booker	19845.72	21	0.0000	'Yes' and 'missing' sig diff from 'no'
Previous terminations	19836.08	20	0.0000	P=0.007
Congenital abnormalities	19835.32	20	0.0000	P=0.010
Previous miscarriages	19832.19	20	0.0000	P=0.063
Parity + hospital + antenatal risk status [block] +				
Gestation > 41 weeks?	25514.48	58	0.0000	P=0.000
Birthweight	24934.47	61	0.0000	All sig diff from 2500-3999g
Ethnic group	24814.81	64	0.0000	All sig diff from W Euro
Time of birth	24752.37	68	0.0000	All sig diff from 10:00-11:59
Age	24358.27	64	0.0000	All sig diff from 30-34 except 45+
Intended place of birth	24331.11	58	0.0000	P=0.000. Home safer
Patient category	24140.16	60	0.0000	Just 'private' sig diff from 'normal'
Carstairs quintile	23953.87	62	0.0000	All sig diff from '1' except '2'
Sex of baby	23937.79	59	0.0000	Male sig diff from female
Smoking status	23906.80	61	0.0000	All sig diff from 'non' bar 'missing'
Year	23845.27	69	0.0000	All years sig diff from 1988
No of US scans	23826.42	63	0.0000	'0', '4', '5+' and 'missing' sig diff from '1'
Amniocentesis	23813.24	59	0.0000	'Yes' and 'missing' sig diff from 'no'
Interpreter required	23810.46	58	0.0000	P=0.000
CVB	23745.93	59	0.0000	'Yes' and 'missing' sig diff from 'no'
Month	23722.14	68	0.0000	7 months sig diff from Sep
Single	23711.51	59	0.0000	'Yes' and 'missing' sig diff from 'no'
Previous terminations	23709.57	58	0.0000	P=0.000
Previous miscarriages	23706.40	58	0.0000	P=0.002
Late booker	23704.72	59	0.0000	'Missing' sig diff from 'no'
Congenital abnormalities	23703.00	58	0.0000	P=0.012

Table F.5 (cont'd): Model selection for foetal distress

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Parity + hospital + antenatal risk status [block] + gestation >41 weeks +				
Birthweight	26694.62	62	0.0000	All sig diff from 2500-3999g
Ethnic group	26681.97	65	0.0000	All sig diff from W Eur except Oriental
Time of birth	26511.70	69	0.0000	All sig diff from 10:00-11:59
Age	26156.03	65	0.0000	All sig diff from 30-34 except 45+
Intended place of birth	26144.27	59	0.0000	P=0.000. Home safer
Patient category	25932.09	61	0.0000	Just 'private' sig diff from 'normal'
Carstairs quintile	25782.62	63	0.0000	All sig diff from '1' except '2'
Sex of baby	23739.11	60	0.0000	Male sig diff from female
Smoking status	25723.14	62	0.0000	All sig diff from 'non' bar 'missing'
Year	25657.63	70	0.0000	All years sig diff from 1988
No of US scans	25645.67	64	0.0000	'0', '4' & 'missing' sig diff from '1'
Amniocentesis	25627.49	60	0.0000	'Yes' and 'missing' sig diff from 'no'
Interpreter required	25625.52	59	0.0000	P=0.000
CVB	25562.46	60	0.0000	'Yes' and 'missing' sig diff from 'no'
Month	25540.65	69	0.0000	8 months sig diff from Sep
Single	25529.07	60	0.0000	'Yes' and 'missing' sig diff from 'no'
Previous terminations	25528.31	59	0.0000	P=0.000
Previous miscarriages	25525.08	59	0.0000	P=0.001
Late booker	25522.65	60	0.0000	'Missing' sig diff from 'no'
Congenital abnormalities	25520.34	59	0.0000	P=0.015
Parity + hospital + antenatal risk status [block] + gestation >41 weeks + birthweight +				
Ethnic group	27820.25	69	0.0000	All sig diff from W Eur except Oriental
Time of birth	27665.47	73	0.0000	All sig diff from 10:00-11:59
Age	27339.80	69	0.0000	All sig diff from 30-34
Intended place of birth	27326.15	63	0.0000	P=0.000. Home safer
Patient category	27099.54	65	0.0000	Just 'private' sig diff from 'normal'
Carstairs quintile	26949.16	67	0.0000	All sig diff from '1' except '2'
Sex of baby	26923.81	64	0.0000	Male sig diff from female
Smoking status	26880.32	66	0.0000	All sig diff from 'non' bar 'missing'
Year	26843.36	74	0.0000	All years sig diff from 1988
No of US scans	26840.40	68	0.0000	'0', '4' & 'missing' sig diff from '1'
Amniocentesis	26813.39	64	0.0000	'Yes' and 'missing' sig diff from 'no'
Interpreter required	26805.10	63	0.0000	P=0.000
CVB	26748.77	64	0.0000	'Yes' and 'missing' sig diff from 'no'
Month	26720.67	73	0.0000	8 months sig diff from Sep
Single	26711.57	64	0.0000	'Yes' and 'missing' sig diff from 'no'
Late booker	26708.25	64	0.0000	'Missing' sig diff from 'no'
Previous terminations	26707.85	63	0.0000	P=0.000
Previous miscarriages	26702.69	63	0.0000	P=0.004
Congenital abnormalities	26698.34	63	0.0000	P=0.053

Table F.5 (cont'd): Model selection for foetal distress

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Parity + hospital + antenatal risk status [block] + gestation >41 weeks + birthweight + ethnic group +				
Time of birth	28801.61	80	0.0000	All sig diff from 10:00-11:59
Age	28560.93	76	0.0000	All sig diff from 30-34
Intended place of birth	28398.01	70	0.0000	P=0.000. Home safer
Smoking status	28197.07	73	0.0000	All sig diff from 'non' bar 'missing'
Patient category	28152.64	72	0.0000	Just 'private' sig diff from 'normal'
Sex of baby	28043.43	71	0.0000	Male sig diff from female
Year	27977.34	81	0.0000	All years sig diff from 1988 bar 2000
No of US scans	27960.45	75	0.0000	'0', '5+' & 'missing' sig diff from '1'
Amniocentesis	27944.59	71	0.0000	'Yes' and 'missing' sig diff from 'no'
Carstairs quintile	27926.81	74	0.0000	All sig diff from '1' except '2'
CVB	27867.05	71	0.0000	'Missing' sig diff from 'no'
Interpreter required	27859.43	70	0.0000	P=0.000
Late booker	27845.97	71	0.0000	'Yes' and 'missing' sig diff from 'no'
Month	27845.54	80	0.0000	8 months sig diff from Sep
Single	27840.12	71	0.0000	'Yes' and 'missing' sig diff from 'no'
Previous miscarriages	27832.36	70	0.0000	P=0.000
Previous terminations	27828.07	70	0.0000	P=0.005
Congenital abnormalities	27823.02	70	0.0000	P=0.095
Parity + hospital + antenatal risk status [block] + gestation >41 weeks + birthweight + ethnic group + time of birth +				
Age	29548.73	87	0.0000	All sig diff from 30-34
Intended place of birth	29368.70	81	0.0000	P=0.000. Home safer
Smoking status	29178.80	84	0.0000	All sig diff from 'non' bar 'missing'
Patient category	29144.96	83	0.0000	Just 'private' sig diff from 'normal'
Sex of baby	29025.11	82	0.0000	Male sig diff from female
Year	28958.94	92	0.0000	All years sig diff from 1988
No of US scans	28943.10	86	0.0000	'0', '5+' & 'missing' sig diff from '1'
Amniocentesis	28927.67	82	0.0000	'Yes' and 'missing' sig diff from 'no'
Carstairs quintile	28907.10	85	0.0000	All sig diff from '1' except '2'
CVB	28849.10	82	0.0000	'Missing' sig diff from 'no'
Interpreter required	28840.51	81	0.0000	P=0.000
Month	28827.18	91	0.0000	8 months sig diff from Sep
Late booker	28826.72	82	0.0000	'Yes' and 'missing' sig diff from 'no'
Single	28821.14	82	0.0000	'Yes' and 'missing' sig diff from 'no'
Previous miscarriages	28813.14	81	0.0000	P=0.001
Previous terminations	28809.57	81	0.0000	P=0.005
Congenital abnormalities	28804.22	81	0.0000	P=0.106

Table F.5 (cont'd): Model selection for foetal distress

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Parity + hospital + antenatal risk status [block] + gestation >41 weeks + birthweight + ethnic group + time of birth + age +				
Smoking status	30180.00	91	0.0000	All sig diff from 'non' bar 'missing'
Intended place of birth	30146.58	88	0.0000	P=0.000. Home safer
. Patient category	29943.07	90	0.0000	Just 'private' sig diff from 'normal'
Carstairs quintile	29819.06	92	0.0000	All sig diff from '1'
Sex of baby	29775.03	89	0.0000	Male sig diff from female
Year	29717.09	99	0.0000	All years sig diff from 1988 bar 2000
No of US scans	29694.98	93	0.0000	'0', '5+' & 'missing' sig diff from '1'
Single	29658.72	89	0.0000	'Yes' and 'missing' sig diff from 'no'
Amniocentesis	29632.83	89	0.0000	'Missing' sig diff from 'no'
CVB	29610.69	89	0.0000	'Yes' and 'missing' sig diff from 'no'
Interpreter required	29602.86	88	0.0000	P=0.000
Month	29575.73	98	0.0000	7 months sig diff from Sep
Late booker	29554.58	89	0.0000	'Missing' sig diff from 'no'
Previous terminations	29551.74	88	0.0000	P=0.082
Congenital abnormalities	29551.30	88	0.0000	P=0.109
Previous miscarriages	29549.11	88	0.0000	P=0.537
Parity + hospital + antenatal risk status [block] + gestation >41 weeks + birthweight + ethnic group + time of birth + age + smoking status +				
Intended place of birth	30760.22	92	0.0000	P=0.000. Home safer
Patient category	30539.98	94	0.0000	Just 'private' sig diff from 'normal'
Sex of baby	30399.37	93	0.0000	Male sig diff from female
Carstairs quintile	30372.30	96	0.0000	All sig diff from '1'
Year	30337.38	103	0.0000	All years sig diff from 1988 bar 2000
No of US scans	30321.46	97	0.0000	'0', '5+' & 'missing' sig diff from '1'
Amniocentesis	30258.46	93	0.0000	'Missing' sig diff from 'no'
Interpreter required	30245.66	92	0.0000	P=0.000
CVB	30236.90	93	0.0000	'Yes' and 'missing' sig diff from 'no'
Single	30228.16	93	0.0000	'Yes' and 'missing' sig diff from 'no'
Month	30205.66	102	0.0000	7 months sig diff from Sep
Late booker	30189.88	93	0.0000	'Missing' sig diff from 'no'
Congenital abnormalities	30182.82	92	0.0000	P=0.093. Drop – has been non-sig for last 5 iterations
Previous terminations	30180.50	92	0.0000	P=0.478
Previous miscarriages	30180.11	92	0.0000	P=0.745

Table F.5 (cont'd): Model selection for foetal distress

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Parity + hospital + antenatal risk status [block] + gestation >41 weeks + birthweight + ethnic group + time of birth + age + smoking status + intended place of birth +				
Patient category	31137.26	95	0.0000	Just 'private' sig diff from 'normal'
Sex of baby	30979.42	94	0.0000	Male sig diff from female
Carstairs quintile	30943.74	97	0.0000	All sig diff from '1'
Year	30919.69	104	0.0000	All years sig diff from 1988 bar 2000
No of US scans	30890.93	98	0.0000	'0', '5+' & 'missing' sig diff from '1'
Amniocentesis	30834.38	94	0.0000	'Missing' sig diff from 'no'
Interpreter required	30823.37	93	0.0000	P=0.000
CVB	30814.60	94	0.0000	'Yes' and 'missing' sig diff from 'no'
Single	30805.30	94	0.0000	'Yes' and 'missing' sig diff from 'no'
Month	30785.40	103	0.0000	7 months sig diff from Sep
Late booker	30768.52	94	0.0000	'Missing' sig diff from 'no'
Previous terminations	30760.86	93	0.0000	P=0.423
Previous miscarriages	30760.47	93	0.0000	P=0.613
Parity + hospital + risk status [block] + gestation >41 weeks + birthweight + ethnic group + time of birth + age + smoking status + intended place of birth + patient category +				
Sex of baby	31357.57	97	0.0000	Male sig diff from female
Year	31303.98	107	0.0000	All years sig diff from 1988 bar 2000
Carstairs quintile	31290.33	100	0.0000	All sig diff from '1'
No of US scans	31202.34	101	0.0000	'0', '5+' & 'missing' sig diff from '1'
Interpreter required	31199.49	96	0.0000	P=0.000
Single	31176.85	97	0.0000	'Yes' and 'missing' sig diff from 'no'
Month	31162.35	106	0.0000	7 months sig diff from Sep
CVB	31152.23	97	0.0000	'Yes' and 'missing' sig diff from 'no'
Amniocentesis	31151.84	97	0.0000	'Missing' sig diff from 'no'
Late booker	31141.36	97	0.0000	'Missing' sig diff from 'no'
Previous terminations	31138.66	96	0.0000	P=0.237
Previous miscarriages	31137.58	96	0.0000	P=0.574
Parity + hospital + antenatal risk status [block] + gestation >41 weeks + birthweight + ethnic group + time of birth + age + smoking status + intended place of birth + patient category + sex of baby +				
Year	31524.25	109	0.0000	All years sig diff from 1988 bar 2000
Carstairs quintile	31511.23	102	0.0000	All sig diff from '1'
No of US scans	31421.22	103	0.0000	'0', '5+' & 'missing' sig diff from '1'
Interpreter required	31419.68	98	0.0000	P=0.000
Single	31397.14	99	0.0000	'Yes' and 'missing' sig diff from 'no'
Month	31383.06	108	0.0000	7 months sig diff from Sep
CVB	31372.73	99	0.0000	'Yes' and 'missing' sig diff from 'no'
Amniocentesis	31372.02	99	0.0000	'Missing' sig diff from 'no'
Late booker	31361.77	99	0.0000	'Missing' sig diff from 'no'
Previous terminations	31358.93	98	0.0000	P=0.243. Drop – has been non-sig for last 5 iterations
Previous miscarriages	31357.88	98	0.0000	P=0.575. Drop – has been non-sig for last 5 iterations

Table F.5 (cont'd): Model selection for foetal distress

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Parity + hospital + antenatal risk status [block] + gestation >41 weeks + birthweight + ethnic group + time of birth + age + smoking status + intended place of birth + patient category + sex of baby + year +				
Carstairs quintile	31682.26	114	0.0000	All sig diff from '1'
Interpreter required	31586.28	110	0.0000	P=0.000
No of US scans	31579.54	115	0.0000	'0', '5+' & 'missing' sig diff from '1'
Single	31561.67	111	0.0000	'Yes' & 'missing' sig diff from 'no'
Month	31548.70	120	0.0000	7 months sig diff from Sep
CVB	31535.74	111	0.0000	'Yes' sig diff from 'no'
Amniocentesis	31535.16	111	0.0000	'Missing' sig diff from 'no'
Late booker	31252.56	111	0.0000	'Yes' / 'missing' not sig diff from 'no'
Parity + hospital + antenatal risk status [block] + gestation >41 weeks + birthweight + ethnic group + time of birth + age + smoking status + intended place of birth + patient category + sex of baby + year + Carstairs quintile +				
No of US scans	31736.88	120	0.0000	'0', '5+' & 'missing' sig diff from '1'
Interpreter required	31736.23	115	0.0000	P=0.000
Single	31712.15	116	0.0000	'Yes' & 'missing' sig diff from 'no'
Month	31706.76	125	0.0000	7 months sig diff from Sep
Amniocentesis	31692.95	116	0.0000	'Missing' sig diff from 'no'
CVB	31692.64	116	0.0000	'Yes' sig diff from 'no'
Late booker	31683.63	116	0.0000	'Yes' / 'missing' not sig diff from 'no'
Parity + hospital + antenatal risk status [block] + gestation >41 weeks + birthweight + ethnic group + time of birth + age + smoking status + intended place of birth + patient category + sex of baby + year + Carstairs quintile + no of US scans +				
Interpreter required	31791.06	121	0.0000	P=0.000
Single	31766.36	122	0.0000	'Yes' & 'missing' sig diff from 'no'
Month	31761.29	131	0.0000	7 months sig diff from Sep
CVB	31746.06	122	0.0000	'Yes' sig diff from 'no'
Amniocentesis	31742.28	122	0.0000	'Missing' sig diff from 'no'
Late booker	31737.23	122	0.0000	'Yes' / 'missing' not sig diff from 'no'
Parity + hospital + risk status [block] + gestation >41 weeks + birthweight + ethnic group + time of birth + age + smoking status + intended place of birth + patient category + sex of baby + year + Carstairs quintile + no of US scans + interpreter required +				
Single	31822.90	123	0.0000	'Yes' & 'missing' sig diff from 'no'
Month	31815.33	132	0.0000	7 months sig diff from Sep
CVB	31800.04	123	0.0000	'Yes' sig diff from 'no'
Amniocentesis	31796.42	123	0.0000	'Missing' sig diff from 'no'
Late booker	31791.74	123	0.0000	'Yes' / 'missing' not sig diff from 'no'

Table F.5 (cont'd): Model selection for foetal distress

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Parity + hospital + antenatal risk status [block] + gestation >41 weeks + birthweight + ethnic group + time of birth + age + smoking status + intended place of birth + patient category + sex of baby + year + Carstairs quintile + no of US scans + interpreter required + single +				
Month	31847.24	134	0.0000	7 months sig diff from Sep. LRT showed this to be a sig better fit than same model without month (p=0.0114)
CVB	31831.86	125	0.0000	'Yes' sig diff from 'no'. LRT showed this to be a sig better fit than same model without CVB (p=0.0114)
Amniocentesis	31828.23	125	0.0000	'Missing' sig diff from 'no'.
Late booker	31823.98	125	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'. Drop – has been non-sig for last 5 iterations
Parity + hospital + antenatal risk status [block] + gestation >41 weeks + birthweight + ethnic group + time of birth + age + smoking status + intended place of birth + patient category + sex of baby + year + Carstairs quintile + no of US scans + interpreter required + single +month+				
CVB	31856.18	136	0.0000	'Yes' sig diff from 'no'. LRT showed this to be a sig better fit than same model without CVB (p=0.0115)
Amniocentesis	31852.57	136	0.0000	'Missing' sig diff from 'no'. LRT showed this not to be a sig better fit than same model without amniocentesis (p=0.0696)
Parity + hospital + antenatal risk status [block] + gestation >41 weeks + birthweight + ethnic group + time of birth + age + smoking status + intended place of birth + patient category + sex of baby + year + Carstairs quintile + no of US scans + interpreter required + single + month + CVB +				
Amniocentesis	31865.67	138	0.0000	'Missing' sig diff from 'no'. LRT showed this to be a sig better fit than same model without amniocentesis (p=0.0087)
Additive model without the 18 non-significant high-/medium-risk conditions	31848.81	120	0.0000	Drop these 18 - LRT showed this not to be a significantly worse fit than the same model without these conditions (p=0.5328)
Additive model without the 18 non-significant high-/medium-risk conditions and with US scans collapsed into 0, 1, 2-4, 5+, missing (final additive model)	31848.59	118	0.0000	Use collapsed variable – LRT showed this not to be a significantly worse fit than the same model with US scans not collapsed (p=0.8947)

Table F.5 (cont'd): Model selection for foetal distress

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Final additive model +				
Intended place of birth * hospital	31912.52	132	0.0000	LRT showed this to be a significantly better fit than the final additive model (p=0.0000)
Intended place of birth * time	31888.23	129	0.0000	LRT showed this to be a significantly better fit than the final additive model (p=0.0000)
Intended place of birth * malpresentation	31886.21	119	0.0000	LRT showed this to be a significantly better fit than the final additive model (p=0.0000)
Intended place of birth * parity	31865.07	123	0.0000	LRT showed this to be a significantly better fit than the final additive model (p=0.0056)
Intended place of birth * asthma	31855.30	119	0.0000	LRT showed this to be a significantly better fit than the final additive model (p=0.0096)
Intended place of birth * preterm labour	31853.80	119	0.0000	LRT showed this to be a significantly better fit than the final additive model (p=0.0225)
Intended place of birth * suspected congenital abnormality	31852.68	119	0.0000	LRT showed this to be a significantly better fit than the final additive model (p=0.0431)
Intended place of birth * Carstairs quintile	31859.58	123	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.0515)
Intended place of birth * ethnic group	31858.30	125	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.2058)
Intended place of birth * age	31856.22	125	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.3660)
Intended place of birth * year	31855.89	130	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.8370)
Intended place of birth * month	31855.05	129	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.8408)
Intended place of birth * CVB	31853.27	120	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.0964)
Intended place of birth * single	31852.61	120	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.1341)
Intended place of birth * birthweight	31852.54	121	0.0000	Collinearity problem. Try collapsing <500g and 500-1499g.
Intended place of birth * collapsed birthweight	31794.49	120	0.0000	No longer collinearity, but LRT showed this not to be a significantly better fit that the final additive model with the two smallest weight groups combined (p=0.2665)
Intended place of birth * gestation > 41 weeks	31851.63	119	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.0813)
Intended place of birth * previous CS	31851.37	119	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.0954)
Intended place of birth * smoking status	31851.12	122	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.6395)
Intended place of birth * BMI	31850.85	120	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.3224)
Intended place of birth * no of US scans	31850.74	122	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.7083)
Intended place of birth * previous stillbirth/neonatal death	31849.76	119	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.2793)

Intended place of birth * multiple pregnancy	31849.51	119	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.3383)
Intended place of birth * anaemia	31849.48	120	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.6390)
Intended place of birth * hypertension/pre-eclampsia	31849.47	120	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.6446)
Intended place of birth * oligo/polyhydramnios	31849.05	119	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.4959)
Intended place of birth * small for dates	31848.95	119	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.5472)
Intended place of birth * haemoglobinopathies	31848.68	119	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.7608)
Intended place of birth * pre-existing hypertension	31848.67	119	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.7816)
Intended place of birth * recurrent antepartum haemorrhage	31848.63	119	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.8387)
Intended place of birth * interpreter required	31848.62	119	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.8572)
Intended place of birth * placenta praevia	31848.61	119	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.8903)
Intended place of birth * placental abruption	31848.59	119	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.9785)
Final additive model + intended place of birth*malpresentation +				
Intended place of birth*asthma	31892.87	120	0.0000	LRT p=0.0099
Intended place of birth*suspected congenital abnormality	31889.17	120	0.0000	LRT p=0.0854. Once iPoB*malpresentation controlled for, even if there was a suspected congenital abnormality, distress was more likely in the hospital group
Final additive model (with 'malpresentation, asthma or suspected congenital abnormality' as a single binary variable) +				
Intended place of birth*malpresentation, asthma or suspected congenital abnormality	31062.86	117	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.0811)
Final model = final additive model + intended place of birth*malpresentation + intended place of birth*asthma				

F.6 Failure to progress in stage 1 of labour model

Table F.6: Model selection for failure to progress in stage 1 of labour

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Hospital	1787.78	14	0.0000	11 hospitals sig diff from Hillingdon
Antenatal risk status [block]	1135.09	37	0.0000	17 conditions p<0.05
Time of birth	412.26	11	0.0000	8 time slots sig diff from 1000-1159
Birthweight	354.38	4	0.0000	All sig diff fr '2500-3999' bar '<500'
Parity	234.97	5	0.0000	'0', '1', '4' and '>4' sig diff from '2'
No of US scans	153.49	6	0.0000	All sig diff from '1' except '2'
Year	135.18	12	0.0000	8 years sig diff from 1988
Carstairs quintile	98.82	5	0.0000	Just '5' sig diff from '1'
Ethnic group	86.79	7	0.0000	All sig diff from 'W Euro' except 'B Caribbean' and 'Oriental'
Age	33.86	7	0.0000	'16-19' & '45+' sig diff from '30-34'
Interpreter required	32.37	1	0.0000	P=0.000
Gestation > 41 weeks?	25.47	1	0.0000	P=0.000
Patient category	25.27	3	0.0000	Just 'private' sig diff from 'normal'
Sex of baby	15.25	2	0.0005	'Male' and 'indeterminate' sig diff from 'female'
Late booker	13.37	2	0.0012	'Yes' and 'missing' sig diff from 'no'
Smoking status	10.16	4	0.0378	'Medium' sig diff from 'nonsmoker'
Month	8.88	11	0.6332	None sig diff from Sept
CVB	4.15	2	0.1258	'Yes'/'missing' not sig diff from 'no'
Intended place of birth	4.05	1	0.0443	P=0.040. Hospital safer
Amniocentesis	2.97	2	0.2270	'Yes'/'missing' not sig diff from 'no'
Previous terminations	2.16	1	0.1417	P=0.139
Single	1.88	2	0.3900	'Yes'/'missing' not sig diff from 'no'
Congenital abnormalities	0.08	1	0.7769	P=0.777
Previous miscarriages	0.00	1	0.9926	P=0.993
Hospital +				
Antenatal risk status [block]	2888.08	51	0.0000	15 conditions p<0.05
Time of birth	2199.70	25	0.0000	8 time slots sig diff from 1000-1159
Birthweight	2147.79	18	0.0000	All sig diff fr '2500-3999' bar '<500'
Parity	2041.12	19	0.0000	'0', '1' and '>4' sig diff from '2'
Year	1957.17	26	0.0000	5 years sig diff from 1988
No of US scans	1881.37	20	0.0000	All sig diff from '1' except '0'
Age	1837.07	21	0.0000	'16-19', '20-24' and '45+' sig diff from '30-34'
Ethnic group	1827.42	21	0.0000	'B African', 'Mediterranean' & 'S Asian' sig diff from 'W Euro'
Patient category	1811.70	17	0.0000	Just 'private' sig diff from 'normal'
Carstairs quintile	1808.96	19	0.0000	Just 'missing' sig diff from '1'
Gestation > 41 weeks?	1805.36	15	0.0000	P=0.000
Interpreter required	1803.27	15	0.0000	P=0.000
Sex of baby	1802.70	16	0.0000	Both 'male' and 'indeterminate' sig diff from 'female'
Smoking status	1799.09	18	0.0000	'Medium' sig diff from 'nonsmoker'
Single	1796.85	16	0.0000	'Yes' sig diff from 'no'
Month	1796.46	25	0.0000	None sig diff from Sept
Late booker	1794.87	16	0.0000	'Yes'/'missing' not sig diff from 'no'
CVB	1793.91	16	0.0000	'Yes' sig diff from 'no'
Amniocentesis	1793.65	16	0.0000	'Missing' sig diff from 'no'
Intended place of birth	1789.75	15	0.0000	P=0.155. Hospital safer
Previous terminations	1788.85	15	0.0000	P=0.299
Congenital abnormalities	1787.87	15	0.0000	P=0.762
Previous miscarriages	1787.78	15	0.0000	P=0.953

Table F.6 (cont'd): Model selection for failure to progress in stage 1 of labour

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Hospital +antenatal risk status [block]+				
Time of birth	3325.10	62	0.0000	8 time slots sig diff from 1000-1159
Parity	3079.92	56	0.0000	'0', '1' & '>4' sig diff from '2'
Birthweight	3071.66	55	0.0000	'1500-2499' and '4000+' sig diff from '2500-3999'
Year	3053.11	63	0.0000	4 years sig diff from 1988
No of US scans	2939.28	57	0.0000	All sig diff from '1' except '2' & 'missing'
Age	2921.89	58	0.0000	'16-19' and '45+' sig diff from '30-34'
Ethnic group	2911.11	58	0.0000	'B African' & 'S Asian' sig diff from 'W Euro'
Sex of baby	2906.33	53	0.0000	Both 'male' and 'indeterminate' sig diff from 'female'
Patient category	2906.01	54	0.0000	'Private' sig diff from 'normal'
Carstairs quintile	2903.54	56	0.0000	'Missing' sig diff from '1'
Interpreter required	2901.02	52	0.0000	P=0.000
Late booker	2899.48	53	0.0000	'Yes' sig diff from 'no'
Month	2897.40	62	0.0000	None sig diff from Sept
Gestation > 41 weeks?	2897.30	52	0.0000	P=0.002
Smoking status	2896.80	55	0.0000	'Medium' sig diff from 'nonsmoker'
CVB	2893.66	53	0.0000	'Yes' sig diff from 'no'
Single	2893.12	53	0.0000	'Yes' sig diff from 'no'
Amniocentesis	2890.66	53	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'
Intended place of birth	2890.36	52	0.0000	P=0.126. Hospital safer
Previous terminations	2889.93	52	0.0000	P=0.171
Congenital abnormalities	2888.32	52	0.0000	P=0.628
Previous miscarriages	2888.18	52	0.0000	P=0.753
Hospital + antenatal risk status [block] + time of birth +				
Parity	3521.41	67	0.0000	'0', '1' & '>4' sig diff from '2'
Birthweight	3507.74	66	0.0000	'1500-2499' and '4000+' sig diff from '2500-3999'
Year	3490.13	74	0.0000	4 years sig diff from 1988
No of US scans	3382.46	68	0.0000	All sig diff from '1' except '2' & 'missing'
Age	3358.91	69	0.0000	'16-19' and '45+' sig diff from '30-34'
Ethnic group	3349.92	69	0.0000	'B African' & 'S Asian' sig diff from 'W Euro'
Patient category	3345.87	65	0.0000	'Private' sig diff from 'normal'
Sex of baby	3343.31	64	0.0000	Both 'male' and 'indeterminate' sig diff from 'female'
Carstairs quintile	3341.24	67	0.0000	'Missing' sig diff from '1'
Interpreter required	3338.33	63	0.0000	P=0.000
Late booker	3336.76	64	0.0000	'Yes' sig diff from 'no'
Month	3334.16	73	0.0000	None sig diff from Sept
Smoking status	3333.49	66	0.0000	'Medium' sig diff from 'nonsmoker'
Gestation > 41 weeks?	3332.08	63	0.0000	P=0.007
CVB	3330.49	64	0.0000	'Yes' sig diff from 'no'
Single	3329.98	64	0.0000	'Yes' sig diff from 'no'
Intended place of birth	3328.73	63	0.0000	P=0.052. Hospital safer
Amniocentesis	3327.81	64	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'
Previous terminations	3326.96	63	0.0000	P=0.170
Congenital abnormalities	3325.28	63	0.0000	P=0.665
Previous miscarriages	3325.28	63	0.0000	P=0.672

Table F.6 (cont'd): Model selection for failure to progress in stage 1 of labour

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Hospital + antenatal risk status [block] + time of birth + parity +				
Birthweight	3705.48	71	0.0000	'1500-2499' and '4000+' sig diff from '2500-3999'
Year	3687.40	79	0.0000	4 years sig diff from 1988
No of US scans	3579.92	73	0.0000	All sig diff from '1' except '2' & 'missing'
Age	3565.49	74	0.0000	'16-19', '20-24' and '45+' sig diff from '30-34'
Ethnic group	3550.37	74	0.0000	'B African' & 'S Asian' sig diff from 'W Euro'
Patient category	3542.45	70	0.0000	'Private' sig diff from 'normal'
Carstairs quintile	3540.80	72	0.0000	'5' & 'missing' sig diff from '1'
Sex of baby	3540.02	69	0.0000	Both 'male' and 'indeterminate' sig diff from 'female'
Interpreter required	3538.02	68	0.0000	P=0.000
Late booker	3535.12	69	0.0000	'Yes' sig diff from 'no'
Month	3530.59	78	0.0000	None sig diff from Sept. Drop – has been non-sig for last 5 iterations
Gestation > 41 weeks?	3529.02	68	0.0000	P=0.005
Intended place of birth	3527.33	68	0.0000	P=0.013. Hospital safer
Smoking status	3526.61	71	0.0000	'Medium' sig diff from 'nonsmoker'
CVB	3526.13	69	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'
Single	3525.80	69	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'
Amniocentesis	3524.34	69	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'
Previous terminations	3524.08	68	0.0000	P=0.100. Drop – has been non-sig for last 5 iterations
Previous miscarriages	3521.63	68	0.0000	P=0.641. Drop – has been non-sig for last 5 iterations
Congenital abnormalities	3521.61	68	0.0000	P=0.656. Drop – has been non-sig for last 5 iterations
Hospital + antenatal risk status [block] + time of birth + parity + birthweight +				
Year	3867.24	83	0.0000	4 years sig diff from 1988
No of US scans	3753.97	77	0.0000	All sig diff from '1' except '2' & 'missing'
Ethnic group	3747.04	78	0.0000	'B African' & 'S Asian' sig diff from 'W Euro'
Age	3744.82	78	0.0000	'16-19', '20-24' and '45+' sig diff from '30-34'
Patient category	3726.79	74	0.0000	'Private' sig diff from 'normal'
Carstairs quintile	3728.20	76	0.0000	'5' & 'missing' sig diff from '1'
Interpreter required	3723.91	72	0.0000	P=0.000
Sex of baby	3716.34	73	0.0000	Both 'male' and 'indeterminate' sig diff from 'female'
Late booker	3720.53	73	0.0000	'Yes' sig diff from 'no'
Intended place of birth	3710.55	72	0.0000	P=0.022. Hospital safer
CVB	3710.37	73	0.0000	'Yes' sig diff from 'no'
Single	3709.23	73	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'
Gestation > 41 weeks?	3708.40	72	0.0000	P=0.085
Amniocentesis	3708.19	73	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'
Smoking status	3707.77	75	0.0000	None sig diff from 'nonsmoker'

Table F.6 (cont'd): Model selection for failure to progress in stage 1 of labour

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Hospital + antenatal risk status [block] + time of birth + parity + birthweight + year +				
Ethnic group	3916.30	90	0.0000	'B African', 'S Asian' & 'Medit' sig diff from 'W Euro'
Age	3910.69	90	0.0000	'16-19', '20-24' and '45+' sig diff from '30-34'
No of US scans	3898.99	89	0.0000	All sig diff from '1' except '2' & 'missing'
Patient category	3892.76	86	0.0000	'Private' sig diff from 'normal'
Carstairs quintile	3887.71	88	0.0000	'5' sig diff from '1'
Interpreter required	3884.82	84	0.0000	P=0.000
Late booker	3879.73	85	0.0000	'Yes' sig diff from 'no'
Sex of baby	3878.16	85	0.0000	Both 'male' and 'indeterminate' sig diff from 'female'
Single	3872.76	85	0.0000	'Yes' sig diff from 'no'
Intended place of birth	3872.65	84	0.0000	P=0.018. Hospital safer
CVB	3870.87	85	0.0000	'Yes' /'missing' not sig diff from 'no'
Gestation > 41 weeks?	3869.84	84	0.0000	P=0.131
Smoking status	3870.93	87	0.0000	None sig diff from 'nonsmoker'
Amniocentesis	3870.03	85	0.0000	Neither sig diff from 'no'. Drop – non-sig for last 5 iterations
Hospital + antenatal risk status [block] + time of birth + parity + birthweight + year + ethnic group +				
Age	3962.74	97	0.0000	'16-19', '20-24' and '45+' sig diff from '30-34'
No of US scans	3946.89	96	0.0000	All sig diff from '1' except '2' & 'missing'
Patient category	3939.21	93	0.0000	'Private' sig diff from 'normal'
Carstairs quintile	3928.91	95	0.0000	'5' sig diff from '1'
Sex of baby	3926.78	92	0.0000	Both 'male' and 'indeterminate' sig diff from 'female'
Late booker	3925.00	92	0.0000	'Yes' sig diff from 'no'
Interpreter required	3924.07	91	0.0000	P=0.005
Intended place of birth	3923.51	91	0.0000	P=0.006. Hospital safer
Single	3919.61	92	0.0000	'Yes' /'missing' not sig diff from 'no'
CVB	3919.60	92	0.0000	'Yes' /'missing' not sig diff from 'no'
Gestation > 41 weeks?	3918.94	91	0.0000	P=0.102
Smoking status	3917.54	94	0.0000	None sig diff from 'nonsmoker'
Hospital + antenatal risk status [block] + time of birth + parity + birthweight + year + ethnic group + age +				
No of US scans	3995.90	103	0.0000	All sig diff from '1' except '2' & 'missing'
Patient category	3988.00	100	0.0000	'Private' sig diff from 'normal'
Carstairs quintile	3980.57	102	0.0000	'5' sig diff from '1'
Late booker	3975.64	99	0.0000	'Yes' sig diff from 'no'
Sex of baby	3973.48	99	0.0000	Both 'male' and 'indeterminate' sig diff from 'female'
Interpreter required	3971.94	98	0.0000	P=0.002
Intended place of birth	3969.24	98	0.0000	P=0.009. Hospital safer
CVB	3967.10	99	0.0000	'Yes' sig diff from 'no'
Single	3964.32	99	0.0000	'Yes' /'missing' not sig diff from 'no'
Gestation > 41 weeks?	3965.21	98	0.0000	P=0.113
Smoking status	3965.22	101	0.0000	None sig diff from 'nonsmoker'

Table F.6 (cont'd): Model selection for failure to progress in stage 1 of labour

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Hospital + antenatal risk status [block] + time of birth + parity + birthweight + year + ethnic group + age + no of US scans +				
Patient category	4023.84	106	0.0000	'Private' sig diff from 'normal'
Carstairs quintile	4014.67	108	0.0000	'5' sig diff from '1'
Sex of baby	4006.38	105	0.0000	Both 'male' and 'indeterminate' sig diff from 'female'
Interpreter required	4004.36	104	0.0000	P=0.003
Late booker	4003.96	105	0.0000	'Yes' sig diff from 'no'
Intended place of birth	4001.05	104	0.0000	P=0.021. Hospital safer
CVB	3999.92	105	0.0000	'Yes' /'missing' not sig diff from 'no'
Smoking status	3998.66	107	0.0000	None sig diff from 'nonsmoker'. Drop – has been non-sig for last 5 iterations
Gestation > 41 weeks?	3998.28	104	0.0000	P=0.120. Drop – has been non-sig for last 5 iterations
Single	3997.75	105	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'
Hospital + antenatal risk status [block] + time of birth + parity + birthweight + year + ethnic group + age + no of US scans + patient category +				
Carstairs quintile	4039.81	111	0.0000	'5' sig diff from '1'
Sex of baby	4034.36	108	0.0000	Both 'male' and 'indeterminate' sig diff from 'female'
Interpreter required	4032.70	107	0.0000	P=0.002
Late booker	4032.27	108	0.0000	'Yes' sig diff from 'no'
Intended place of birth	4028.39	107	0.0000	P=0.030. Hospital safer
CVB	4028.32	108	0.0000	'Yes' /'missing' not sig diff from 'no'
Single	4025.60	108	0.0000	'Yes' /'missing' not sig diff from 'no'
Hospital + antenatal risk status [block] + time of birth + parity + birthweight + year + ethnic group + age + no of US scans + patient category + Carstairs quintile +				
Sex of baby	4050.39	113	0.0000	Both 'male' and 'indeterminate' sig diff from 'female'. LRT p=0.0051
Late booker	4048.47	113	0.0000	'Yes' sig diff from 'no'. LRT p=0.0132
Interpreter required	4047.90	112	0.0000	P=0.004. LRT p=0.045
Intended place of birth	4044.76	112	0.0000	P=0.023. Hospital safer.
CVB	4044.18	113	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'. LRT p=0.1125
Single	4041.53	113	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'. LRT p=0.4238. Drop – has been non-sig for last 5 iterations

Table F.6 (cont'd): Model selection for failure to progress in stage 1 of labour

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Hospital + antenatal risk status [block] + time of birth + parity + birthweight + year + ethnic group + age + no of US scans + patient category + Carstairs quintile + sex of baby +				
Late booker	4059.01	115	0.0000	'Yes' sig diff from 'no'. LRT p=0.0134
Interpreter required	4058.45	114	0.0000	P=0.004. LRT p=0.0045
Intended place of birth	4055.33	114	0.0000	P=0.023. Hospital safer.
CVB	4054.74	115	0.0000	'Yes' /'missing' not sig diff from 'no'
Hospital + antenatal risk status [block] + time of birth + parity + birthweight + year + ethnic group + age + no of US scans + patient category + Carstairs quintile + sex of baby + late booker +				
Interpreter required	4066.40	116	0.0000	P=0.006. LRT p=0.0066
Intended place of birth	4063.89	116	0.0000	P=0.024. Hospital safer. LRT p=0.0273
CVB	4063.21	117	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'. LRT p=0.1227. Drop – has been non-sig for last 5 iterations
Hospital + antenatal risk status [block] + time of birth + parity + birthweight + year + ethnic group + age + no of US scans + patient category + Carstairs quintile + sex of baby + late booker + interpreter required +				
Intended place of birth	4071.37	117	0.0000	P=0.023. Hospital safer. LRT p=0.0259
Additive model = Hospital + antenatal risk status [block] + time of birth + parity + birthweight + year + ethnic group + age + no of US scans + patient category + Carstairs quintile + sex of baby + late booker + interpreter required + intended place of birth				
Additive model without 22 non-significant high-/medium-risk conditions	4044.49	95	0.0000	LRT showed this not to be a significantly worse fit than the full additive model (p=0.2158).
Additive model without non-sig high-/medium-risk conditions and with birthweight <1500g as one category	4043.54	94	0.0000	LRT showed this not to be a significantly worse fit than the full additive model (p=0.3303).
Final additive model = Hospital + antenatal risk status [collapsed block] + time of birth + parity + collapsed birthweight + year + ethnic group + age + no of US scans + patient category + Carstairs quintile + sex of baby + late booker + interpreter required + intended place of birth				

Table F.6 (cont'd): Model selection for failure to progress in stage 1 of labour

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Final additive model +				
Intended place of birth*parity	4104.24	99	0.0000	LRT showed this to be a significantly better fit than the final additive model (p=0.000). But large SE for parity>4 because there were no cases of delay in stage 1 among parity >4 group who intended home birth – try combining with parity 4
Intended place of birth*collapsed parity	4096.97	97	0.0000	LRT showed this to be a significantly better fit than the final additive model (p=0.000).
Intended place of birth*age	4052.39	101	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.2635). Also large SEs
Intended place of birth*malpresentation	4048.07	95	0.0000	LRT showed this to be a significantly better fit than the final additive model (p=0.0332). But large SEs for malpresentation and interaction effect
Intended place of birth*recurrent antepartum haemorrhage	4046.65	95	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.0780).
Intended place of birth*placental abruption	4045.95	95	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.1205).
Intended place of birth*anaemia	4045.37	96	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.4008).
Intended place of birth*previous CS	4044.37	95	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.3622).
Intended place of birth*multiple pregnancy	4044.28	95	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.3895). Also large SEs
Intended place of birth*hypertension/pre-eclampsia	4044.16	96	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.7333). Also large SEs
Intended place of birth*haemoglobinopathies	4044.15	95	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.4337).
Intended place of birth*suspected congenital abnormality	4044.08	95	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.4642).
Intended place of birth*placenta praevia	4043.83	95	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.5882). Also large SEs
Intended place of birth*pre-existing diabetes	4043.82	95	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.5948).
Intended place of birth*small for dates	4043.64	95	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.7494). Also large SEs
Intended place of birth*preterm labour	4043.62	95	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.7836).
Intended place of birth*birthweight	-	-	0.0000	Model would not converge because there were no cases of delay in stage 1 among low birthweight babies whose mothers intended a home birth

F.7 Failure to progress in stage 2 of labour model

Table F.7: Model selection for failure to progress in stage 2 of labour

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Parity	31471.81	5	0.0000	All sig diff from '2'
Antenatal risk status [block]	2687.96	37	0.0000	25 conditions p<0.05
Hospital	2022.27	14	0.0000	All bar 2 sig diff from Hillingdon
Year	2000.68	12	0.0000	All sig diff from 1988 bar 1989
Birthweight	1799.23	4	0.0000	All sig diff from '2500-3999g'
Ethnic group	1280.53	7	0.0000	'B African', 'B Caribb', 'S Asian' + 'missing' sig diff from 'W Euro'
Smoking status	986.37	4	0.0000	All sig diff from 'nonsmoker'
Carstairs quintile	717.56	5	0.0000	All sig diff from '1'
Previous miscarriages	428.79	1	0.0000	P=0.000
Intended place of birth	428.68	1	0.0000	P=0.000. Home safer
Gestation > 41 weeks?	396.44	1	0.0000	P=0.000
Time of birth	371.80	11	0.0000	All sig diff from 1000-1159
Age	352.52	7	0.0000	All sig diff from '30-34' bar '25-29'
No of US scans	306.38	6	0.0000	All sig diff from '1'
Late booker	222.89	2	0.0000	'Yes' & 'missing' sig diff from 'no'
Interpreter required	182.10	1	0.0000	P=0.000
Single	137.71	2	0.0000	'Yes' sig diff from 'no'
Amniocentesis	68.71	2	0.0000	'Yes' & 'missing' sig diff from 'no'
Month	64.16	11	0.0000	4 months sig diff from Sept
Patient category	44.29	3	0.0000	'Overseas' and 'private' sig diff from 'normal'
CVB	24.40	2	0.0000	'Missing' sig diff from 'no'
Sex of baby	19.57	2	0.0001	'Boy' sig diff from 'girl'
Previous terminations	2.22	1	0.1366	P=0.135
Congenital abnormalities	0.04	1	0.8384	P=0.838
Parity +				
Antenatal risk status [block]	35339.71	42	0.0000	19 conditions p<0.05
Age	34769.08	12	0.0000	All sig diff from '30-34' bar '45+'
Birthweight	34666.01	9	0.0000	All sig diff from '2500-3999g'
Year	33566.24	17	0.0000	All sig diff from 1988 bar 1989
Hospital	33263.21	19	0.0000	All bar 3 sig diff from Hillingdon
Single	32448.95	7	0.0000	'Yes' sig diff from 'no'
Ethnic group	32384.02	12	0.0000	All sig diff from 'W Euro' bar 'Mediterranean'
Smoking status	32075.56	9	0.0000	All sig diff from 'nonsmoker'
Carstairs quintile	32020.73	10	0.0000	All sig diff from '1'
Time of birth	31794.17	16	0.0000	All sig diff from 10:00-11:59
Late booker	31771.80	7	0.0000	'Yes' & 'missing' sig diff from 'no'
No of US scans	31745.12	11	0.0000	All sig diff from '1'
Amniocentesis	31692.44	7	0.0000	'Yes' and 'missing' sig diff form 'no'
Gestation > 41 weeks?	31622.71	6	0.0000	P=0.000
Interpreter required	31562.73	6	0.0000	P=0.000
Patient category	31532.44	8	0.0000	'Overseas' and 'private' sig diff from 'normal'
Month	31519.25	16	0.0000	1 month sig diff from Sept
Intended place of birth	31515.22	6	0.0000	P=0.000. Home safer, but by much smaller margin!
CVB	31502.09	7	0.0000	'Missing' sig diff from 'no'
Previous miscarriages	31501.81	6	0.0000	P=0.000
Sex of baby	31491.91	7	0.0000	'Boy' sig diff from 'girl'
Previous terminations	31472.72	6	0.0000	P=0.339
Congenital abnormalities	31472.50	6	0.0000	P=0.410

Table F.7 (cont'd): Model selection for failure to progress in stage 2 of labour

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Parity + antenatal risk status [block] +				
Age	38530.23	49	0.0000	All sig diff from '30-34' bar '45+'
Birthweight	37667.72	46	0.0000	All sig diff from '2500-3999g'
Year	37415.42	56	0.0000	All sig diff from 1988 bar 1989
Hospital	37045.09	56	0.0000	All bar 2 sig diff from Hillingdon
Single	36237.01	44	0.0000	'Yes' sig diff from 'no'
Ethnic group	36180.78	49	0.0000	All sig diff from 'W Euro' bar 'Mediterranean'
Smoking status	35881.27	46	0.0000	All sig diff from 'nonsmoker'
Carstairs quintile	35829.11	47	0.0000	All sig diff from '1'
Time of birth	35669.42	53	0.0000	All time slots sig diff from 10:00-11:59
No of US scans	35581.66	48	0.0000	All sig diff from '1'
Late booker	35539.28	44	0.0000	Both 'yes' and 'missing' sig diff form 'no'
Amniocentesis	35535.83	44	0.0000	Both 'yes' and 'missing' sig diff form 'no'
Gestation > 41 weeks?	35429.13	43	0.0000	P=0.000
Interpreter required	35424.23	43	0.0000	P=0.000
Patient category	35389.41	45	0.0000	'Overseas' and 'private' sig diff from 'normal'
Month	35378.14	53	0.0000	1 month sig diff from Sept
Previous miscarriages	35377.29	43	0.0000	P=0.000
Intended place of birth	35372.27	43	0.0000	P=0.000. Home safer
CVB	35365.37	44	0.0000	'Missing' sig diff from 'no'
Sex of baby	35361.77	44	0.0000	'Boy' sig diff from 'girl'
Previous terminations	35343.93	43	0.0000	P=0.039
Congenital abnormalities	35339.77	43	0.0000	P=0.813
Parity + antenatal risk status [block] + age +				
Birthweight	40709.45	53	0.0000	All sig diff from '2500-3999g'
Hospital	40134.24	63	0.0000	All bar 2 sig diff from Hillingdon
Year	40043.84	61	0.0000	All sig diff from 1988 bar 1989
Ethnic group	39239.68	56	0.0000	All sig diff from 'W Euro' bar 'Mediterranean' and 'missing'
Time of birth	38875.20	60	0.0000	All time slots sig diff from 10:00-11:59
No of US scans	38743.47	55	0.0000	All sig diff from '1' bar '4' and '>4'
Single	38734.19	51	0.0000	'Yes' sig diff from 'no'
Smoking status	38683.23	53	0.0000	All sig diff from 'nonsmoker' except 'medium'
Carstairs quintile	38665.59	54	0.0000	All sig diff from '1'
Patient category	38628.55	52	0.0000	'Overseas' and 'private' sig diff from 'normal'
Amniocentesis	38609.55	51	0.0000	Both 'yes' and 'missing' sig diff form 'no'
Late booker	38607.52	51	0.0000	'Yes' sig diff from 'no'
Gestation > 41 weeks?	38596.34	50	0.0000	P=0.000
Intended place of birth	38587.07	50	0.0000	P=0.000. Home safer
Interpreter required	38567.66	50	0.0000	P=0.000
CVB	38566.51	51	0.0000	'Missing' sig diff from 'no'
Month	38563.82	60	0.0000	1 month sig diff from Sept
Sex of baby	38553.99	51	0.0000	'Boy' sig diff from 'girl'
Previous miscarriages	38531.57	50	0.0000	P=0.247
Previous terminations	38531.04	50	0.0000	P=0.369
Congenital abnormalities	38530.51	50	0.0000	P=0.598

Table F.7 (cont'd): Model selection for failure to progress in stage 2 of labour

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Parity + antenatal risk status [block] + age + birthweight +				
Hospital	42344.48	67	0.0000	All bar 1 sig diff from Hillingdon
Year	42219.80	65	0.0000	All sig diff from 1988 bar 1989
Ethnic group	41308.65	60	0.0000	'B African', 'B Caribbean' & 'Oriental' sig diff from 'W Euro'
Time of birth	41063.92	64	0.0000	All time slots sig diff from 10:00-11:59
No of US scans	40916.83	59	0.0000	All sig diff from '1'
Single	40901.60	55	0.0000	'Yes' sig diff from 'no'
Carstairs quintile	40810.08	58	0.0000	All sig diff from '1'
Smoking status	40807.12	57	0.0000	All sig diff from 'nonsmoker' except 'medium'
Patient category	40806.23	56	0.0000	'Overseas' and 'private' sig diff from 'normal'
Amniocentesis	40780.24	55	0.0000	Both 'yes' and 'missing' sig diff form 'no'
Intended place of birth	40774.02	54	0.0000	P=0.000. Home safer
Late booker	40757.47	55	0.0000	'Yes' sig diff from 'no'
Month	40741.75	64	0.0000	1 month sig diff from Sept
CVB	40740.64	55	0.0000	'Missing' sig diff from 'no'
Interpreter required	40738.38	54	0.0000	P=0.000
Gestation > 41 weeks?	40727.44	54	0.0000	P=0.000
Previous miscarriages	40711.11	54	0.0000	P=0.196
Sex of baby	40710.82	55	0.0000	Neither 'boy' nor 'indeterminate' sig diff from 'girl'
Congenital abnormalities	40710.64	54	0.0000	P=0.5273. Drop – has been non-sig for last 5 iterations
Previous terminations	40710.36	54	0.0000	P=0.341
Parity + antenatal risk status [block] + age + birthweight + hospital +				
Year	43737.08	79	0.0000	All sig diff from 1988 bar 1989
Ethnic group	42976.63	74	0.0000	All sig diff from 'W Euro'
Time of birth	42705.62	78	0.0000	All time slots sig diff from 10:00-11:59
Carstairs quintile	42526.80	72	0.0000	All sig diff from '1' except '2'
Patient category	42524.30	70	0.0000	'Overseas' and 'private' sig diff from 'normal'
No of US scans	42517.62	73	0.0000	All sig diff from '1' except '4' and '>4'
Single	42504.04	69	0.0000	'Yes' sig diff from 'no'
Amniocentesis	42442.61	69	0.0000	'Missing' sig diff from 'no'
Smoking status	42432.67	71	0.0000	All sig diff from 'nonsmoker' except 'medium'
Intended place of birth	42409.07	68	0.0000	P=0.000. Home safer
CVB	42402.01	69	0.0000	'Missing' sig diff from 'no'
Late booker	42387.95	69	0.0000	'Yes' sig diff from 'no'
Month	42377.48	78	0.0000	1 month sig diff from Sept
Interpreter required	42377.09	68	0.0000	P=0.000
Gestation > 41 weeks?	42360.43	68	0.0000	P=0.000
Sex of baby	42345.60	69	0.0000	Neither 'boy' nor 'indeterminate' sig diff from 'girl'
Previous terminations	42345.41	68	0.0000	P=0.335
Previous miscarriages	42345.36	68	0.0000	P=0.347

Table F.7 (cont'd): Model selection for failure to progress in stage 2 of labour

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Parity + antenatal risk status [block] + age + birthweight + hospital + year +				
Ethnic group	44449.85	86	0.0000	All sig diff from 'W Euro'
Time of birth	44105.09	90	0.0000	All time slots sig diff from 10:00-11:59
Patient category	43879.56	82	0.0000	'Overseas' and 'private' sig diff from 'normal'
No of US scans	43867.23	85	0.0000	All sig diff from '1' except '0' and '3'
Single	43862.07	81	0.0000	'Yes' sig diff from 'no'
Carstairs quintile	43831.82	84	0.0000	All sig diff from '1'
Amniocentesis	43825.54	81	0.0000	'Missing' sig diff from 'no'
Intended place of birth	43812.55	80	0.0000	P=0.000. Home safer
Smoking status	43794.23	83	0.0000	All sig diff from 'nonsmoker' except 'medium'
CVB	43781.94	81	0.0000	'Missing' sig diff from 'no'
Interpreter required	43776.22	80	0.0000	P=0.000
Month	43776.13	90	0.0000	1 month sig diff from Sept
Late booker	43771.15	81	0.0000	'Yes' and 'missing' sig diff from 'no'
Gestation > 41 weeks?	43753.11	80	0.0000	P=0.000
Sex of baby	43738.11	81	0.0000	Neither 'boy' nor 'indeterminate' sig diff from 'girl'
Previous miscarriages	43737.28	80	0.0000	P=0.655
Previous terminations	43737.18	80	0.0000	P=0.745
Parity + antenatal risk status [block] + age + birthweight + hospital + year + ethnic group +				
Time of birth	44824.64	97	0.0000	All time slots sig diff from 10:00-11:59
Patient category	44623.41	89	0.0000	'Private' sig diff from 'normal'
No of US scans	44587.00	92	0.0000	'4', '>4' and 'missing' sig diff from '1'
Single	44546.97	88	0.0000	'Yes' sig diff from 'no'
Amniocentesis	44545.88	88	0.0000	'Missing' sig diff from 'no'
Smoking status	44545.40	90	0.0000	All sig diff from 'nonsmoker' except 'medium'
Intended place of birth	44534.04	87	0.0000	P=0.000. Home safer
Carstairs quintile	44502.39	91	0.0000	All sig diff from '1'
CVB	44500.75	88	0.0000	'Missing' sig diff from 'no'
Month	44486.23	97	0.0000	1 month sig diff from Sept
Late booker	44472.73	88	0.0000	'Yes' and 'missing' sig diff from 'no'
Interpreter required	44470.89	87	0.0000	P=0.000
Gestation > 41 weeks?	44463.44	87	0.0000	P=0.000
Previous terminations	44451.42	87	0.0000	P=0.208. Drop – has been non-sig for last 5 iterations
Sex of baby	44451.16	88	0.0000	Neither 'boy' nor 'indeterminate' sig diff from 'girl'
Previous miscarriages	44450.23	87	0.0000	P=0.538. Drop – has been non-sig for last 5 iterations

Table F.7 (cont'd): Model selection for failure to progress in stage 2 of labour

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Parity + antenatal risk status [block] + age + birthweight + hospital + year + ethnic group + time of birth +				
Patient category	45001.91	100	0.0000	'Private' sig diff from 'normal'
No of US scans	44962.40	103	0.0000	'4', '>4' and 'missing' sig diff from '1'
Amniocentesis	44921.90	99	0.0000	'Missing' sig diff from 'no'
Smoking status	44919.43	101	0.0000	All sig diff from 'nonsmoker' except 'medium'
Single	44913.08	99	0.0000	'Yes' sig diff from 'no'
Intended place of birth	44910.31	98	0.0000	P=0.000. Home safer
Carstairs quintile	44876.82	102	0.0000	All sig diff from '1'
CVB	44876.05	99	0.0000	'Missing' sig diff from 'no'
Month	44862.08	108	0.0000	1 month sig diff from Sept
Late booker	44848.33	99	0.0000	'Yes' and 'missing' sig diff from 'no'
Interpreter required	44845.66	98	0.0000	P=0.000
Gestation > 41 weeks?	44841.74	98	0.0000	P=0.000
Sex of baby	44826.13	99	0.0000	Neither 'boy' nor 'indeterminate' sig diff from 'girl'. Drop – has been non-sig for last 5 iterations
Parity + antenatal risk status [block] + age + birthweight + hospital + year + ethnic group + time of birth + patient category +				
Smoking status	45105.88	104	0.0000	All sig diff from 'nonsmoker' except 'medium'
Single	45098.19	102	0.0000	'Yes' sig diff from 'no'
Intended place of birth	45091.72	101	0.0000	P=0.000. Home safer
No of US scans	45078.82	106	0.0000	'4', '>4' and 'missing' sig diff from '1'
Carstairs quintile	45062.76	105	0.0000	All sig diff from '1'
Amniocentesis	45042.79	102	0.0000	'Missing' sig diff from 'no'
Month	45039.07	111	0.0000	1 month sig diff from Sept
Interpreter required	45021.99	101	0.0000	P=0.000
Late booker	45018.94	102	0.0000	'Yes' and 'missing' sig diff from 'no'
CVB	45017.84	102	0.0000	'Missing' sig diff from 'no'
Gestation > 41 weeks?	45016.95	101	0.0000	P=0.000
Parity + antenatal risk status [block] + age + birthweight + hospital + year + ethnic group + time of birth + patient category + smoking status +				
Intended place of birth	45198.28	105	0.0000	P=0.000. Home safer
No of US scans	45181.34	110	0.0000	'4', '>4' and 'missing' sig diff from '1'
Single	45177.57	106	0.0000	'Yes' sig diff from 'no'
Carstairs quintile	45155.06	109	0.0000	All sig diff from '1'
Amniocentesis	45146.69	106	0.0000	'Missing' sig diff from 'no'
Month	45141.82	115	0.0000	1 month sig diff from Sept
Interpreter required	45127.86	105	0.0000	P=0.000
CVB	45121.73	106	0.0000	'Missing' sig diff from 'no'
Gestation > 41 weeks?	45121.30	105	0.0000	P=0.000
Late booker	45120.37	106	0.0000	'Yes' and 'missing' sig diff from 'no'

Table F.7 (cont'd): Model selection for failure to progress in stage 2 of labour

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Parity + antenatal risk status [block] + age + birthweight + hospital + year + ethnic group + time of birth + patient category + smoking status + intended place of birth +				
No of US scans	45272.71	111	0.0000	'4', '>4' and 'missing' sig diff from '1'
Single	45270.81	107	0.0000	'Yes' sig diff from 'no'
Carstairs quintile	45247.64	110	0.0000	All sig diff from '1'
Amniocentesis	45236.64	107	0.0000	'Missing' sig diff from 'no'
Month	45234.38	116	0.0000	1 month sig diff from Sept
Interpreter required	45220.62	106	0.0000	P=0.000
Gestation > 41 weeks?	45213.38	106	0.0000	P=0.000
CVB	45212.99	107	0.0000	'Missing' sig diff from 'no'
Late booker	45211.31	107	0.0000	'Yes' and 'missing' sig diff from 'no'
Parity + antenatal risk status [block] + age + birthweight + hospital + year + ethnic group + time of birth + patient category + smoking status + intended place of birth + no of US scans +				
Single	45344.97	113	0.0000	'Yes' sig diff from 'no'
Carstairs quintile	45322.44	116	0.0000	All sig diff from '1'
Month	45309.37	122	0.0000	1 month sig diff from Sept
Amniocentesis	45295.57	113	0.0000	'Missing' sig diff from 'no'
Interpreter required	45295.21	112	0.0000	P=0.000
Gestation > 41 weeks?	45288.27	112	0.0000	P=0.000
Late booker	45283.05	113	0.0000	'Yes' and 'missing' sig diff from 'no'
CVB	45279.81	113	0.0000	'Missing' sig diff from 'no'
Parity + antenatal risk status [block] + age + birthweight + hospital + year + ethnic group + time of birth + patient category + smoking status + intended place of birth + no of US scans + single+				
Carstairs quintile	45388.86	118	0.0000	All sig diff from '1'
Month	45381.46	124	0.0000	1 month sig diff from Sept
Interpreter required	45369.80	114	0.0000	P=0.000
Amniocentesis	45367.88	115	0.0000	'Missing' sig diff from 'no'
Gestation > 41 weeks?	45360.62	114	0.0000	P=0.000
Late booker	45353.07	115	0.0000	'Yes' and 'missing' sig diff from 'no'
CVB	45352.17	115	0.0000	'Missing' sig diff from 'no'
Parity + antenatal risk status [block] + age + birthweight + hospital + year + ethnic group + time of birth + patient category + smoking status + intended place of birth + no of US scans + single + Carstairs quintile +				
Month	45425.06	129	0.0000	1 month sig diff from Sept
Amniocentesis	45411.46	120	0.0000	'Missing' sig diff from 'no'
Interpreter required	45411.29	119	0.0000	P=0.000
Gestation > 41 weeks?	45404.66	119	0.0000	P=0.000
Late booker	45396.74	120	0.0000	'Yes' and 'missing' sig diff from 'no'
CVB	45396.32	120	0.0000	'Missing' sig diff from 'no'

Table F.7 (cont'd): Model selection for failure to progress in stage 2 of labour

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Parity + antenatal risk status [block] + age + birthweight + hospital + year + ethnic group + time of birth + patient category + smoking status + intended place of birth + no of US scans + single + Carstairs quintile + month +				
Interpreter required	45447.44	130	0.0000	P=0.000
Amniocentesis	45447.37	131	0.0000	'Missing' sig diff from 'no'
Gestation > 41 weeks?	45440.36	130	0.0000	P=0.000
Late booker	45432.93	131	0.0000	'Yes' and 'missing' sig diff from 'no'
CVB	45432.48	131	0.0000	'Missing' sig diff from 'no'
Parity + antenatal risk status [block] + age + birthweight + hospital + year + ethnic group + time of birth + patient category + smoking status + intended place of birth + no of US scans + single + Carstairs quintile + month + interpreter required +				
Amniocentesis	45469.83	132	0.0000	'Missing' sig diff from 'no'. LRT p=0.0000
Gestation > 41 weeks?	45463.03	131	0.0000	P=0.000. LRT p=0.0001
CVB	45454.70	132	0.0000	'Missing' sig diff from 'no'. LRT p=0.0265
Late booker	45454.57	132	0.0000	'Yes' and 'missing' sig diff from 'no'. LRT p=0.0283
Parity + antenatal risk status [block] + age + birthweight + hospital + year + ethnic group + time of birth + patient category + smoking status + intended place of birth + no of US scans + single + Carstairs quintile + month + interpreter required + amniocentesis +				
Gestation > 41 weeks?	45485.37	133	0.0000	P=0.000. LRT p=0.0001
Late booker	45476.37	134	0.0000	'Yes' and 'missing' sig diff from 'no'. LRT p=0.0380
CVB	45474.40	134	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'. LRT p=0.1017
Parity + antenatal risk status [block] + age + birthweight + hospital + year + ethnic group + time of birth + patient category + smoking status + intended place of birth + no of US scans + single + Carstairs quintile + month + interpreter required + amniocentesis + gestation > 41 weeks? +				
Late booker	45492.04	135	0.0000	'Missing' sig diff from 'no'. LRT p=0.0357
CVB	45489.93	135	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'. LRT p=0.1023
Additive model = Parity + antenatal risk status [block] + age + birthweight + hospital + year + ethnic group + time of birth + patient category + smoking status + intended place of birth + no of US scans + single + Carstairs quintile + month + interpreter required + amniocentesis + gestation > 41 weeks? + late booker				

Table F.7 (cont'd): Model selection for failure to progress in stage 2 of labour

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Additive model without 21 non-significant high-/medium-risk conditions	45460.43	114	0.0000	LRT showed this not to be a significantly worse fit than the full additive model (p=0.0640)
Additive model without non-significant risk conditions and month in 5 categories: Dec-Mar, Apr-Aug, Sep, Oct, Nov	45455.17	107	0.0000	LRT showed this not to be a significantly worse fit than the model in the row above (p=0.7197)
Additive model without non-significant risk conditions, month in 5 categories (Dec-Mar, Apr-Aug, Sep, Oct, Nov) and parity in 4 categories (0, 1, 2, >2)	45454.57	105	0.0000	LRT showed this not to be a significantly worse fit than the model in the row above (p=0.7400)
Final additive model = Collapsed parity + antenatal risk status [collapsed block] + age + birthweight + hospital + year + ethnic group + time of birth + patient category + smoking status + intended place of birth + no of US scans + single + Carstairs quintile + collapsed month + interpreter required + amniocentesis + gestation > 41 weeks? + late booker				
Final additive model +				
Parity*multiple pregnancy	45640.18	108	0.0000	LRT showed this to be a significantly better fit than the final additive model (p=0.0000)
Parity*malpresentation	45633.78	108	0.0000	LRT showed this to be a significantly better fit than the final additive model (p=0.0000)
Parity*birthweight	45593.60	117	0.0000	LRT showed this to be a significantly better fit than the final additive model (p=0.0000). The only interaction involving parity which didn't follow the pattern of higher-parity women being less likely to experience the outcome
Parity*hospital	45576.88	147	0.0000	LRT showed this to be a significantly better fit than the final additive model (p=0.0000)
Parity*year	45521.78	141	0.0000	LRT showed this to be a significantly better fit than the final additive model (p=0.0012)
Parity*time of birth	45513.92	138	0.0000	LRT showed this to be a significantly better fit than the final additive model (p=0.0033)
Parity*ethnic group	45511.44	126	0.0000	LRT showed this to be a significantly better fit than the final additive model (p=0.0000)
Parity*Carstairs quintile	45493.27	120	0.0000	LRT showed this to be a significantly better fit than the final additive model (p=0.0007)
Parity*anaemia	45483.69	111	0.0000	LRT showed this to be a significantly better fit than the final additive model (p=0.0001)
Parity*preterm birth	45477.30	108	0.0000	LRT showed this to be a significantly better fit than the final additive model (p=0.0000)
Intended place of birth*hospital	45471.68	121	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.2829)
Parity*gestational diabetes	45469.62	108	0.0000	LRT showed this to be a significantly better fit than the final additive model (p=0.0018)
Parity*BMI	45468.87	111	0.0000	LRT showed this to be a significantly better fit than the final additive model (p=0.0264)
Parity*gestation >41 weeks	45468.86	108	0.0000	LRT showed this to be a significantly better fit than the final additive model (p=0.0025)

Table F.7 (cont'd): Model selection for failure to progress in stage 2 of labour

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Parity*gestational hypertension/pre-eclampsia	45465.88	111	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.0790)
Intended place of birth*year	45464.57	119	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.6684)
Intended place of birth*parity	45463.40	108	0.0000	LRT showed this to be a significantly better fit than the final additive model (p=0.0315)
Parity*oligo/polyhydramnios	45460.71	108	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.1047)
Intended place of birth*birthweight	45460.25	110	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.1657). Try with <1500g as single category
Intended place of birth*collapsed birthweight	45457.62	109	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.2930).
Parity*placental abruption	45459.52	108	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.1749)
Intended place of birth*gestation hypertension/pre-eclampsia	45459.35	109	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.1233)
Parity*placenta praevia	45459.07	108	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.2117)
Intended place of birth*gestation >41 weeks	45458.33	108	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.0756)
Intended place of birth*previous CS	45457.54	108	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.1236)
Intended place of birth*age	45457.38	114	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.9469). Large SEs for smallest age groups
Intended place of birth*collapsed age	45453.86	110	0.0000	LRT showed this not to be a significantly better fit than the equivalent additive model (p=0.9430)
Intended place of birth*malpresentation	45456.94	108	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.1832)
Intended place of birth*previous stillbirth/neonatal death	45456.86	108	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.1935). Also large SEs
Intended place of birth*placenta praevia	45456.34	108	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.2781)
Intended place of birth*gestational diabetes	45456.20	108	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.3088)
Intended place of birth*BMI	45455.89	109	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.6963)
Intended place of birth*anaemia	45455.72	109	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.7591)
Intended place of birth*multiple pregnancy	45455.49	108	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.5726). Also large SEs
Intended place of birth*placental abruption	45455.41	108	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.6197). Also large SEs

Table F.7 (cont'd): Model selection for failure to progress in stage 2 of labour

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Intended place of birth*preterm birth	45455.34	108	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.6793)
Intended place of birth*small for dates	45455.20	108	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.8539). Also large SEs
Intended place of birth*oligo/polyhydramnios	45455.18	108	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.9170). Also large SEs
Final model = Collapsed parity*birthweight + antenatal risk status [collapsed block] + age + hospital + year + ethnic group + time of birth + patient category + smoking status + intended place of birth + no of US scans + single + Carstairs quintile + collapsed month + interpreter required + amniocentesis + gestation > 41 weeks? + late booker				

F.8 Postpartum haemorrhage model

Table F.8: Model selection for postpartum haemorrhage

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Antenatal risk status [block]	5312.47	37	0.0000	21 conditions p<0.05. (NB no cases of PPH among those with TB so this condition was merged with 'other')
No of US scans	1107.14	6	0.0000	All sig diff from '1' except '0'
Birthweight	947.37	4	0.0000	All sig diff from '2500-3999g' except '<500g'
Age	628.09	7	0.0000	All sig diff from '30-34' bar '<16'
Hospital	392.19	14	0.0000	10 hospitals sig diff from Hillingdon
Year	348.08	12	0.0000	All years sig diff from 1998 bar 1989
Ethnic group	303.92	7	0.0000	All sig diff from 'W Euro' except 'Mediterranean' and 'missing'
Time of birth	182.83	11	0.0000	All time slots sig diff from 1000-1159 bar one
Parity	93.63	5	0.0000	All sig diff from '2' except '1'
Smoking status	90.22	4	0.0000	All sig diff from 'nonsmoker'
Intended place of birth	88.98	1	0.0000	P=0.000. Home safer
Gestation > 41 weeks?	65.27	1	0.0000	P=0.000
Previous miscarriages	62.02	1	0.0000	P=0.000
Amniocentesis	42.03	2	0.0000	'Yes' and 'missing' sig diff from 'no'
Previous terminations	25.06	1	0.0000	P=0.000
Late booker	16.86	2	0.0002	'Missing' sig diff from 'no'
Sex of baby	14.52	2	0.0007	'Male' sig diff from 'female'
Single	12.90	2	0.0016	'Yes' sig diff from 'no'
Carstairs quintile	12.83	5	0.0250	Just '3' sig diff from '1'
Month	10.93	11	0.4494	No month sig diff from Oct
CVB	4.41	2	0.1104	Neither 'yes' nor 'missing' sig diff from 'no'
Patient category	0.78	3	0.8546	None sig diff from 'normal'
Interpreter required	0.63	1	0.4271	P=0.431
Congenital abnormalities	0.59	1	0.4436	P=0.446

Table F.8 (cont'd): Model selection for postpartum haemorrhage

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Antenatal risk status [block] +				
Birthweight	5997.48	41	0.0000	All sig diff from '2500-3999g'
Age	5638.52	44	0.0000	All sig diff from '30-34' bar '<16'
Hospital	5634.67	51	0.0000	7 hospitals sig diff from Hillingdon
Year	5547.90	49	0.0000	All years sig diff from 1998 bar 1989 and 1993
Parity	5529.99	42	0.0000	All sig diff from '2' except '1' and '3'
Ethnic group	5515.24	44	0.0000	All sig diff from 'W Euro' except 'Mediterranean' and 'missing'
Gestation > 41 weeks?	5464.61	38	0.0000	P=0.000
No of US scans	5462.30	43	0.0000	All sig diff from '1' bar '0' and 'missing'
Smoking status	5393.87	41	0.0000	All sig diff from 'nonsmoker' except 'missing'
Time of birth	5386.55	48	0.0000	3 time slots sig diff from 1000-1159
Intended place of birth	5365.35	38	0.0000	P=0.000. Home safer
Amniocentesis	5339.77	39	0.0000	'Yes' sig diff from 'no'
Late booker	5329.34	39	0.0000	'Yes' sig diff from 'no'
Single	5327.66	39	0.0000	'Yes' and 'missing' sig diff from 'no'
Carstairs quintile	5325.80	42	0.0000	Just '3' sig diff from '1'
Previous terminations	5325.41	38	0.0000	P=0.000
Sex of baby	5325.12	39	0.0000	'Male' sig diff from 'female'
Previous miscarriages	5324.11	38	0.0000	P=0.000
Month	5321.08	48	0.0000	No month sig diff from Oct
Congenital abnormalities	5318.12	38	0.0000	P=0.019
Patient category	5317.98	40	0.0000	None sig diff from 'normal'
Interpreter required	5314.45	38	0.0000	P=0.165
CVB	5313.20	39	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'
Antenatal risk status [block] + birthweight +				
Hospital	6352.18	55	0.0000	6 hospitals sig diff from Hillingdon
Age	6278.93	48	0.0000	All sig diff from '30-34' bar '<16'
Parity	6276.49	46	0.0000	All sig diff from '2' except '1' and '3'
Year	6234.57	53	0.0000	All years sig diff from 1998 bar 1989 and 1993
Ethnic group	6200.30	48	0.0000	All sig diff from 'W Euro' except 'Mediterranean' and 'missing'
No of US scans	6158.47	47	0.0000	All sig diff from '1' bar '0' and 'missing'
Gestation > 41 weeks?	6090.68	42	0.0000	P=0.000
Time of birth	6069.51	52	0.0000	2 time slots sig diff from 1000-1159
Intended place of birth	6059.38	42	0.0000	P=0.006. Home safer
Smoking status	6052.15	45	0.0000	All sig diff from 'nonsmoker' except 'missing'
Sex of baby	6034.63	43	0.0000	'Male' sig diff from 'female'
Amniocentesis	6022.77	43	0.0000	'Yes' sig diff from 'no'
Previous terminations	6011.37	42	0.0000	P=0.000
Carstairs quintile	6009.35	46	0.0000	Just '3' sig diff from '1'
Late booker	6009.24	43	0.0000	'Yes' sig diff from 'no'
Single	6008.73	43	0.0000	'Missing' sig diff from 'no'
Previous miscarriages	6008.13	42	0.0000	P=0.001
Month	6006.27	52	0.0000	No month sig diff from Oct
Congenital abnormalities	6002.13	42	0.0000	P=0.034
Patient category	6002.07	44	0.0000	None sig diff from 'normal'
Interpreter required	5998.37	42	0.0000	P=0.352
CVB	5998.15	43	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'

Table F.8 (cont'd): Model selection for postpartum haemorrhage

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Antenatal risk status [block] + birthweight + hospital +				
Age	6618.85	62	0.0000	All sig diff from '30-34' bar '<16'
Parity	6610.98	60	0.0000	All sig diff from '2' except '1' and '3'
Year	6587.63	67	0.0000	All years sig diff from 1998 bar 1989
No of US scans	6535.43	61	0.0000	All sig diff from '1' except '0' and 'missing'
Ethnic group	6521.22	62	0.0000	All sig diff from 'W Euro' except 'Mediterranean' and 'missing'
Gestation > 41 weeks?	6438.98	56	0.0000	P=0.000
Time of birth	6426.82	66	0.0000	3 time slots sig diff from 1000-1159
Intended place of birth	6410.88	56	0.0000	P=0.000
Smoking status	6403.61	59	0.0000	All sig diff from 'nonsmoker' except 'missing'
Sex of baby	6390.71	57	0.0000	'Male' sig diff from 'female'
Amniocentesis	6373.25	57	0.0000	'Yes' sig diff from 'no'
Carstairs quintile	6372.15	60	0.0000	'4', '5' and 'missing' sig diff from '1'
Late booker	6369.07	57	0.0000	'Yes' sig diff from 'no'
Single	6364.73	57	0.0000	'Missing' sig diff from 'no'
Previous miscarriages	6363.48	56	0.0000	P=0.001
Month	6360.80	66	0.0000	No month sig diff from Oct
Patient category	6359.83	58	0.0000	'Private' sig diff from 'normal'
Previous terminations	6359.76	56	0.0000	P=0.005
Interpreter required	6357.30	56	0.0000	P=0.027
Congenital abnormalities	6355.49	56	0.0000	P=0.073
CVB	6352.38	57	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'
Antenatal risk status [block] + birthweight + hospital + age +				
Parity	7020.70	67	0.0000	'0' and '1' sig diff from '2'
Year	6811.70	74	0.0000	All years sig diff from 1998 bar 1989 and 1993
Ethnic group	6777.99	69	0.0000	All sig diff from 'W Euro' except 'Mediterranean' and 'missing'
No of US scans	6772.67	68	0.0000	All sig diff from '1' except '0' and 'missing'
Gestation > 41 weeks?	6708.40	63	0.0000	P=0.000
Time of birth	6692.11	73	0.0000	3 time slots sig diff from 1000-1159
Intended place of birth	6686.55	63	0.0000	P=0.000
Sex of baby	6656.24	64	0.0000	'Male' sig diff from 'female'
Smoking status	6646.85	66	0.0000	All sig diff from 'nonsmoker' except 'missing'
Single	6630.87	64	0.0000	'Missing' sig diff from 'no'
Late booker	6629.55	64	0.0000	'Yes' sig diff from 'no'
Patient category	6629.55	65	0.0000	'Private' sig diff from 'normal'
Carstairs quintile	6628.08	67	0.0000	None sig diff from '1'
Month	6626.98	73	0.0000	No month sig diff from Oct. Drop – has been non-sig since the outset.
Previous terminations	6624.29	63	0.0000	P=0.018
Interpreter required	6622.78	63	0.0000	P=0.052
Congenital abnormalities	6622.12	63	0.0000	P=0.074
Previous miscarriages	6619.92	63	0.0000	P=0.298
CVB	6619.78	64	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'. Drop – has been non-sig since the outset
Amniocentesis	6618.99	64	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'

Table F.8 (cont'd): Model selection for postpartum haemorrhage

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Antenatal risk status [block] + birthweight + hospital + age + parity +				
Year	7185.01	79	0.0000	All years sig diff from 1998 bar 1989 and 1993
Ethnic group	7173.70	74	0.0000	All sig diff from 'W Euro' except 'Mediterranean' and 'missing'
No of US scans	7157.98	73	0.0000	All sig diff from '1' except '0' and 'missing'
Gestation > 41 weeks?	7091.50	68	0.0000	P=0.000
Time of birth	7085.40	78	0.0000	2 time slots sig diff from 1000-1159
Intended place of birth	7071.17	68	0.0000	P=0.000
Sex of baby	7058.87	69	0.0000	'Male' sig diff from 'female'
Smoking status	7034.02	71	0.0000	All sig diff from 'nonsmoker' except 'missing'
Patient category	7033.40	70	0.0000	'Private' sig diff from 'normal'
Single	7030.88	69	0.0000	'Missing' sig diff from 'no'
Carstairs quintile	7030.54	72	0.0000	'3' and '5' sig diff from '1'
Late booker	7030.49	69	0.0000	'Yes' sig diff from 'no'
Previous miscarriages	7028.16	68	0.0000	P=0.005
Previous terminations	7025.79	68	0.0000	P=0.022
Congenital abnormalities	7024.65	68	0.0000	P=0.050
Interpreter required	7022.67	68	0.0000	P=0.167
Amniocentesis	7020.82	69	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'
Antenatal risk status [block] + birthweight + hospital + age + parity + year +				
Ethnic group	7329.89	86	0.0000	All sig diff from 'W Euro' except 'Mediterranean', 'other' and 'missing'
No of US scans	7283.44	85	0.0000	All sig diff from '1' except '0' and 'missing'
Gestation > 41 weeks?	7260.13	80	0.0000	P=0.000
Time of birth	7251.42	90	0.0000	2 time slots sig diff from 1000-1159
Intended place of birth	7237.13	80	0.0000	P=0.000
Sex of baby	7223.60	81	0.0000	'Male' sig diff from 'female'
Single	7196.38	81	0.0000	'Missing' sig diff from 'no'
Patient category	7195.39	82	0.0000	'Private' sig diff from 'normal'
Smoking status	7194.81	83	0.0000	'Light' sig diff from 'nonsmoker'
Carstairs quintile	7192.36	84	0.0000	'3' sig diff from '1'
Previous miscarriages	7191.84	80	0.0000	P=0.008
Previous terminations	7191.50	80	0.0000	P=0.010
Late booker	7188.31	81	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'
Congenital abnormalities	7187.88	80	0.0000	P=0.094
Interpreter required	7186.86	80	0.0000	P=0.179
Amniocentesis	7185.15	81	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'

Table F.8 (cont'd): Model selection for postpartum haemorrhage

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Antenatal risk status [block] + birthweight + hospital + age + parity + year + ethnic group +				
No of US scans	7430.69	92	0.0000	All sig diff from '1' except '0' and 'missing'
Gestation > 41 weeks?	7403.26	87	0.0000	P=0.000
Time of birth	7396.21	97	0.0000	2 time slots sig diff from 1000-1159
Intended place of birth	7381.90	87	0.0000	P=0.000
Sex of baby	7368.08	88	0.0000	'Male' sig diff from 'female'
Smoking status	7341.75	90	0.0000	'Light' sig diff from 'nonsmoker'
Single	7340.26	88	0.0000	'Missing' sig diff from 'no'
Patient category	7338.68	89	0.0000	'Private' sig diff from 'normal'
Carstairs quintile	7337.76	91	0.0000	'3' sig diff from '1'
Previous miscarriages	7336.61	87	0.0000	P=0.008
Late booker	7334.84	88	0.0000	'Yes' sig diff from 'no'
Congenital abnormalities	7333.00	87	0.0000	P=0.081. Drop – has been non-sig for last 5 iterations
Previous terminations	7331.96	87	0.0000	P=0.146
Interpreter required	7331.18	87	0.0000	P=0.261
Amniocentesis	7330.01	88	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'
Antenatal risk status [block] + birthweight + hospital + age + parity + year + ethnic group + no of US scans +				
Gestation > 41 weeks?	7505.89	93	0.0000	P=0.000
Time of birth	7492.63	103	0.0000	2 time slots sig diff from 1000-1159
Intended place of birth	7478.36	93	0.0000	P=0.000
Sex of baby	7467.72	94	0.0000	'Male' sig diff from 'female'
Smoking status	7444.28	96	0.0000	'Light' sig diff from 'nonsmoker'
Single	7441.91	94	0.0000	'Missing' sig diff from 'no'
Carstairs quintile	7437.71	97	0.0000	'3' sig diff from '1'
Patient category	7435.22	95	0.0000	None sig diff from 'normal'
Previous miscarriages	7434.43	93	0.0000	P=0.050
Amniocentesis	7433.68	94	0.0000	'Yes' + 'missing' not sig diff from 'no'. Drop – non-sig for last 5 iterations
Previous terminations	7432.28	93	0.0000	P=0.203
Late booker	7431.46	94	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'
Interpreter required	7431.42	93	0.0000	P=0.396. Drop –non-sig for last 5 iterations
Antenatal risk status [block] + birthweight + hospital + age + parity + year + ethnic group + no of US scans + gestation >41 weeks? +				
Time of birth	7568.72	104	0.0000	2 time slots sig diff from 1000-1159
Intended place of birth	7552.95	94	0.0000	P=0.000
Sex of baby	7543.03	95	0.0000	'Male' sig diff from 'female'
Smoking status	7519.87	97	0.0000	'Light' sig diff from 'nonsmoker'
Single	7517.05	95	0.0000	'Missing' sig diff from 'no'
Carstairs quintile	7512.83	98	0.0000	'3' sig diff from '1'
Patient category	7509.89	96	0.0000	None sig diff from 'normal'
Previous miscarriages	7509.79	94	0.0000	P=0.046
Previous terminations	7507.61	94	0.0000	P=0.187
Late booker	7506.77	95	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'

Table F.8 (cont'd): Model selection for postpartum haemorrhage

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Antenatal risk status [block] + birthweight + hospital + age + parity + year + ethnic group + no of US scans + gestation >41 weeks? + time of birth +				
Intended place of birth	7614.85	105	0.0000	P=0.000
Sex of baby	7605.95	106	0.0000	'Male' sig diff from 'female'
Smoking status	7582.75	108	0.0000	'Light' sig diff from 'nonsmoker'
Single	7579.79	106	0.0000	'Missing' sig diff from 'no'
Carstairs quintile	7575.89	109	0.0000	'3' sig diff from '1'
Patient category	7572.87	107	0.0000	None sig diff from 'normal'
Previous miscarriages	7572.51	105	0.0000	P=0.049
Previous terminations	7570.37	105	0.0000	P=0.196
Late booker	7569.68	106	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'
Antenatal risk status [block] + birthweight + hospital + age + parity + year + ethnic group + no of US scans + gestation >41 weeks? + time of birth + intended place of birth +				
Sex of baby	7652.17	107	0.0000	'Male' sig diff from 'female'. LRT p=0.000
Smoking status	7629.38	109	0.0000	'Light' and 'medium' sig diff from 'nonsmoker'. LRT p=0.0058
Single	7625.96	107	0.0000	'Missing' sig diff from 'no'. LRT p=0.0039
Carstairs quintile	7621.65	110	0.0000	'3' sig diff from '1'. LRT p=0.2365
Patient category	7619.44	108	0.0000	None sig diff from 'normal'. LRT p=0.2051
Previous miscarriages	7618.49	106	0.0000	P=0.054. LRT p=0.0564
Previous terminations	7616.45	106	0.0000	P=0.203. LRT p=0.2063. Drop – has been non-sig for last 5 iterations
Late booker	7615.72	107	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'. LRT p=0.6503
Antenatal risk status [block] + birthweight + hospital + age + parity + year + ethnic group + no of US scans + gestation >41 weeks? + time of birth + intended place of birth + sex of baby +				
Smoking status	7666.26	111	0.0000	'Light' sig diff from 'nonsmoker'. LRT p=0.0070
Single	7663.24	109	0.0000	'Missing' sig diff from 'no'. LRT p=0.0040
Carstairs quintile	7658.92	112	0.0000	'3' sig diff from '1'. LRT p=0.2396
Patient category	7656.70	110	0.0000	None sig diff from 'normal'. LRT p=0.2097. Drop – has been non-sig for last 5 iterations
Previous miscarriages	7655.83	108	0.0000	P=0.053. LRT p=0.0556
Late booker	7653.02	109	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'. LRT p=0.6532. Drop – has been non-sig for last 5 iterations

Table F.8 (cont'd): Model selection for postpartum haemorrhage

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Antenatal risk status [block] + birthweight + hospital + age + parity + year + ethnic group + no of US scans + gestation >41 weeks? + time of birth + intended place of birth + sex of baby + smoking status +				
Single	7677.27	113	0.0000	'Missing' sig diff from 'no'. LRT p=0.0041
Carstairs quintile	7673.97	116	0.0000	'3' sig diff from '1'. LRT p=0.1730
Previous miscarriages	7670.40	112	0.0000	P=0.039. LRT p=0.0418
Antenatal risk status [block] + birthweight + hospital + age + parity + year + ethnic group + no of US scans + gestation >41 weeks? + time of birth + intended place of birth + sex of baby + smoking status + single +				
Carstairs quintile	7684.94	118	0.0000	'3' sig diff from '1'. LRT p=0.1751
Previous miscarriages	7681.42	114	0.0000	P=0.039. LRT p=0.0416
Antenatal risk status [block] + birthweight + hospital + age + parity + year + ethnic group + no of US scans + gestation >41 weeks? + time of birth + intended place of birth + sex of baby + smoking status + single + previous miscarriages +				
Carstairs quintile	7689.13	119	0.0000	'3' sig diff from '1'. LRT p=0.1728, so didn't add
Additive model without the 18 non-significant high-/medium-risk conditions	7673.26	101	0.0000	Drop these 18 - LRT showed this not to be a significantly worse fit than the same model without these conditions (p=0.8332)
Additive model with time bands from 12:00 – 23:59 collapsed into a single time band	7669.15	96	0.0000	Use collapsed time var from now on – LRT showed this not to be a significantly worse fit than the same model with the full list of time bands (p=0.5338)
Additive model with 'smoking status' as a 3-factor variable (smoker/non-smoker/missing)	7668.83	94	0.0000	Use collapsed smoking var from now on – LRT showed this not to be a significantly worse fit than the same model with the full smoking variable (p=0.8529)
Final additive model +				
Intended place of birth * year	7685.09	106	0.0000	Huge SEs. LRT showed this not to be a significantly better fit than final additive model (p=0.1797)
Intended place of birth * parity	7678.64	99	0.0000	LRT showed this not to be a significantly better fit than final additive model (p=0.0809)
Intended place of birth * BMI	7672.73	96	0.0000	LRT showed this not to be a significantly better fit than final additive model (p=0.1426)
Intended place of birth * gestation hypertension/pre-eclampsia	7672.05	96	0.0000	LRT showed this not to be a significantly better fit than final additive model (p=0.1998)
Intended place of birth * time	7671.61	100	0.0000	LRT showed this not to be a significantly better fit than final additive model (p=0.8368)

Intended place of birth * preterm labour	7671.31	95	0.0000	LRT showed this not to be a significantly better fit than final additive model (p=0.1153)
Intended place of birth * recurrent antepartum haemorrhage	7670.45	95	0.0000	LRT showed this not to be a significantly better fit than final additive model (p=0.2043)
Intended place of birth * anaemia	7670.25	96	0.0000	LRT showed this not to be a significantly better fit than final additive model (p=0.4924)
Intended place of birth * previous baby >4.5kg	7670.03	95	0.0000	LRT showed this not to be a significantly better fit than final additive model (p=0.2736)
Intended place of birth * malpresentation	7669.96	95	0.0000	LRT showed this not to be a significantly better fit than final additive model (p=0.2882)
Intended place of birth * previous CS	7669.78	95	0.0000	LRT showed this not to be a significantly better fit than final additive model (p=0.3320)
Intended place of birth * gestation >41 weeks?	7669.44	95	0.0000	LRT showed this not to be a significantly better fit than final additive model (p=0.4346)
Intended place of birth * previous stillbirth/neonatal death	7669.11	95	0.0000	LRT showed this not to be a significantly better fit than final additive model (p=0.6013)
Intended place of birth * multiple pregnancy	7669.13	95	0.0000	LRT showed this not to be a significantly better fit than final additive model (p=0.5862)
Intended place of birth * haemoglobinopathies	7669.00	95	0.0000	LRT showed this not to be a significantly better fit than final additive model (p=0.6830)
Intended place of birth * small for dates	7668.85	95	0.0000	LRT showed this not to be a significantly better fit than final additive model (p=0.8963)
Intended place of birth * oligo/polyhydramnios	7668.84	95	0.0000	LRT showed this not to be a significantly better fit than final additive model (p=0.9313)
Intended place of birth * age	-	-	-	Observed zeroes – no PPH cases in among those planning a home birth in the <25 and 45+ age groups. Try <35 vs 35+
Intended place of birth * collapsed age (<35/35+)	7516.12	89	0.0000	LRT showed this not to be a significantly better fit than final additive model with age similarly collapsed (p=0.3817)
Intended place of birth * hospital	-	-	-	Observed zeroes – no cases of PPH among those planning a home birth in Welwyn GC – no more than 7 cases in any hospital
Intended place of birth * fibroids	-	-	-	Observed zeroes – no cases of PPH among those planning a home birth who had fibroids
Intended place of birth * placenta praevia	-	-	-	Just 3 cases of PPH among those planning a home birth with placenta praevia – model would not converge
Intended place of birth * placental abruption	-	-	-	Just 3 cases of PPH among those planning a home birth with placental abruption – model would not converge
Intended place of birth * birthweight	-	-	-	Just 1 case of PPH among those planning a home birth whose baby was low birthweight, so no point collapsing the low birthweight categories

F.9 Pyrexia model

Table F.9: Model selection for pyrexia

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Parity	3008.51	5	0.0000	'0', '1' & '<4' sig diff from '2'
Hospital	895.80	14	0.0000	13 sig diff from Hillingdon
Birthweight	675.01	4	0.0000	All sig diff from '2500-3999g'
Ethnic group	371.50	7	0.0000	All sig diff from 'W Euro'
Antenatal risk status [block]	360.79	37	0.0000	21 conditions p<0.05
Time of birth	353.76	11	0.0000	8 time slots sig diff from 10:00-11:59
Year	316.05	12	0.0000	7 years sig diff from 1988
No of US scans	170.32	6	0.0000	All sig diff from '1'
Gestation > 41 weeks?	149.90	1	0.0000	P=0.000
Previous terminations	125.39	1	0.0000	P=0.000
Smoking status	104.90	4	0.0000	All except 'medium' sig diff from 'nonsmoker'
Carstairs quintile	103.66	5	0.0000	All sig diff from '1'
Intended place of birth	84.45	1	0.0000	P=0.000. Home safer (OR 3.98)
Late booker	58.41	2	0.0000	'Yes' and 'missing' sig diff from 'no'
Month	49.53	11	0.0000	4 months sig diff from Sept
Single	35.97	2	0.0000	'Yes' and 'missing' sig diff from 'no'
Amniocentesis	30.82	2	0.0000	'Yes' and 'missing' sig diff from 'no'
CVB	27.67	2	0.0000	'Missing' sig diff from 'no'
Patient category	16.89	3	0.0007	'Amenity' + 'overseas' sig diff from 'normal'
Age	13.12	7	0.0692	'35-39' sig diff from '30-34'
Sex of baby	4.91	2	0.0859	'Indeterminate' sig diff from 'female'
Congenital abnormalities	3.13	1	0.0771	P=0.082
Interpreter required	2.52	1	0.1125	P=0.106
Previous miscarriages	1.17	1	0.2790	P=0.283
Parity +				
Hospital	3740.22	19	0.0000	13 sig diff from Hillingdon
Birthweight	3737.13	9	0.0000	All sig diff from '2500-3999g'
Antenatal risk status [block]	3731.07	42	0.0000	17 conditions p<0.05
Ethnic group	3407.52	12	0.0000	All sig diff from 'W Euro'
Time of birth	3328.45	16	0.0000	11 time slots sig diff from 10:00-11:59
Year	3305.70	17	0.0000	7 years sig diff from 1988
No of US scans	3167.62	11	0.0000	All sig diff from '1'
Age	3162.40	12	0.0000	'16-19', '20-24', '25-29' & '45+' sig diff from '30-34'
Previous terminations	3132.76	6	0.0000	P=0.000
Carstairs quintile	3114.73	10	0.0000	All sig diff from '1'
Gestation > 41 weeks?	3100.57	6	0.0000	P=0.000
Smoking status	3081.91	9	0.0000	All except 'medium' sig diff from 'nonsmoker'
Amniocentesis	3068.01	7	0.0000	'Yes' and 'missing' sig diff from 'no'
Late booker	3055.47	7	0.0000	'Yes' and 'missing' sig diff from 'no'
Previous miscarriages	3054.13	6	0.0000	P=0.000
Month	3048.50	16	0.0000	1 month sig diff from Sept
CVB	3035.75	7	0.0000	'Missing' sig diff from 'no'
Intended place of birth	3034.41	6	0.0000	P=0.000. Home safer (OR 2.34)
Patient category	3022.83	8	0.0000	'Amenity' + 'overseas' sig diff from 'normal'
Interpreter required	3015.55	6	0.0000	P=0.006
Sex of baby	3013.10	7	0.0000	'Indeterminate' sig diff from 'female'
Congenital abnormalities	3012.92	6	0.0000	P=0.040
Single	3012.13	7	0.0000	'Missing' sig diff from 'no'

Table F.9 (cont'd): Model selection for pyrexia

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Parity + hospital +				
Birthweight	4450.36	23	0.0000	All sig diff from '2500-3999g' except '1500-2499g'
Antenatal risk status [block]	4416.01	56	0.0000	14 conditions p<0.05
Time of birth	4053.31	30	0.0000	8 time slots sig diff from 10:00-11:59
Year	4027.39	31	0.0000	7 years sig diff from 1988
Ethnic group	3928.22	26	0.0000	All sig diff from 'W Euro' except 'missing'
Age	3841.82	26	0.0000	'16-19', '20-24', '25-29' & '45+' sig diff from '30-34'
Previous terminations	3822.43	20	0.0000	P=0.000
Gestation > 41 weeks?	3812.74	20	0.0000	P=0.000
Smoking status	3806.82	23	0.0000	All except 'medium' sig diff from 'nonsmoker'
No of US scans	3803.71	25	0.0000	All sig diff from '1' except '0' and 'missing'
Previous miscarriages	3781.47	20	0.0000	P=0.000
Month	3779.30	30	0.0000	2 months sig diff from Sept
Amniocentesis	3768.18	21	0.0000	'Yes' sig diff from 'no'
Intended place of birth	3766.56	20	0.0000	P=0.000. Home safer (OR 2.36)
Late booker	3757.10	21	0.0000	'Yes' and 'missing' sig diff from 'no'
Patient category	3753.56	22	0.0000	'Overseas' and 'private' sig diff from 'normal'
CVB	3747.35	21	0.0000	'Missing' sig diff from 'no'
Carstairs quintile	3746.61	24	0.0000	'5' sig diff from '1'
Sex of baby	3744.66	21	0.0000	'Indeterminate' sig diff from 'female'
Single	3742.08	21	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'
Congenital abnormalities	3742.05	20	0.0000	P=0.182
Interpreter required	3740.84	20	0.0000	P=0.428
Parity + hospital + birthweight +				
Antenatal risk status [block]	4965.55	60	0.0000	15 conditions p<0.05
Time of birth	4764.19	34	0.0000	8 time slots sig diff from 10:00-11:59
Year	4720.86	35	0.0000	6 years sig diff from 1988
Ethnic group	4650.29	30	0.0000	All sig diff from 'W Euro' bar 'missing'
Age	4539.63	30	0.0000	'16-19', '20-24', '25-29' & '45+' sig diff from '30-34'
Previous terminations	4525.94	24	0.0000	P=0.000
Smoking status	4508.66	27	0.0000	All except 'medium' sig diff from 'nonsmoker'
Gestation > 41 weeks?	4507.87	24	0.0000	P=0.000
No of US scans	4497.68	29	0.0000	All sig diff from '1' except '0' and 'missing'
Month	4491.93	34	0.0000	2 months sig diff from Sept
Previous miscarriages	4478.48	24	0.0000	P=0.000
Intended place of birth	4477.05	24	0.0000	P=0.000. Home safer (OR 2.37)
Amniocentesis	4475.19	25	0.0000	'Yes' sig diff from 'no'
Patient category	4462.27	26	0.0000	'Overseas' + 'private' sig diff from 'normal'
Carstairs quintile	4458.03	28	0.0000	'5' sig diff from '1'
Congenital abnormalities	4456.72	24	0.0000	P=0.014
Late booker	4455.49	25	0.0000	'Missing' sig diff from 'no'
CVB	4453.68	25	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'
Sex of baby	4452.16	25	0.0000	Neither 'male' nor 'indeterminate' sig diff from 'female'
Interpreter required	4451.32	24	0.0000	P=0.322
Single	4450.82	25	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'

Table F.9 (cont'd): Model selection for pyrexia

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Parity + hospital + birthweight + antenatal risk status [block] +				
Time of birth	5274.24	71	0.0000	8 time slots sig diff from 10:00-11:59
Year	5226.65	72	0.0000	6 years sig diff from 1988
Ethnic group	5131.66	67	0.0000	All sig diff from 'W Euro'
Age	5054.67	67	0.0000	'16-19', '20-24' & '25-29' sig diff from '30-34'
Previous terminations	5038.49	61	0.0000	P=0.000
Gestation > 41 weeks?	5026.75	61	0.0000	P=0.000
Smoking status	5017.42	64	0.0000	All except 'medium' sig diff from 'nonsmoker'
Month	5004.48	71	0.0000	1 month sig diff from Sept
No of US scans	4994.08	66	0.0000	All sig diff from '1' except '0' and 'missing'
Amniocentesis	4990.01	62	0.0000	'Yes' sig diff from 'no'
Previous miscarriages	4987.23	61	0.0000	P=0.000
Intended place of birth	4986.36	61	0.0000	P=0.000. Home safer (OR 2.18)
Patient category	4978.54	63	0.0000	'Private' sig diff from 'normal'
Congenital abnormalities	4975.89	61	0.0000	P=0.002
Carstairs quintile	4970.86	65	0.0000	'5' sig diff from '1'
CVB	4968.01	62	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'
Late booker	4967.80	62	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'
Sex of baby	4967.40	62	0.0000	Neither 'male' nor 'indeterminate' sig diff from 'female'
Interpreter required	4965.98	61	0.0000	P=0.506
Single	4965.90	62	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'
Parity + hospital + birthweight + antenatal risk status [block] + time of birth +				
Year	5535.60	83	0.0000	6 years sig diff from 1988
Ethnic group	5443.73	78	0.0000	All sig diff from 'W Euro'
Age	5361.37	78	0.0000	'16-19', '20-24', '25-29' & '45+' sig diff from '30-34'
Previous terminations	5346.97	72	0.0000	P=0.000
Gestation > 41 weeks?	5330.44	72	0.0000	P=0.000
Smoking status	5326.53	75	0.0000	All except 'medium' sig diff from 'nonsmoker'
Month	5312.96	82	0.0000	1 month sig diff from Sept
No of US scans	5300.99	77	0.0000	All sig diff from '1' except '0' and 'missing'
Amniocentesis	5298.54	73	0.0000	'Yes' sig diff from 'no'
Previous miscarriages	5294.92	72	0.0000	P=0.000
Intended place of birth	5293.93	72	0.0000	P=0.000. Home safer (OR 2.14)
Patient category	5287.44	74	0.0000	'Private' sig diff from 'normal'
Congenital abnormalities	5284.70	72	0.0000	P=0.002
Carstairs quintile	5279.80	76	0.0000	'5' sig diff from '1'
Late booker	5276.59	73	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'
CVB	5276.50	73	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'
Sex of baby	5276.11	73	0.0000	Neither 'male' nor 'indeterminate' sig diff from 'female'
Interpreter required	5274.70	72	0.0000	P=0.480
Single	5274.56	73	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'

Table F.9 (cont'd): Model selection for pyrexia

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Parity + hospital + birthweight + antenatal risk status [block] + time of birth + year +				
Ethnic group	5679.47	90	0.0000	All sig diff from 'W Euro'
Previous terminations	5615.83	84	0.0000	P=0.000
Age	5601.18	90	0.0000	'16-19', '20-24' & '25-29' sig diff from '30-34'
Gestation > 41 weeks?	5595.26	84	0.0000	P=0.000
Month	5575.37	94	0.0000	2 months sig diff from Sept
Smoking status	5573.47	87	0.0000	All except 'medium' sig diff from 'nonsmoker'
Intended place of birth	5556.15	84	0.0000	P=0.000. Home safer (OR 2.17)
Previous miscarriages	5553.92	84	0.0000	P=0.000
Amniocentesis	5550.15	85	0.0000	'Yes' sig diff from 'no'
Patient category	5546.69	86	0.0000	'Overseas' and 'private' sig diff from 'normal'
Carstairs quintile	5544.93	88	0.0000	'5' and 'missing' sig diff from '1'
No of US scans	5544.09	89	0.0000	'4' sig diff from '1'
Congenital abnormalities	5543.04	84	0.0000	P=0.008
Late booker	5540.15	85	0.0000	'Yes' sig diff from 'no'
Sex of baby	5537.49	85	0.0000	Neither 'male' nor 'indeterminate' sig diff from 'female'
CVB	5536.07	85	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'
Interpreter required	5535.96	84	0.0000	P=0.541. Drop – has been non-sig for last 5 iterations
Single	5536.55	85	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'. Drop – has been non-sig for last 5 iterations
Parity + hospital + birthweight + antenatal risk status [block] + time of birth + year + ethnic group +				
Previous terminations	5758.03	91	0.0000	P=0.000
Age	5747.14	97	0.0000	'16-19', '20-24' & '25-29' sig diff from '30-34'
Gestation > 41 weeks?	5743.67	91	0.0000	P=0.000
Month	5711.92	101	0.0000	1 month sig diff from Sept
Previous miscarriages	5699.63	91	0.0000	P=0.000
Smoking status	5698.44	94	0.0000	All except 'medium' sig diff from 'nonsmoker'
Intended place of birth	5697.04	91	0.0000	P=0.000. Home safer (OR 2.06)
Amniocentesis	5695.42	92	0.0000	'Yes' sig diff from 'no'
No of US scans	5688.29	96	0.0000	'4' sig diff from '1'
Congenital abnormalities	5687.21	91	0.0000	P=0.007
Patient category	5686.44	93	0.0000	None sig diff from 'normal'
Carstairs quintile	5684.21	95	0.0000	None sig diff from '1'
Sex of baby	5681.50	92	0.0000	Neither 'male' nor 'indeterminate' sig diff from 'female'. Drop – has been non-sig for last 5 iterations
Late booker	5681.19	92	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'
CVB	5679.86	92	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'. Drop – has been non-sig for last 5 iterations

Table F.9 (cont'd): Model selection for pyrexia

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Parity + hospital + birthweight + antenatal risk status [block] + time of birth + year + ethnic group + previous terminations +				
Gestation > 41 weeks?	5822.96	92	0.0000	P=0.000
Age	5818.23	98	0.0000	'16-19', '20-24' & '25-29' sig diff from '30-34'
Month	5790.42	102	0.0000	1 month sig diff from Sept
Smoking status	5783.86	95	0.0000	All except 'medium' sig diff from 'nonsmoker'
Previous miscarriages	5777.80	92	0.0000	P=0.000
Intended place of birth	5775.62	92	0.0000	P=0.000. Home safer (OR 2.06)
Amniocentesis	5772.06	93	0.0000	'Yes' sig diff from 'no'
No of US scans	5765.97	97	0.0000	'4' sig diff from '1'
Congenital abnormalities	5765.63	92	0.0000	P=0.007
Patient category	5764.45	94	0.0000	None sig diff from 'normal'
Carstairs quintile	5762.64	96	0.0000	None sig diff from '1'
Late booker	5759.88	93	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'
Parity + hospital + birthweight + antenatal risk status [block] + time of birth + year + ethnic group + previous terminations + gestation >41 weeks? +				
Age	5881.64	99	0.0000	'16-19', '20-24' & '25-29' sig diff from '30-34'
Month	5855.22	103	0.0000	1 month sig diff from Sept
Smoking status	5848.97	96	0.0000	All except 'medium' sig diff from 'nonsmoker'
Previous miscarriages	5843.12	93	0.0000	P=0.000
Intended place of birth	5840.34	93	0.0000	P=0.000. Home safer (OR 2.05)
Amniocentesis	5836.41	94	0.0000	'Yes' sig diff from 'no'
No of US scans	5830.78	98	0.0000	'4' sig diff from '1'
Congenital abnormalities	5830.62	93	0.0000	P=0.007
Patient category	5828.82	95	0.0000	None sig diff from 'normal'
Carstairs quintile	5827.55	97	0.0000	None sig diff from '1'
Late booker	5824.70	94	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'
Parity + hospital + birthweight + antenatal risk status [block] + time of birth + year + ethnic group + previous terminations + gestation >41 weeks? + age +				
Month	5913.55	110	0.0000	1 month sig diff from Sept
Intended place of birth	5900.43	100	0.0000	P=0.000. Home safer (OR 2.11)
Previous miscarriages	5897.02	100	0.0000	P=0.000
Smoking status	5895.67	103	0.0000	'Light' sig diff from 'nonsmoker'
Amniocentesis	5891.59	101	0.0000	'Yes' sig diff from 'no'
Carstairs quintile	5890.39	104	0.0000	'5' and 'missing' sig diff from '1'
Congenital abnormalities	5889.44	100	0.0000	P=0.006
No of US scans	5888.96	105	0.0000	'4' sig diff from '1'
Patient category	5888.81	102	0.0000	None sig diff from 'normal'
Late booker	5884.95	101	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'

Table F.9 (cont'd): Model selection for pyrexia

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Parity + hospital + birthweight + antenatal risk status [block] + time of birth + year + ethnic group + previous terminations + gestation >41 weeks? + age + month +				
Intended place of birth	5932.44	111	0.0000	P=0.000. Home safer (OR 2.11)
Previous miscarriages	5929.12	111	0.0000	P=0.000
Smoking status	5927.33	114	0.0000	'Light' sig diff from 'nonsmoker'
Amniocentesis	5923.87	112	0.0000	'Yes' sig diff from 'no'
Carstairs quintile	5922.35	115	0.0000	'5' and 'missing' sig diff from '1'
Congenital abnormalities	5921.44	111	0.0000	P=0.006
No of US scans	5921.02	116	0.0000	'4' sig diff from '1'
Patient category	5920.74	113	0.0000	None sig diff from 'normal'. Drop – has been non-sig for last 5 iterations
Late booker	5916.96	112	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'. Drop – has been non-sig for last 5 iterations
Parity + hospital + birthweight + antenatal risk status [block] + time of birth + year + ethnic group + previous terminations + gestation >41 weeks? + age + month + intended place of birth +				
Previous miscarriages	5947.79	112	0.0000	P=0.000
Smoking status	5946.62	115	0.0000	'Light' sig diff from 'nonsmoker'
Amniocentesis	5942.47	113	0.0000	'Yes' sig diff from 'no'
Carstairs quintile	5941.20	116	0.0000	'5' and 'missing' sig diff from '1'
Congenital abnormalities	5940.48	112	0.0000	P=0.006
No of US scans	5939.67	117	0.0000	'4' sig diff from '1'
Parity + hospital + birthweight + antenatal risk status [block] + time of birth + year + ethnic group + previous terminations + gestation >41 weeks? + age + month + intended place of birth + previous miscarriages +				
Smoking status	5962.98	116	0.0000	'Heavy and 'light' sig diff from 'nonsmoker'. LRT p=0.0043
Amniocentesis	5958.03	114	0.0000	'Yes' sig diff from 'no'. LRT p=0.0060
Carstairs quintile	5956.47	117	0.0000	'Missing' sig diff from '1'. LRT p=0.1226
Congenital abnormalities	5955.91	113	0.0000	P=0.005
No of US scans	5954.74	118	0.0000	'4' sig diff from '1'
Parity + hospital + birthweight + antenatal risk status [block] + time of birth + year + ethnic group + previous terminations + gestation >41 weeks? + age + month + intended place of birth + previous miscarriages + smoking status +				
Amniocentesis	5973.34	118	0.0000	'Yes' sig diff from 'no'. LRT p=0.0056
Carstairs quintile	5972.94	121	0.0000	'5' & 'missing' sig diff from '1'. LRT p=0.0764
Congenital abnormalities	5971.18	117	0.0000	P=0.005. LRT p=0.0042
No of US scans	5970.31	122	0.0000	'4' sig diff from '1'. LRT p=0.2915

Table F.9 (cont'd): Model selection for pyrexia

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Parity + hospital + birthweight + antenatal risk status [block] + time of birth + year + ethnic group + previous terminations + gestation >41 weeks? + age + month + intended place of birth + previous miscarriages + smoking status + amniocentesis +				
Carstairs quintile	5983.61	123	0.0000	'5' & 'missing' sig diff from '1'. LRT p=0.0680
Congenital abnormalities	5981.09	119	0.0000	P=0.007. LRT p=0.0054
No of US scans	5979.54	124	0.0000	None sig diff from '1'. LRT p=0.4011
Parity + hospital + birthweight + antenatal risk status [block] + time of birth + year + ethnic group + previous terminations + gestation >41 weeks? + age + month + intended place of birth + previous miscarriages + smoking status + amniocentesis + congenital abnormalities +				
Carstairs quintile	5991.33	124	0.0000	'5' & 'missing' sig diff from '1'. LRT p=0.0688
No of US scans	5987.38	125	0.0000	None sig diff from '1'. LRT p=0.3912
Full additive model = Parity + hospital + birthweight + antenatal risk status [block] + time of birth + year + ethnic group + previous terminations + gestation >41 weeks? + age + month + intended place of birth + previous miscarriages + smoking status + amniocentesis + congenital abnormalities				
Full additive model without 24 non-sig high/medium-risk conditions	5956.01	95	0.0000	LRT showed this not to be significantly worse fit than full additive model (p=0.4018)
Full additive model without non-sig conditions and parity collapsed to 4 levels (0, 1, 2, >2)	5953.57	93	0.0000	LRT showed this not to be significantly worse fit than model in row above (p=0.2942)
Full additive model without non-sig conditions, parity collapsed to 4 levels and 30+ age groups collapsed (new ref cat)	5949.21	90	0.0000	LRT showed this not to be significantly worse fit than model in row above (p=0.2257)
Full additive model without non-sig conditions, parity collapsed to 4 levels, 30+ age groups collapsed and month collapsed to 5 levels (Jan-Jun, Jul, Aug, Sep, Oct-Dec)	5943.96	83	0.0000	LRT showed this not to be significantly worse fit than model in row above (p=0.6295)
Final additive model = Collapsed parity + hospital + birthweight + antenatal risk status [collapsed block] + time of birth + year + ethnic group + previous terminations + gestation >41 weeks? + collapsed age + collapsed month + intended place of birth + previous miscarriages + smoking status + amniocentesis + congenital abnormalities				

Table F.9 (cont'd): Model selection for pyrexia

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Final additive model +				
Intended place of birth*parity	5948.80	86	0.0000	LRT showed this not to be significantly better fit than full additive model (p=0.1844)
Intended place of birth*anaemia	5948.25	85	0.0000	LRT showed this not to be significantly better fit than full additive model (p=0.1173)
Intended place of birth*smoking status	5947.62	87	0.0000	LRT showed this not to be significantly better fit than full additive model (p=0.4541). Also large SEs.
Intended place of birth*BMI	5946.66	85	0.0000	LRT showed this not to be significantly better fit than full additive model (p=0.2599)
Intended place of birth*previous miscarriages	5946.54	84	0.0000	LRT showed this not to be significantly better fit than full additive model (p=0.1086)
Intended place of birth*previous CS	5945.16	84	0.0000	LRT showed this not to be significantly better fit than full additive model (p=0.2747). Also large SEs.
Intended place of birth*gestation >41 weeks	5945.10	84	0.0000	LRT showed this not to be significantly better fit than full additive model (p=0.2858)
Intended place of birth*congenital abnormalities	5944.85	84	0.0000	LRT showed this not to be significantly better fit than full additive model (p=0.3468)
Intended place of birth*age	5944.53	87	0.0000	LRT showed this not to be significantly better fit than full additive model (p=0.9661). Also large SEs.
Intended place of birth*suspected congenital abnormality	5944.39	84	0.0000	LRT showed this not to be significantly better fit than full additive model (p=0.5151)
Intended place of birth*previous stillbirth/neonatal death	5944.28	84	0.0000	LRT showed this not to be significantly better fit than full additive model (p=0.5738). Also large SEs.
Intended place of birth*previous terminations	5944.19	84	0.0000	LRT showed this not to be significantly better fit than full additive model (p=0.6321)
Intended place of birth*placental abruption	5944.01	84	0.0000	LRT showed this not to be significantly better fit than full additive model (p=0.8194). Also large SEs.
Intended place of birth*placenta praevia	5944.01	84	0.0000	LRT showed this not to be significantly better fit than full additive model (p=0.8294). Also large SEs.
Intended place of birth*preterm labour	5943.98	84	0.0000	LRT showed this not to be significantly better fit than full additive model (p=0.8833)
Intended place of birth*gestational diabetes	5943.97	84	0.0000	LRT showed this not to be significantly better fit than full additive model (p=0.9506)
Intended place of birth*birthweight	-	-	0.0000	'<500g' dropped due to collinearity. Try '<1500g' as a single category
Intended place of birth*collapsed birthweight	5941.20	85	0.0000	LRT showed this not to be significantly better fit than equivalent additive model (p=0.5912)
Intended place of birth*multiple pregnancy	-	-	-	There were no cases of pyrexia among those with multiple pregnancy who intended a home birth
Intended place of birth*large for dates	-	-	-	There were no 'large for dates' cases among those who intended a home birth

F.10 Retained placenta model

Table F.10: Model selection for retained placenta

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Birthweight	521.25	4	0.0000	All sig diff from '2500-3999' except '4000+'
Antenatal risk status [block]	447.27	37	0.0000	11 conditions p<0.05
Ethnic group	386.10	7	0.0000	All sig diff from 'W Euro' except 'Oriental' and 'missing'
Age	253.65	7	0.0000	All sig diff from 30-34 bar <16 and 45+
Hospital	210.92	14	0.0000	6 sig diff from Hillingdon
Smoking status	180.31	4	0.0000	All sig diff from 'nonsmoker'
No of US scans	174.82	6	0.0000	All sig diff from '1' except '0'
Parity	124.47	5	0.0000	'0', '1' and '3' sig diff from '2'
Sex of baby	98.34	2	0.0000	'Male' and 'indeterminate' sig diff from 'female'
Previous miscarriages	91.53	1	0.0000	P=0.000
Amniocentesis	83.18	2	0.0000	'Missing' sig diff from 'no'
Previous terminations	62.82	1	0.0000	P=0.000
Year	52.59	12	0.0000	4 years sig diff from 1988
Carstairs quintile	42.15	5	0.0000	'4' and '5' sig diff from '1'
Interpreter required	37.54	1	0.0000	P=0.000
Intended place of birth	36.96	1	0.0000	P=0.000. Home safer
Gestation > 41 weeks?	35.57	1	0.0000	P=0.000
Late booker	20.83	2	0.0000	'Missing' sig diff from 'no'
Time of birth	16.30	11	0.1305	1 slot sig diff from 1000-1159
Month	8.44	11	0.6737	1 month sig diff from Sep
CVB	8.42	2	0.0149	'Missing' sig diff from 'no'
Congenital abnormalities	6.46	1	0.0111	P=0.010
Single	5.69	2	0.0581	'Yes' sig diff from 'no'
Patient category	4.28	3	0.2331	None sig diff from 'normal'
Birthweight +				
Ethnic group	967.24	11	0.0000	All sig diff from 'W Euro' except 'Oriental' and 'missing'
Age	776.27	11	0.0000	All sig diff from 30-34 bar <16, 45+
Hospital	737.30	18	0.0000	7 sig diff from Hillingdon
Antenatal risk status [block]	683.56	41	0.0000	12 conditions p<0.05
Smoking status	671.25	8	0.0000	All sig diff from nonsmoker bar missing
Parity	627.90	9	0.0000	'0', '1' and '3' sig diff from '2'
No of US scans	616.62	10	0.0000	All sig diff from '1' except '0'
Sex of baby	606.43	6	0.0000	'Male' sig diff from 'female'
Amniocentesis	598.14	6	0.0000	'Yes' + 'missing' sig diff from 'no'
Previous miscarriages	595.77	5	0.0000	P=0.000
Carstairs quintile	575.83	9	0.0000	'4' and '5' sig diff from '1'
Gestation > 41 weeks?	575.64	5	0.0000	P=0.000
Previous terminations	574.12	5	0.0000	P=0.000
Year	572.01	16	0.0000	4 years sig diff from 1988
Interpreter required	561.87	5	0.0000	P=0.000
Intended place of birth	551.32	5	0.0000	P=0.000. Home safer
Late booker	547.13	6	0.0000	'Yes' and 'missing' sig diff from 'no'
Time of birth	535.26	15	0.0000	None sig diff from '1000-1159'
Month	530.27	15	0.0000	1 month sig diff from Sep
Patient category	527.01	7	0.0000	'Overseas' sig diff from 'normal'
CVB	526.35	6	0.0000	'Yes' + 'missing' not sig diff from 'no'
Single	526.29	6	0.0000	'Yes' + 'missing' not sig diff from 'no'
Congenital abnormalities	523.14	5	0.0000	P=0.165

Table F.10 (cont'd): Model selection for retained placenta

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Birthweight + ethnic group +				
Age	1194.01	18	0.0000	All sig diff from '30-34' except '<16' and '45+'
Hospital	1131.94	25	0.0000	7 hospitals sig diff from Hillingdon
Antenatal risk status [block]	1123.88	48	0.0000	13 conditions p<0.05
No of US scans	1062.04	17	0.0000	All sig diff from '1' except '0'
Parity	1051.60	16	0.0000	'0', '1' and '3' sig diff from '2'
Sex of baby	1050.05	13	0.0000	'Male' sig diff from 'female'
Amniocentesis	1035.59	13	0.0000	'Yes' sig diff from 'no'
Previous miscarriages	1035.13	12	0.0000	P=0.000
Smoking status	1034.77	15	0.0000	All sig diff from 'nonsmoker' except 'missing'
Year	1016.32	23	0.0000	4 years sig diff from 1988
Gestation > 41 weeks?	1015.97	12	0.0000	P=0.000
Previous terminations	1012.26	12	0.0000	P=0.000
Intended place of birth	1007.37	12	0.0000	P=0.000. Home safer
Late booker	982.01	13	0.0000	'Missing' sig diff from 'no'
Time of birth	981.24	22	0.0000	None sig diff from '1000-1159'
Month	977.17	22	0.0000	1 month sig diff from Sep
Carstairs quintile	973.65	16	0.0000	None sig diff from '1'
Interpreter required	971.93	12	0.0000	P=0.035
Single	971.41	13	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'
CVB	971.23	13	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'
Patient category	970.30	14	0.0000	None sig diff from 'normal'
Congenital abnormalities	969.67	12	0.0000	P=0.114
Birthweight + ethnic group + age +				
Parity	1384.92	23	0.0000	'0' and '1' sig diff from '2'
Antenatal risk status [block]	1342.60	55	0.0000	12 conditions p<0.05
Hospital	1331.98	32	0.0000	5 hospitals sig diff from Hillingdon
Smoking status	1316.64	22	0.0000	All sig diff from 'nonsmoker' except 'missing'
Sex of baby	1276.04	20	0.0000	'Male' sig diff from 'female'
No of US scans	1262.71	24	0.0000	'3', '4' and '5+' sig diff from '1'
Intended place of birth	1243.46	19	0.0000	P=0.000. Home safer
Gestation > 41 weeks?	1243.45	19	0.0000	P=0.000
Previous terminations	1233.11	19	0.0000	P=0.000
Previous miscarriages	1232.65	19	0.0000	P=0.000
Year	1229.08	30	0.0000	3 years sig diff from 1988
Amniocentesis	1215.85	20	0.0000	'Yes' sig diff from 'no'
Time of birth	1208.08	29	0.0000	None sig diff from '1000-1159'
Late booker	1207.30	20	0.0000	'Missing' sig diff from 'no'
Single	1206.17	20	0.0000	'Yes' sig diff from 'no'
Month	1203.71	29	0.0000	1 month sig diff from Sep
Carstairs quintile	1202.20	23	0.0000	'3' sig diff from '1'
Patient category	1197.87	21	0.0000	None sig diff from 'normal'
Interpreter required	1197.46	19	0.0000	P=0.070
Congenital abnormalities	1196.46	19	0.0000	P=0.113
CVB	1195.00	20	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'

Table F.10 (cont'd): Model selection for retained placenta

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Birthweight + ethnic group + age + parity +				
Smoking status	1555.78	27	0.0000	All sig diff from 'nonsmoker' except 'missing'
Antenatal risk status [block]	1542.84	60	0.0000	14 conditions p<0.05
Hospital	1498.97	37	0.0000	4 hospitals sig diff from Hillingdon
Sex of baby	1468.83	25	0.0000	'Male' sig diff from 'female'
No of US scans	1448.87	29	0.0000	'3', '4' and '5+' sig diff from '1'
Previous miscarriages	1448.38	24	0.0000	P=0.000
Gestation > 41 weeks?	1424.41	24	0.0000	P=0.000
Intended place of birth	1422.54	24	0.0000	P=0.000. Home safer
Previous terminations	1422.19	24	0.0000	P=0.000
Year	1418.68	35	0.0000	1 year sig diff from 1988
Amniocentesis	1403.32	25	0.0000	'Yes' sig diff from 'no'
Late booker	1399.41	25	0.0000	'Missing' sig diff from 'no'
Time of birth	1398.61	34	0.0000	None sig diff from '1000-1159'
Carstairs quintile	1397.37	28	0.0000	'3' sig diff from '1'
Single	1395.45	25	0.0000	'Yes' sig diff from 'no'
Month	1394.17	34	0.0000	1 month sig diff from Sep
Patient category	1389.53	26	0.0000	None sig diff from 'normal'
Congenital abnormalities	1387.18	24	0.0000	P=0.129
Interpreter required	1386.73	24	0.0000	P=0.187
CVB	1385.73	25	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'
Birthweight + ethnic group + age + parity + smoking status +				
Antenatal risk status [block]	1716.03	64	0.0000	13 conditions p<0.05
Hospital	1668.21	41	0.0000	4 hospitals sig diff from Hillingdon
Sex of baby	1641.85	29	0.0000	'Male' sig diff from 'female'
No of US scans	1616.90	33	0.0000	'3', '4' and '5+' sig diff from '1'
Previous miscarriages	1611.56	28	0.0000	P=0.000
Gestation > 41 weeks?	1593.71	28	0.0000	P=0.000
Year	1593.31	39	0.0000	3 years sig diff from 1988
Intended place of birth	1590.86	28	0.0000	P=0.000. Home safer
Previous terminations	1577.93	28	0.0000	P=0.000
Amniocentesis	1574.80	29	0.0000	'Yes' sig diff from 'no'
Time of birth	1569.50	38	0.0000	None sig diff from '1000-1159'. Drop – has been non-sig for last 5 iterations
Late booker	1568.02	29	0.0000	'Missing' sig diff from 'no'
Month	1565.42	38	0.0000	1 month sig diff from Sep
Carstairs quintile	1561.04	32	0.0000	None sig diff from '1'
Single	1559.68	29	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'
Patient category	1559.13	30	0.0000	None sig diff from 'normal'
Congenital abnormalities	1558.19	28	0.0000	P=0.116. Drop – has been non-sig for last 5 iterations
CVB	1556.85	29	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'. Drop – has been non-sig for last 5 iterations
Interpreter required	1556.81	28	0.0000	P=0.316

Table F.10 (cont'd): Model selection for retained placenta

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Birthweight + ethnic group + age + parity + smoking status + antenatal risk status [block] +				
Hospital	1823.15	78	0.0000	4 hospitals sig diff from Hillingdon
Sex of baby	1803.48	66	0.0000	'Male' sig diff from 'female'
No of US scans	1773.15	70	0.0000	'3', '4' and '5+' sig diff from '1'
Previous miscarriages	1768.43	65	0.0000	P=0.000
Gestation > 41 weeks?	1756.34	65	0.0000	P=0.000
Year	1755.59	76	0.0000	3 years sig diff from 1988
Intended place of birth	1747.79	65	0.0000	P=0.000. Home safer
Previous terminations	1736.76	65	0.0000	P=0.000
Amniocentesis	1731.65	66	0.0000	'Yes' sig diff from 'no'
Late booker	1728.62	66	0.0000	'Missing' sig diff from 'no'
Month	1725.75	75	0.0000	1 month sig diff from Sep
Carstairs quintile	1721.29	69	0.0000	None sig diff from '1'
Single	1720.93	66	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'
Patient category	1719.09	67	0.0000	None sig diff from 'normal'. Drop – has been non-sig for last 5 iterations
Interpreter required	1717.17	65	0.0000	P=0.293
Birthweight + ethnic group + age + parity + smoking status + antenatal risk status [block] + hospital +				
Sex of baby	1910.24	80	0.0000	'Male' sig diff from 'female'
Previous miscarriages	1876.82	79	0.0000	P=0.000
No of US scans	1873.19	84	0.0000	'3', '4' and '5+' sig diff from '1'
Year	1860.60	90	0.0000	3 years sig diff from 1988
Gestation > 41 weeks?	1860.14	79	0.0000	P=0.000
Intended place of birth	1855.49	79	0.0000	P=0.000. Home safer
Previous terminations	1842.70	79	0.0000	P=0.000
Amniocentesis	1834.75	80	0.0000	'Yes' sig diff from 'no'
Month	1832.99	89	0.0000	1 month sig diff from Sep
Late booker	1832.01	80	0.0000	'Missing' sig diff from 'no'
Single	1829.78	80	0.0000	'Missing' sig diff from 'no'
Carstairs quintile	1829.75	83	0.0000	None sig diff from '1'
Interpreter required	1825.17	79	0.0000	P=0.163. Drop – has been non-sig for last 5 iterations
Birthweight + ethnic group + age + parity + smoking status + antenatal risk status [block] + hospital + sex of baby +				
Previous miscarriages	1963.75	81	0.0000	P=0.000
No of US scans	1958.51	86	0.0000	'3', '4' and '5+' sig diff from '1'
Year	1947.61	92	0.0000	3 years sig diff from 1988
Gestation > 41 weeks?	1947.56	81	0.0000	P=0.000
Intended place of birth	1942.68	81	0.0000	P=0.000. Home safer
Previous terminations	1929.58	81	0.0000	P=0.000
Amniocentesis	1921.56	82	0.0000	'Yes' sig diff from 'no'
Month	1920.14	91	0.0000	1 month sig diff from Sep
Late booker	1919.12	82	0.0000	'Missing' sig diff from 'no'
Single	1916.85	82	0.0000	'Missing' sig diff from 'no'
Carstairs quintile	1916.83	85	0.0000	None sig diff from '1'

Table F.10 (cont'd): Model selection for retained placenta

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Birthweight + ethnic group + age + parity + smoking status + antenatal risk status [block] + hospital + sex of baby + previous miscarriages +				
No of US scans	2004.93	87	0.0000	'3', '4' and '5+' sig diff from '1'
Gestation > 41 weeks?	2001.42	82	0.0000	P=0.000
Year	2000.33	93	0.0000	3 years sig diff from 1988
Intended place of birth	1995.54	82	0.0000	P=0.000. Home safer
Previous terminations	1983.19	82	0.0000	P=0.000
Amniocentesis	1975.57	83	0.0000	'Yes' sig diff from 'no'
Month	1973.58	92	0.0000	1 month sig diff from Sep
Late booker	1972.39	83	0.0000	'Missing' sig diff from 'no'
Carstairs quintile	1970.40	86	0.0000	None sig diff from '1'. Drop – has been non-sig for last 5 iterations
Single	1970.34	83	0.0000	'Missing' sig diff from 'no'
Birthweight + ethnic group + age + parity + smoking status + antenatal risk status [block] + hospital + sex of baby + previous miscarriages + no of US scans +				
Gestation > 41 weeks?	2042.83	88	0.0000	P=0.000
Year	2041.84	99	0.0000	3 years sig diff from 1988
Intended place of birth	2034.69	88	0.0000	P=0.000. Home safer
Previous terminations	2023.83	88	0.0000	P=0.000
Month	2014.85	98	0.0000	1 month sig diff from Sep
Amniocentesis	2013.42	89	0.0000	'Yes' sig diff from 'no'
Single	2012.51	89	0.0000	'Missing' sig diff from 'no'
Late booker	2011.99	89	0.0000	'Missing' sig diff from 'no'
Birthweight + ethnic group + age + parity + smoking status + antenatal risk status [block] + hospital + sex of baby + previous miscarriages + no of US scans + gestation > 41 weeks? +				
Year	2079.00	100	0.0000	3 years sig diff from 1988
Intended place of birth	2072.10	89	0.0000	P=0.000. Home safer
Previous terminations	2062.00	89	0.0000	P=0.000
Month	2052.54	99	0.0000	1 month sig diff from Sep
Amniocentesis	2051.34	90	0.0000	'Yes' sig diff from 'no'
Single	2050.34	90	0.0000	'Missing' sig diff from 'no'
Late booker	2049.86	90	0.0000	'Missing' sig diff from 'no'
Birthweight + ethnic group + age + parity + smoking status + antenatal risk status [block] + hospital + sex of baby + previous miscarriages + no of US scans + gestation > 41 weeks? + year +				
Intended place of birth	2109.53	101	0.0000	P=0.000. Home safer. LRT p=0.0000
Previous terminations	2098.43	101	0.0000	P=0.000. LRT p=0.0000
Month	2088.66	111	0.0000	1 month sig diff from Sep
Amniocentesis	2087.96	102	0.0000	'Yes' sig diff from 'no'.
Single	2085.93	102	0.0000	'Missing' sig diff from 'no'.
Late booker	2081.89	102	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'.

Table F.10 (cont'd): Model selection for retained placenta

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Birthweight + ethnic group + age + parity + smoking status + antenatal risk status [block] + hospital + sex of baby + previous miscarriages + no of US scans + gestation > 41 weeks? + year + intended place of birth +				
Previous terminations	2128.83	102	0.0000	P=0.000. LRT p=0.0000
Month	2119.18	112	0.0000	1 month sig diff from Sep. LRT p=0.5622
Amniocentesis	2118.25	103	0.0000	'Yes' sig diff from 'no'. LRT p=0.0128
Single	2116.36	103	0.0000	'Missing' sig diff from 'no'. LRT p=0.0329
Late booker	2112.38	103	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'. LRT p=0.2413
Birthweight + ethnic group + age + parity + smoking status + antenatal risk status [block] + hospital + sex of baby + previous miscarriages + no of US scans + gestation > 41 weeks? + year + intended place of birth + previous terminations +				
Month	2138.50	113	0.0000	1 month sig diff from Sep. LRT p=0.5600
Amniocentesis	2137.21	104	0.0000	'Yes' sig diff from 'no'. LRT p=0.0152
Single	2135.09	104	0.0000	'Missing' sig diff from 'no'. LRT p=0.0438
Late booker	2131.60	104	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'. LRT p=0.2504
Birthweight + ethnic group + age + parity + smoking status + antenatal risk status [block] + hospital + sex of baby + previous miscarriages + no of US scans + gestation > 41 weeks? + year + intended place of birth + previous terminations + amniocentesis +				
Month	2146.86	115	0.0000	1 month sig diff from Sep. LRT p=0.5613
Single	2143.47	106	0.0000	'Missing' sig diff from 'no'. LRT p=0.0435
Late booker	2139.60	106	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'. LRT p=0.3016
Birthweight + ethnic group + age + parity + smoking status + antenatal risk status [block] + hospital + sex of baby + previous miscarriages + no of US scans + gestation > 41 weeks? + year + intended place of birth + previous terminations + amniocentesis + single +				
Month	2153.11	117	0.0000	1 month sig diff from Sep. LRT p=0.2613
Late booker	2145.84	108	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'. LRT p=0.0442

Table F.10 (cont'd): Model selection for retained placenta

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Additive model = Birthweight + ethnic group + age + parity + smoking status + antenatal risk status [block] + hospital + sex of baby + previous miscarriages + no of US scans + gestation >41 weeks + year + intended place of birth + previous terminations + amniocentesis + single				
Additive model without 25 non-significant high-/medium-risk conditions (95%)	2107.20	81	0.0000	LRT showed this to be not to be a significantly worse fit than same model with the 25 conditions (p=0.1466).
Additive model without 25 non-sig high-/medium-risk conditions and 2500g-3999g and 4000+g birthweight categories combined	2106.96	80	0.0000	LRT showed this not to be significantly worse fit than model with model on previous row (p=0.6264).
Additive model without 18 non-sig high-/medium-risk conditions, collapsed birthweight, and years 1988-1991 as single category (new ref cat) and 1996-2000 as single category	2101.69	73	0.0000	LRT showed this not to be significantly worse fit than model with model on previous row (p=0.6266).
Final additive model = Collapsed birthweight + ethnic group + age + parity + smoking status + antenatal risk status [collapsed block] + hospital + sex of baby + previous miscarriages + no of US scans + gestation >41 weeks + collapsed year + intended place of birth + previous terminations + amniocentesis + single				
Final additive model +				
Intended place of birth * age	2109.88	80	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.3158). Also very large SEs
Intended place of birth * parity	2107.94	78	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.2819). Also very large SEs
Intended place of birth * suspected congenital abnormality	2104.95	74	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.0707). Also very large SEs
Intended place of birth * BMI	2104.12	75	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.2965).
Intended place of birth * smoking status	2102.79	77	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.8929).
Intended place of birth * gestation > 41 weeks	2102.78	74	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.2950).
Intended place of birth * recurrent antepartum haemorrhage	2102.72	74	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.3100). Also very large SEs
Intended place of birth * malpresentation	2101.93	74	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.6185).
Intended place of birth * multiple pregnancy	2101.93	74	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.6217). Also very large SEs
Intended place of birth * placental abruption	2101.87	74	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.6667). Also very large SEs

Intended place of birth * inflammatory bowel disorder	2101.86	74	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.6804). Also very large SEs
Intended place of birth * pre-existing diabetes	2101.77	74	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.7657). Also very large SEs
Intended place of birth * preterm labour	2101.77	74	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.7781).
Intended place of birth * epilepsy	2101.73	74	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.8359). Also very large SEs
Intended place of birth * previous CS	2101.69	74	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.9515).

F.11 Perinatal mortality model

The model building process used the sample including indeterminate stillbirths. Once the final model was built, it was re-run without indeterminate stillbirths (see Section 5.3.2).

Table F.11: Model selection for perinatal mortality

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Birthweight	4747.34	3	0.0000	LBW & VLBW sig diff from 2500-3999g
Antenatal risk status [block]	3701.09	31	0.0000	13 conditions with p<0.05
Late booker	488.61	2	0.0000	'Yes' and 'missing' sig diff from 'no'
No of US scans	217.64	6	0.0000	All sig diff from '1' except '2'
Congenital abnormalities	139.30	4	0.0000	P=0.000
Hospital	117.53	14	0.0000	All sig diff from Watford bar 3
Sex of baby	98.53	2	0.0000	Male and indeterminate sig diff from female
Year	63.59	12	0.0000	All years sig diff from 2000 bar 4
Smoking status	57.98	4	0.0000	All sig diff from 'nonsmoker'
Ethnic group	57.22	7	0.0000	All sig diff from 'W Euro' except 'Mediterranean' and 'Oriental'
Carstairs quintile	56.63	5	0.0000	'4', '5' and 'missing' sig diff from '1'
Amniocentesis	54.67	2	0.0000	'Yes' & 'missing' sig diff from 'no'
CVB	48.36	2	0.0000	'Yes' & 'missing' sig diff from 'no'
Previous miscarriages	33.03	1	0.0000	P=0.000
Parity	28.80	5	0.0000	'1' and '4' sig diff from '0'
Single	24.14	2	0.0000	'Yes' and 'missing' sig diff from 'no'
Previous terminations	21.72	3	0.0001	'1' and '2' sig diff from '0'
Time of birth	20.78	11	0.0357	4 time slots sig diff from 1000-1159
Age	19.82	7	0.0060	'16-19, '20-24' and '35-39' sig diff from '30-34'
Month	19.03	11	0.0605	2 months sig diff from Oct
Gestation > 41 weeks?	11.00	0	0.0009	P=0.002
Patient category	5.71	3	0.1264	'Overseas' sig diff from 'normal'
Interpreter required	3.56	1	0.0592	P=0.048
Intended place of birth	2.91	1	0.0880	P=0.114 (home safer, but not significantly)

Table F.11 (cont'd): Model selection for perinatal mortality

Explanatory variable(s) in model	$LR\chi^2$	df	p	Notes
Birthweight +				
Antenatal risk status [block]	5676.96	34	0.0000	11 conditions with p<0.05
Year	4834.03	15	0.0000	All years sig diff from 2000 bar 3
Sex of baby	4819.21	5	0.0000	Male and indeterminate sig diff from female
Late booker	4812.15	5	0.0000	'Yes' & 'missing' sig diff from 'no'
No of US scans	4785.35	9	0.0000	'0', '5' & 'missing' sig diff from '1'
Time of birth	4779.95	14	0.0000	5 time slots sig diff from 1000-1159
Congenital abnormalities	4772.83	4	0.0000	P=0.000
Hospital	4770.05	17	0.0000	9 sig diff from Watford
Month	4760.53	14	0.0000	2 months sig diff from Oct
Parity	4758.70	8	0.0000	'4' sig diff from '0'
Age	4758.46	10	0.0000	'20-24' and '25-29' sig diff from '30-34'
Carstairs quintile	4756.46	8	0.0000	Just 'missing' sig diff from '1'
CVB	4755.27	5	0.0000	'Yes' & 'missing' sig diff from 'no'
Gestation > 41 weeks?	4754.95	4	0.0000	P=0.003
Ethnic group	4753.84	10	0.0000	Just 'missing' diff from 'W Euro'
Amniocentesis	4753.41	5	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'
Previous terminations	4752.07	6	0.0000	None sig diff from '0'
Smoking status	4751.79	7	0.0000	None sig diff from 'nonsmoker'
Patient category	4749.49	6	0.0000	None sig diff from 'normal'
Intended place of birth	4748.97	4	0.0000	P=0.175 (hospital safer, but not significantly)
Previous miscarriages	4748.63	4	0.0000	P=0.247
Interpreter required	4748.57	4	0.0000	P=0.255
Single	4748.52	5	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'
Birthweight + antenatal risk status [block] +				
Year	5753.59	46	0.0000	All years sig diff from 2000 bar 3
No of US scans	5729.12	40	0.0000	'0', '5' & 'missing' sig diff from '1'
Late booker	5724.54	36	0.0000	'Yes' & 'missing' sig diff from 'no'
Sex of baby	5720.18	36	0.0000	Male and indeterminate sig diff from female
Time of birth	5712.14	45	0.0000	6 time slots sig diff from 1000-1159
Hospital	5700.29	48	0.0000	11 sig diff from Watford
Month	5691.09	45	0.0000	2 months sig diff from Oct
Age	5689.63	41	0.0000	'20-24' & '25-29' sig diff from '30-34'
Gestation > 41 weeks?	5687.95	35	0.0000	P=0.000
Ethnic group	5685.52	41	0.0000	Just 'missing' diff from 'W Euro'
CVB	5684.26	36	0.0000	Just 'missing' sig diff from 'no'
Carstairs quintile	5683.60	39	0.0000	Just 'missing' sig diff from '1'
Amniocentesis	5681.43	36	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'
Parity	5681.29	39	0.0000	None sig diff from '0'
Previous terminations	5680.75	37	0.0000	None sig diff from '0'
Single	5680.10	36	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'
Patient category	5680.06	37	0.0000	None sig diff from 'normal'
Intended place of birth	5679.47	35	0.0000	P=0.088 (hospital safer, but not significantly)
Smoking status	5679.34	38	0.0000	None sig diff from 'nonsmoker'
Congenital abnormalities	5678.58	35	0.0000	P=0.209
Interpreter required	5677.51	35	0.0000	P=0.452
Previous miscarriages	5677.00	35	0.0000	P=0.845

Table F.11 (cont'd): Model selection for perinatal mortality

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Birthweight + antenatal risk status [block] + year +				
Sex of baby	5796.77	48	0.0000	Male and indeterminate sig diff from female
No of US scans	5794.64	52	0.0000	'0', '5' and 'missing' sig diff from '1'
Time of birth	5787.95	57	0.0000	5 time slots sig diff from 1000-1159
Amniocentesis	5785.35	48	0.0000	'Missing' sig diff from 'no'
Late booker	5781.85	48	0.0000	'Yes' and 'missing' sig diff from 'no'
Hospital	5780.05	60	0.0000	11 sig diff from Watford
Month	5769.30	57	0.0000	2 months sig diff from Oct
Ethnic group	5764.66	53	0.0000	Just 'other' diff from 'W Euro'
Gestation > 41 weeks?	5764.22	47	0.0000	P=0.000
CVB	5763.24	48	0.0000	Just 'missing' sig diff from 'no'
Age	5761.50	53	0.0000	None sig diff from '30-34'
Parity	5757.90	51	0.0000	None sig diff from '0'
Patient category	5756.98	49	0.0000	None sig diff from 'normal'
Single	5756.86	48	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'
Previous terminations	5756.80	49	0.0000	None sig diff from '0'
Intended place of birth	5756.52	47	0.0000	P=0.064 (hospital safer, but not significantly)
Carstairs quintile	5756.51	51	0.0000	None sig diff from '1'
Congenital abnormalities	5755.18	47	0.0000	P=0.213
Smoking status	5754.59	50	0.0000	None sig diff from 'nonsmoker'
Interpreter required	5753.93	47	0.0000	P=0.559
Previous miscarriages	5753.60	47	0.0000	P=0.973
Birthweight + antenatal risk status [block] + year + sex of baby +				
No of US scans	5836.70	54	0.0000	'0', '5' and 'missing' sig diff from '1'
Time of birth	5830.88	59	0.0000	5 time slots sig diff from 1000-1159
Late booker	5823.45	50	0.0000	'Yes' and 'missing' sig diff from 'no'
Hospital	5822.86	62	0.0000	11 sig diff from Watford
Month	5812.20	59	0.0000	2 months sig diff from Oct
Ethnic group	5807.68	55	0.0000	Just 'other' diff from 'W Euro'
Gestation > 41 weeks?	5807.34	49	0.0000	P=0.000
CVB	5806.36	50	0.0000	Just 'missing' sig diff from 'no'
Age	5804.71	55	0.0000	None sig diff from '30-34'
Amniocentesis	5801.68	50	0.0000	'Missing' sig diff from 'no'
Parity	5801.44	53	0.0000	None sig diff from '0'
Patient category	5800.07	51	0.0000	None sig diff from 'normal'
Previous terminations	5799.85	51	0.0000	None sig diff from '0'
Single	5799.84	50	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'
Intended place of birth	5799.64	49	0.0000	P=0.067 (hospital safer, but not significantly)
Congenital abnormalities	5799.31	49	0.0000	P=0.116
Carstairs quintile	5799.30	53	0.0000	None sig diff from '1'
Smoking status	5797.76	52	0.0000	None sig diff from 'nonsmoker'
Interpreter required	5797.11	49	0.0000	P=0.557
Previous miscarriages	5796.78	49	0.0000	P=0.947

Table F.11 (cont'd): Model selection for perinatal mortality

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Birthweight + antenatal risk status [block] + year + sex of baby + no of US scans +				
Time of birth	5868.19	65	0.0000	2 time slots sig diff from 1000-1159
Hospital	5865.86	68	0.0000	8 sig diff from Watford
Late booker	5855.71	56	0.0000	'Yes' and 'missing' sig diff from 'no'
Month	5851.53	65	0.0000	2 months sig diff from Oct
Gestation > 41 weeks?	5847.03	55	0.0000	P=0.000
Ethnic group	5846.76	61	0.0000	Just 'other' diff from 'W Euro'
Age	5844.31	61	0.0000	None sig diff from '30-34'
Patient category	5843.26	57	0.0000	'Private' sig diff from 'normal'
Parity	5841.17	59	0.0000	None sig diff from '0'
Single	5840.06	56	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'. Drop – has been non-sig for last 5 iterations
Previous terminations	5839.48	57	0.0000	None sig diff from '0'. Drop – has been non-sig for last 5 iterations
CVB	5839.46	56	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'
Intended place of birth	5839.22	55	0.0000	P=0.087 (hospital safer, but not significantly)
Congenital abnormalities	5839.22	55	0.0000	P=0.117
Smoking status	5838.14	58	0.0000	None sig diff from 'nonsmoker'. Drop – has been non-sig for last 5 iterations
Carstairs quintile	5837.97	59	0.0000	None sig diff from '1'
Interpreter required	5836.90	55	0.0000	P=0.645. Drop – has been non-sig for last 5 iterations
Amniocentesis	5836.74	56	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'
Previous miscarriages	5836.72	55	0.0000	P=0.879. Drop – has been non-sig for last 5 iterations
Birthweight + antenatal risk status [block] + year + sex of baby + no of US scans + time of birth +				
Hospital	5896.95	79	0.0000	7 sig diff from Watford
Late booker	5887.13	67	0.0000	'Yes' and 'missing' sig diff from 'no'
Month	5883.28	76	0.0000	2 months sig diff from Oct
Gestation > 41 weeks?	5878.06	66	0.0000	P=0.001
Ethnic group	5878.05	72	0.0000	Just 'other' diff from 'W Euro'
Age	5876.00	72	0.0000	None sig diff from '30-34'
Patient category	5874.57	68	0.0000	'Private' sig diff from 'normal'
Parity	5872.91	70	0.0000	None sig diff from '0'. Drop – has been non-sig for last 5 iterations
CVB	5871.11	67	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'
Congenital abnormalities	5870.87	66	0.0000	P=0.106. Drop – has been non-sig for last 5 iterations
Intended place of birth	5870.62	66	0.0000	P=0.094 (hospital safer, but not significantly)
Carstairs quintile	5869.42	70	0.0000	None sig diff from '1'
Amniocentesis	5868.23	67	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'

Table F.11 (cont'd): Model selection for perinatal mortality

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Birthweight + antenatal risk status [block] + year + sex of baby + no of US scans + time of birth + hospital +				
Late booker	5916.51	81	0.0000	'Yes' and 'missing' sig diff from 'no'
Month	5912.38	90	0.0000	2 months sig diff from Oct
Ethnic group	5907.71	86	0.0000	Just 'other' diff from 'W Euro'
Gestation > 41 weeks?	5906.20	86	0.0000	P=0.001
Age	5904.49	86	0.0000	None sig diff from '30-34'. Drop – has been non-sig for last 5 iterations
Patient category	5901.99	82	0.0000	None sig diff from 'normal'
CVB	5899.91	81	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'
Intended place of birth	5899.05	80	0.0000	P=0.121 (hospital safer, but not significantly)
Carstairs quintile	5898.11	84	0.0000	None sig diff from '1'. Drop – has been non-sig for last 5 iterations
Amniocentesis	5897.00	81	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'
Birthweight + antenatal risk status [block] + year + sex of baby + no of US scans + time of birth + hospital + late booker +				
Month	5932.15	92	0.0000	2 months sig diff from Oct
Ethnic group	5927.26	88	0.0000	Just 'other' diff from 'W Euro'
Gestation > 41 weeks?	5925.66	82	0.0000	P=0.001
Patient category	5921.55	84	0.0000	None sig diff from 'normal'
CVB	5919.24	83	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'
Intended place of birth	5918.51	82	0.0000	P=0.131 (hospital safer, but not significantly)
Amniocentesis	5916.56	83	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'
Birthweight + antenatal risk status [block] + year + sex of baby + no of US scans + time of birth + hospital + late booker + month +				
Ethnic group	5941.64	99	0.0000	Just 'other' diff from 'W Euro'. LRT showed this not to be a significant improvement on the previous model (p=0.2188)
Gestation > 41 weeks?	5941.42	93	0.0000	P=0.001. LRT showed this to be a significant improvement (p=0.0023)
Patient category	5937.35	95	0.0000	None sig diff from 'normal'
CVB	5934.94	94	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'. Drop – has been non-sig for last 5 iterations
Intended place of birth	5934.11	93	0.0000	P=0.135 (hospital safer, but not significantly)
Amniocentesis	5932.21	94	0.0000	Neither 'yes' nor 'missing' sig diff from 'no'. Drop – has been non-sig for the last 5 iterations

Table F.11 (cont'd): Model selection for perinatal mortality

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Birthweight + antenatal risk status [block] + year + sex of baby + no of US scans + time of birth + hospital + late booker + month + gestation > 41 weeks +				
Ethnic group	5950.92	100	0.0000	Just 'other' diff from 'W Euro'. LRT showed this not to be a significant improvement on the previous model (p=0.2193)
Patient category	5946.51	96	0.0000	None sig diff from 'normal'. LRT showed this not to be a significant improvement on the previous model (p=0.1655)
Intended place of birth	5943.47	94	0.0000	P=0.127 (hospital safer, but not significantly)
Additive model: Birthweight + antenatal risk status [block] + year + sex of baby + no of US scans + time of birth + hospital + late booker + month + gestation > 41 weeks + intended place of birth				
Final additive model without the 18 non-significant high/medium risk conditions	5930.62	76	0.0000	LRT showed this not to be a significantly worse fit than additive model (p=0.8008)
Final additive model without the 18 non-significant high/medium risk conditions and with >2500g as single birthweight category	5928.73	75	0.0000	LRT showed this not to be a significantly worse fit than the model in the row above (p=0.1686)
Final additive model without the 18 non-significant high/medium risk conditions and with >2500g as single birthweight category and 1-4 US scans as a single category	5927.67	72	0.0000	LRT showed this not to be a significantly worse fit than the model in the row above (p=0.7870)
Final additive model without the 18 non-significant high/medium risk conditions and with >2500g as single birthweight category and 1-4 US scans as a single category and birthtime 08:00-19:59 as single category	5923.99	67	0.0000	LRT showed this not to be a significantly worse fit than the model in the row above (p=0.5961)
Final additive model without the 18 non-significant high/medium risk conditions and with >2500g as single birthweight category and 1-4 US scans as a single category and birthtime 08:00-19:59 as single category and month Mar-Dec as single category	5916.09	58	0.0000	LRT showed this not to be a significantly worse fit than the model in the row above (p=0.6390)
Final additive model: Collapsed birthweight + collapsed antenatal risk status [block] + year + sex of baby + collapsed no of US scans + collapsed time of birth + hospital + late booker + collapsed month + gestation >41 weeks + intended place of birth				

Table F.11 (cont'd): Model selection for perinatal mortality

Explanatory variable(s) in model	LRχ^2	df	p	Notes
Final additive model +				
Intended place of birth * infant resuscitation requiring positive pressure/cardiac massage	6259.54	60	0.0000	LRT showed this to be a significantly better fit than the final additive model (p=0.0000). And the interaction term p=0.020. But the CI for the interaction effect is huge due to small numbers
Intended place of birth * foetal distress	6005.71	60	0.0000	LRT showed this to be a significantly better fit than the final additive model (p=0.0000). But the interaction term p=0.280, so it's only a better fit due to the inclusion of the foetal distress main effect.
Intended place of birth * any infant resuscitation	5978.89	60	0.0000	LRT showed this to be a significantly better fit than the final additive model (p=0.0000). And the interaction term p=0.003. But the CI for the interaction effect is still quite large
Intended place of birth * pyrexia	5974.99	59	0.0000	0 deaths among the 27 cases of pyrexia in the 'intended a home birth' group, so these cases were dropped
Intended place of birth * cord prolapse	5960.64	60	0.0000	LRT showed this to be a significantly better fit than the final additive model (p=0.0000). And the interaction term p=0.001. But the CI for the interaction effect is huge because there was only 1 death in the 'intended home birth' group
Intended place of birth * postpartum haemorrhage	5939.53	59	0.0000	0 deaths among the 39 cases of PPH in the 'intended a home birth' group, so these cases were dropped
Intended place of birth * failure to progress in stage 2 of labour	5927.81	60	0.0000	LRT showed this to be a significantly better fit than the final additive model (p=0.0029). But the interaction term p=0.413, so it's only a better fit due to the inclusion of the failure to progress in stage 2 main effect.
Intended place of birth * failure to progress in stage 1 of labour	5920.79	59	0.0000	0 deaths among the 267 cases of failure to progress in stage 1 in the 'intended a home birth' group, so these cases were dropped
Intended place of birth * malpresentation diagnosed before labour	5919.61	59	0.0000	LRT P = 0.0606, and p-value of interaction effect = 0.024, but the CI for the interaction effect is very large
Intended place of birth * retained placenta	5919.42	60	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.1898).
Intended place of birth * birthweight	5919.40	60	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.1912).
Intended place of birth * BMI	5916.92	59	0.0000	0 deaths among the 250 cases of BMI 30-34 in the 'intended a home birth' group, so these cases were dropped
Intended place of birth * suspected congenital abnormality	5916.44	59	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.5557).
Intended place of birth * obstructed labour	5916.41	59	0.0000	0 deaths among the 12 cases of obstructed labour in the 'intended a home birth' group, so these cases were dropped

Intended place of birth * hospital	5916.28	65	0.0000	At 8 hospitals, there were 0 deaths in the 'intended a home birth' group
Intended place of birth * previous stillbirth/neonatal death	5916.27	58	0.0000	0 deaths among the 55 cases of previous SB/NND in the 'intended a home birth' group, so these cases were dropped
Intended place of birth * placental abruption	5916.27	58	0.0000	0 deaths among the 9 cases of placental abruption in 'intended home birth' group; these cases dropped
Intended place of birth * preterm labour	5916.21	59	0.0000	LRT showed this not to be a significantly better fit than the final additive model (p=0.7303).
Intended place of birth * multiple pregnancy	5916.16	58	0.0000	0 deaths among the 8 cases of multiple pregnancy in the 'intended a home birth' group, so these cases were dropped
Intended place of birth * previously undiagnosed malpresentation	5916.16	59	0.0000	0 deaths among the 13 cases of undiagnosed malpresentation in the 'intended a home birth' group, so these cases were dropped
Intended place of birth * recurrent antepartum haemorrhage	5916.25	58	0.0000	0 deaths among the 39 cases of recurrent antepartum haemorrhage in the 'intended a home birth' group, so these cases were dropped
Intended place of birth * small for dates	5916.09	58	0.0000	0 deaths among the 4 cases of being small for dates in the 'intended a home birth' group, so these cases were dropped
Intended place of birth * oligo/polyhydramnios	5916.09	58	0.0000	0 deaths among the 1 case of oligo/polyhydramnios in the 'intended a home birth' group, so these cases were dropped
Intended place of birth * gestation >41 weeks	5916.02	58	0.0000	0 deaths among the 262 cases of gestation >41 weeks in the 'intended a home birth' group, so these cases were dropped
Intended place of birth * gestational hypertension/pre-eclampsia	5915.49	58	0.0000	0 deaths among the 181 cases of HBP/pre-eclampsia in the 'intended a home birth' group, so these cases were dropped
Intended place of birth*any resuscitation + intended place of birth* malpresentation diagnosed before labour	5980.32	61	0.0000	LRT showed this not to be a significantly better fit than the model containing the iPoB*resuscitation interaction only (p=0.2323), and the p-value of the iPoB*malpresentation interaction was 0.191. Indicates confounding with resuscitation.
Final model: Final additive model + intended place of birth * any infant resuscitation				

Appendix G: Model diagnostics/assessment

G.1 'Intention at booking' model

For the 'intention at booking' model, LRχ^2=12,619.144 with 148 degrees of freedom and p=0.0000.

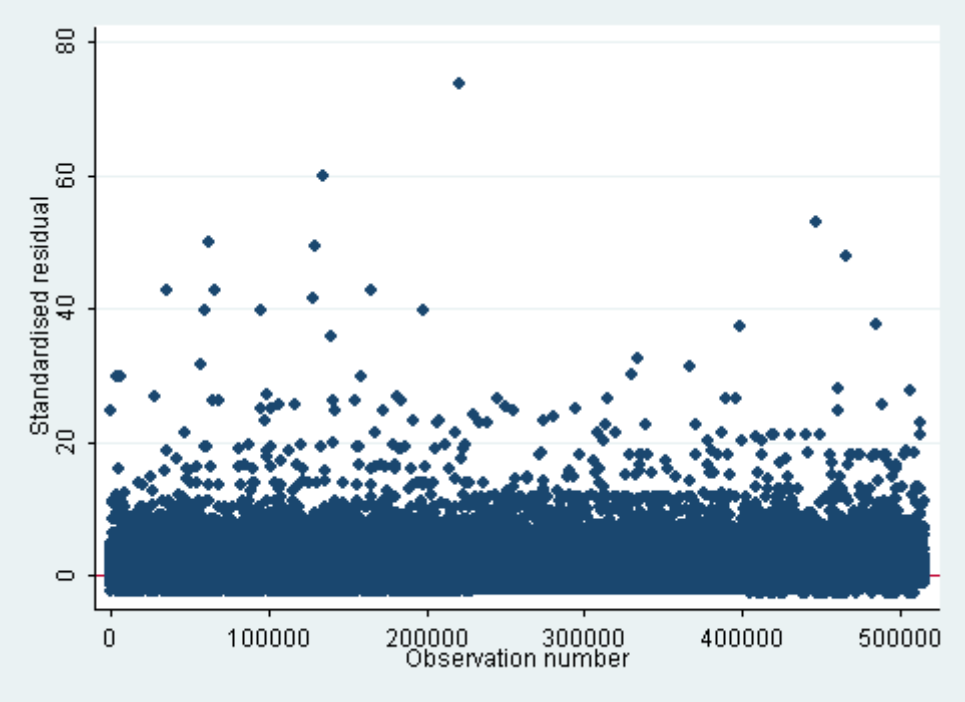
A comparison of predicted probabilities against observed percentages found that the model fit was reasonably good for most sub-groups which contained sufficient observations for a reliable comparison to be made. Some sub-groups were too small for reliable comparison of predicted probabilities and observed percentages. On this measure of goodness-of-fit, therefore, comparison was limited to those sub-groups containing at least 100 observations. For a number of these sub-groups, the predicted probabilities were not particularly close to the observed percentages, indicating that the model fit was less good for these groups. Table G.1 details those sub-groups containing at least 100 observations for which the predicted probability of intending a home birth at booking was more than 2 percentage points different from the observed percentage. This analysis suggested that the model fit was relatively poor for observations from the Hillingdon and West Middlesex hospitals.

Table G.1: Sub-groups for which predicted probabilities from 'intention at booking' model were not close to observed percentages

Sub-group	Predicted probability (%)	Observed percentage
Reference, except for:		
Previous miscarriage(s)	8.0	12.3
Hillingdon 1995-96	3.6	1.0
Hillingdon 1997-98	5.1	3.5
Hillingdon 1999-2000	7.1	2.6
Luton & Dunstable 1997-98	12.4	14.8
Stevenage 1999-2000	2.7	8.1
West Middlesex 1988-90	2.4	5.5
West Middlesex 1993-94	10.4	7.9
West Middlesex 1997-98	11.8	15.6
Hemel Hempstead parity 2+	20.6	17.8
Luton & Dunstable parity 1	12.4	14.8
West Middlesex parity 0	4.1	1.6
West Middlesex parity 1	11.8	15.6
White European parity 2+	20.6	17.8
Age 35-39 parity 0	1.8	4.0
Age 25-29 parity 1	8.3	15.0

Figure G.1 plots the standardised residuals; 19,030 records (3.7% of the total) had residuals outside the range -2 to 2.

Figure G.1: Standardised residuals for 'intention at booking' model

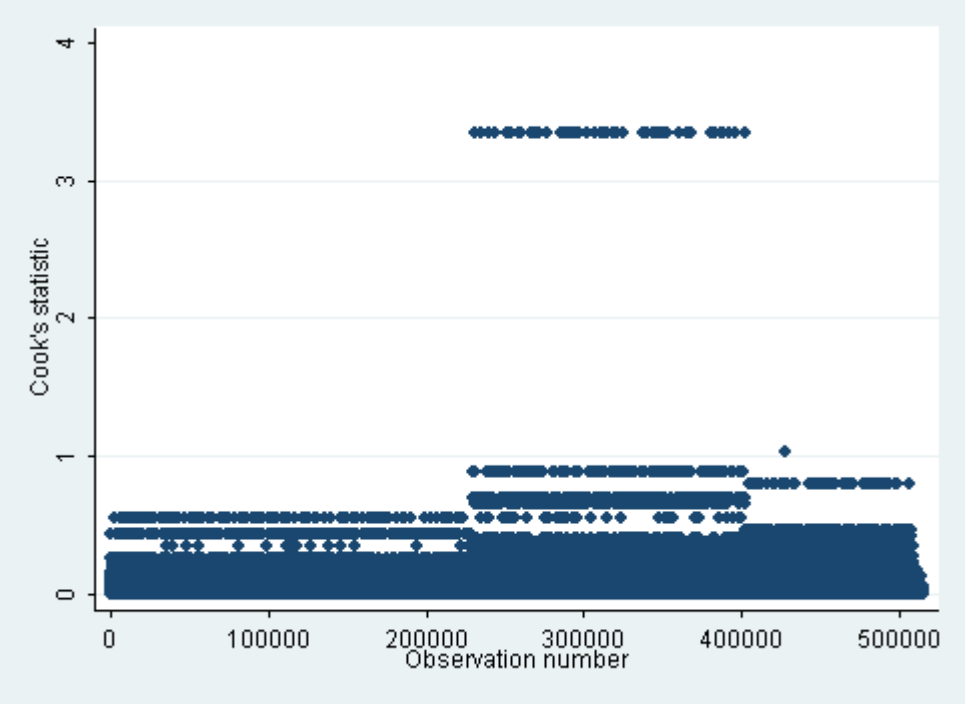


Certain sub-groups were more likely to have large standardised residuals:

- St Mary's or Chelsea & Westminster hospitals
- ethnic groups other than white European
- aged under 25
- Carstairs quintile missing
- single women

Figure G.2 plots Cook's statistic for every observation, which highlights a group of 65 observations which had a relatively large effect on the model's coefficients.

Figure G.2: Cook's statistics for 'intention at booking' model



All 65 of these observations had the following profile:

- Gave birth in 1988-1990
- Received care from Luton & Dunstable hospital
- White European mother
- Mother aged 25-29 at delivery
- Parity 1 (i.e. having second baby)
- Low risk at booking
- Carstairs quintile information missing

A total of 96 observations had the above profile, so two-thirds of pregnancies with this profile were influential according to Cook's Distance. The final model was re-run without the 65 influential observations, which had very little effect on the coefficients for variables not involved in interactions. For variables involved in interactions, the sum of the coefficients for the two relevant main effects and the relevant interaction effect were used to compare the two models. Table G.2 shows the interactions for which the difference between the coefficients for the model excluding the influential observations and the model including the influential observations was greater than 0.1.

Table G.2: Interaction coefficients affected by the removal of influential observations ('intention at booking' model)

Interaction	Sum of coefficients		Difference
	Model including influential observations	Model excluding influential observations	
Luton & Dunstable * 1988-90	-1.5992	-1.7854	0.1863
Central Middlesex * parity 0	-2.0382	-0.4463	-1.5919
Central Middlesex * parity 2+	-0.9982	0.5944	-1.5926
Ealing * parity 0	-1.8351	-1.5259	-0.3092
Ealing * parity 2+	0.2624	0.5717	-0.3093

The relatively large change to the coefficient for Luton & Dunstable in 1998-90 was to be expected since the deleted observations were in this group. The largest differences, however, were for the interactions between Central Middlesex hospital and parity, with a similar (but less marked) pattern evident for the interaction between Ealing hospital and parity.

Central Middlesex and Ealing were two of the three hospitals which did not contribute data for all 13 years (see Table 3.2). In particular, they did not submit data for the reference period of 1997-98, which meant there were observed zeroes in these cells. A different reference period was considered, but not pursued because it would have had to be in the period before 1996 to ensure that all hospitals had submitted data in that year. In the late 1980s and early 1990s, very few women expressed an intention to give birth at home, so had the model used an earlier reference period, many more cells would have been subject to observed zeroes. This would have moved the problem rather than solved it.

Because all but one of the affected coefficients had the same sign in both models, had the influential observations been deleted the substantive conclusions drawn from the model would have changed only for Central Middlesex parity 2+. The model without the influential observations would have resulted in a much higher predicted probability of women in this group intending a home birth at booking. This was not considered to be sufficient grounds for deleting the influential observations, because with or without these observations in the model, the predicted probability for parity 2+ women at Central Middlesex was higher than that for parity 0 and parity 1 women at Central Middlesex. However, in interpreting the model it should be borne in mind that predicted probabilities for women of parity 2+ receiving care from Central Middlesex hospital are less reliable than those for other sub-groups.

G.2 'Changing from hospital to home' model

For the 'changing from hospital to home' model, LRχ^2=2,163 with 40 degrees of freedom and p=0.0000.

A comparison of predicted probabilities against observed percentages found that the model fit was reasonably good for most sub-groups which contained sufficient observations for a reliable comparison to be made. For example, for a 'reference pregnancy', the model predicted that 1.16% of women would intend a home birth at booking, which was reasonably close to the observed percentage of 0.77%.

As with the 'intention at booking' model, comparison was limited to sub-groups containing at least 100 observations, as shown in Table G.3. For a number of these sub-groups, the predicted probabilities were not particularly close to the observed percentages, indicating that the model fit was less good for these groups (Bedford, Chelsea & Westminster, West Middlesex, 1995 and 1996).

Table G.3: Comparison of predicted probabilities against observed percentages for 'changing from hospital to home' model

Group	Pred. prob. (%)	Observed %	No. in group
Reference	1.16	0.77	261
Reference, except for being:			
Parity 0	0.29	0	196
Parity 2+	1.99	1.00	100
High risk antenatally	0.22	0	121
Bedford	1.70	0.53	189
Chelsea & Westminster	1.24	0.41	246
Edgware	1.10	1.57	191
Hillingdon	0.99	1.32	151
Luton & Dunstable	0.47	0	137
Northwick Park	0.52	0	141
Stevenage	1.99	2.36	212
Watford	1.22	1.72	232
Welwyn Garden City	0.26	0.63	160
West Middlesex	0.85	0	112
1989	0.04	0	127
1990	0.29	0.60	168
1991	0.50	0	197
1992	0.61	0.48	209
1993	0.70	0	196
1994	0.90	0.40	253
1995	0.62	1.61	186
1996	1.12	0.35	287
1997	0.97	0.72	279
1999	1.19	1.38	218
2000	1.08	1.30	231

Figure G.3 plots the standardised residuals; 16,330 observations (3.2% of the total) had residuals outside the range -2 to 2. The observations with residuals outside this range were not randomly distributed. This indicated that, ideally, the model should contain interaction terms, but the addition of these terms did not result in a model that was statistically and substantively better than the model without such interactions. Because fewer than 5% of records had residuals outside the rage -2 to 2, the model was judged to be a reasonably good fit on this measure.

However, it is clear from Figure G.3 that there were a few observations with extremely large residuals (31 had residuals larger than 50). Nearly all of these were from St Mary's hospital in 1992, which indicated that the model did not fit well for this sub-group.

Figure G.3: Standardised residuals for 'changing from hospital to home' model

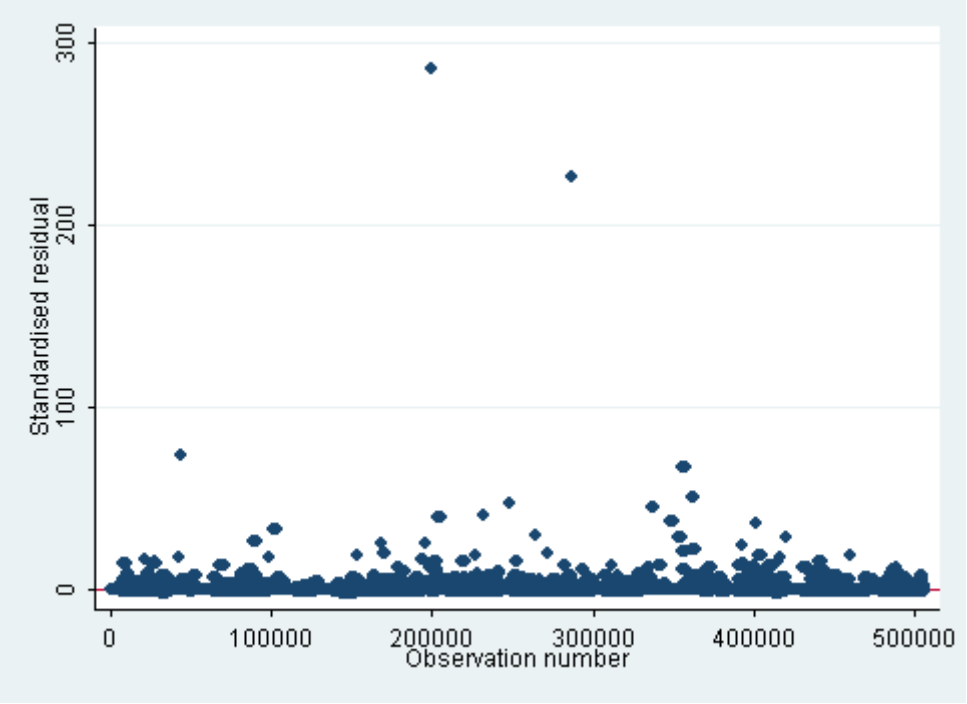
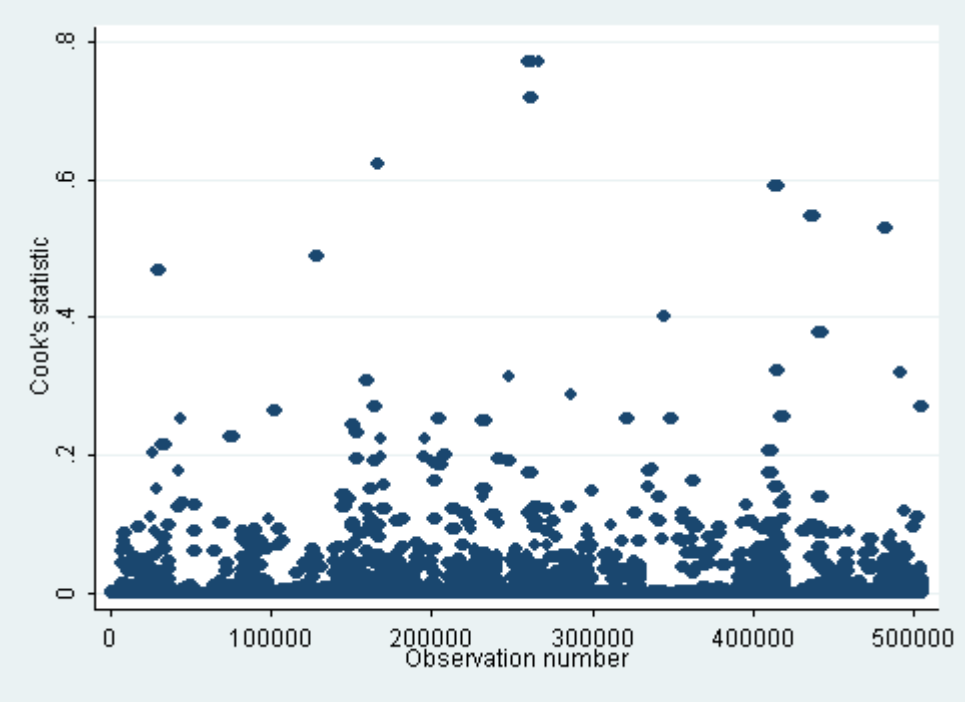


Figure G.4 plots Cook's statistic for every observation, and shows that Cook's statistic was small for all observations. This indicates that no observations had a large effect on the model's coefficients, despite there being a few with very large standardised residuals. For this reason, no further action was taken to improve the fit of the model.

Figure G.4: Cook's statistics for 'changing from hospital to home' model



G.3 'Changing from home to hospital' model

For the 'changing from home to hospital' model, LRχ^2=1347.65 with 56 degrees of freedom and p=0.0000.

For this model, cell sizes were too small to allow confident comparison of predicted probabilities against observed percentages.

Figure G.5 plots the standardised residuals; 5.1% of the observations had residuals outside the range -2 to 2, which was slightly more than is ideal.

Figure G.5: Standardised residuals for 'changing from home to hospital' model

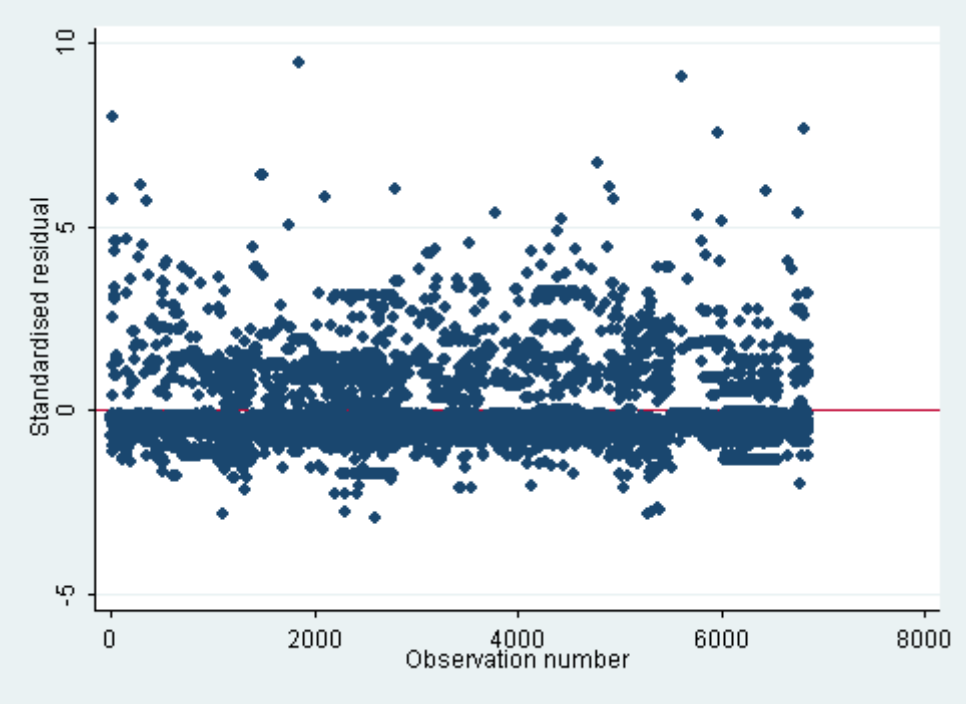
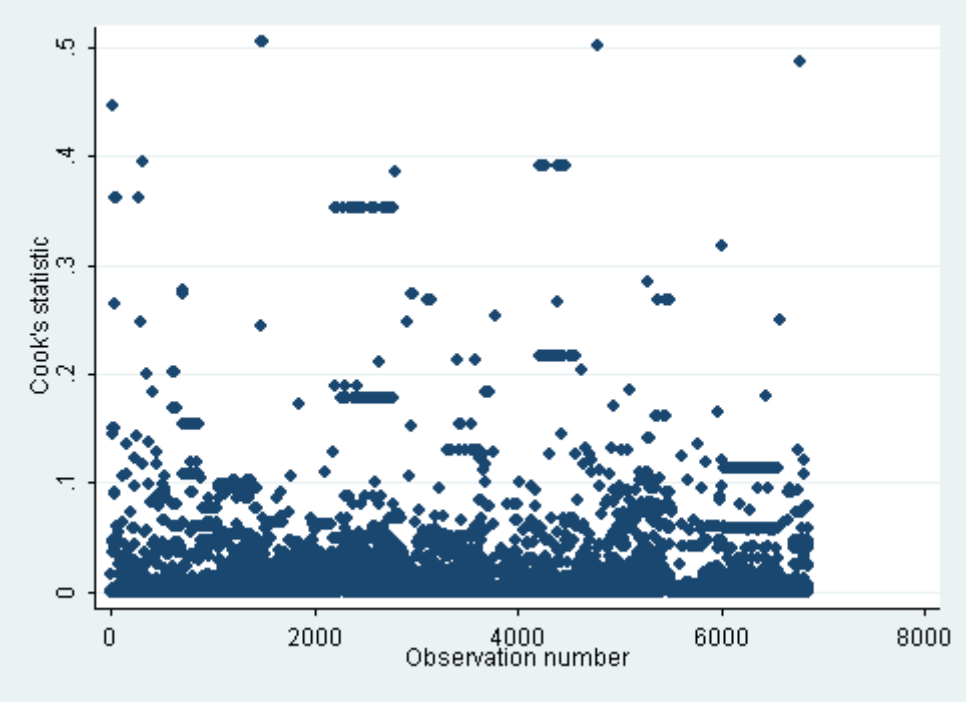


Figure G.6 plots Cook's statistic for every observation, and shows that Cook's statistic was small for all observations. This indicates that no observations had a large effect on the model's coefficients. For this reason, no further action was taken to try to reduce the proportion of observations with large standardised residuals.

Figure G.6: Cook's statistics for 'changing from home to hospital' model



G.4 'Who achieves a planned home birth?' model

For the 'who achieves a planned home birth?' model, LRχ^2=1,294.47 with 42 degrees of freedom and p=0.0000.

As with the 'intention at booking' model, comparison was limited to sub-groups containing at least 100 observations, as shown in Table G.4. This analysis found that the model fit was good for the sub-groups which contained sufficient observations for a reliable comparison to be made, but that most sub-groups contained too few observations for the comparison to be made confidently.

Table G.4: Comparison of predicted probabilities against observed percentages for 'who achieves a planned home birth?' model

Group	Pred. prob. (%)	Observed %	No. in group
Reference	96.9	97.7	174
Reference, except for being:			
Stage 1 of labour 3-5.9 hours	96.7	96.6	262
Stage 1 of labour 6-8.9 hours	96.5	96.9	130
Luton & Dunstable	97.6	97.4	195
Welwyn Garden City	96.5	97.6	124

Figure G.7 plots the standardised residuals; 338 observations (4.8% of the total) had residuals outside the range -2 to 2, of which 97 (29%) were from Hillingdon maternity unit.

Figure G.7: Standardised residuals for 'who achieves a planned home birth?' model

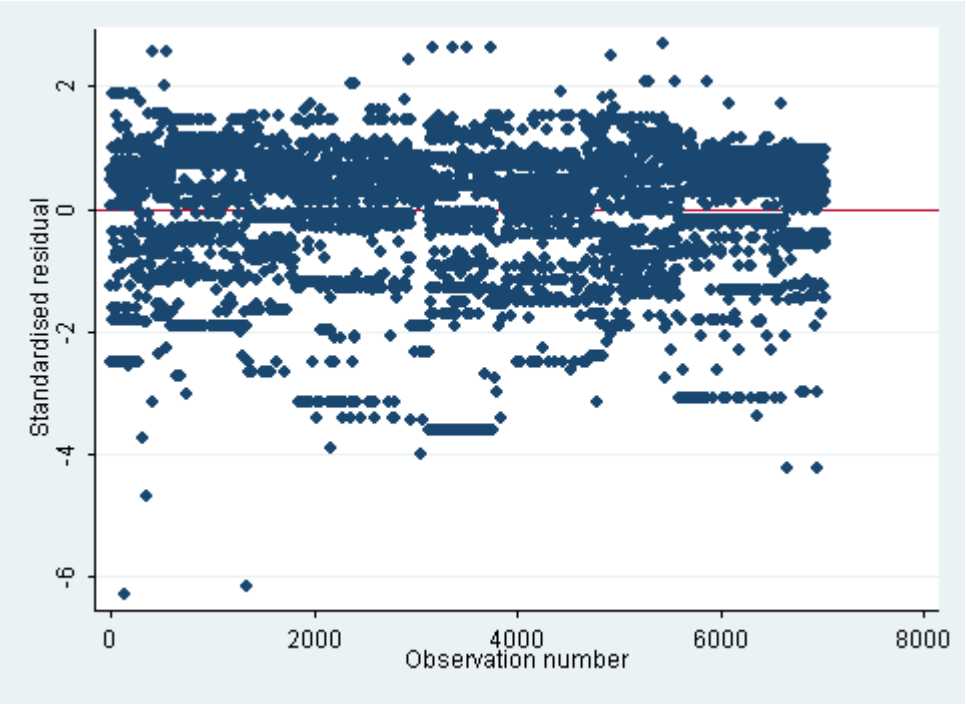
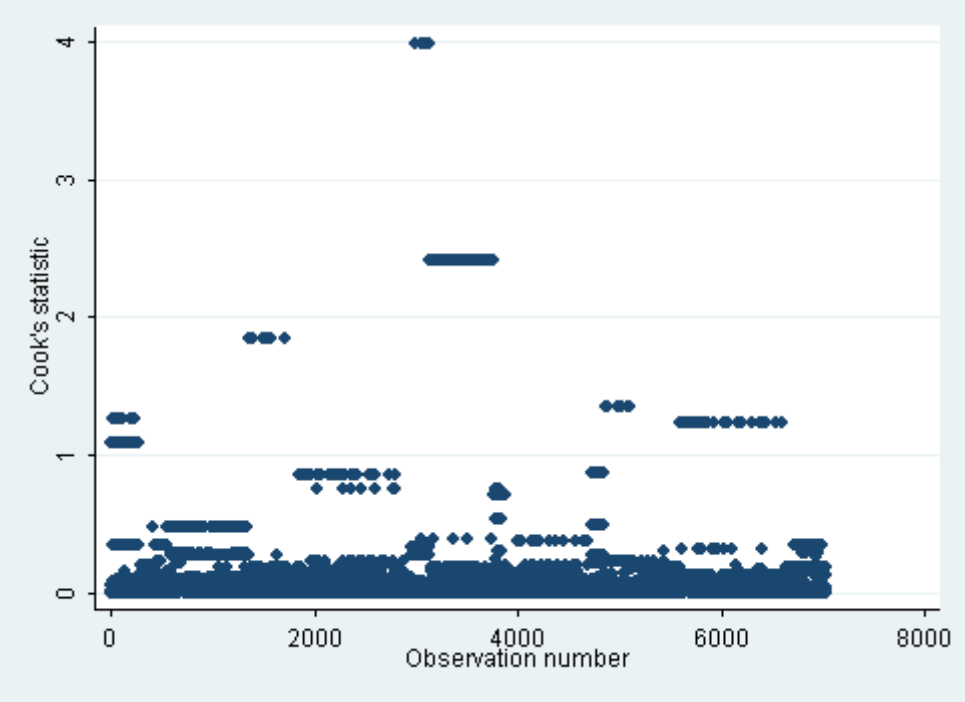


Figure G.8 plots Cook's statistic for every observation, and highlights two groups of observations which had a relatively large effect on the model's coefficients.

Figure G.8: Cook's statistics for 'who achieves a planned home birth?' model



The two groups contained 99 observations (1.4% of the total), most (91) of which:

- Received care from Hillingdon hospital
- Did not develop complications in labour
- Had a first stage of labour lasting less than 4 hours
- Were not high risk before labour commenced
- Were parous
- Had a baby weighing between 2500g and 3999g at birth
- Were White European
- Required no interpreter

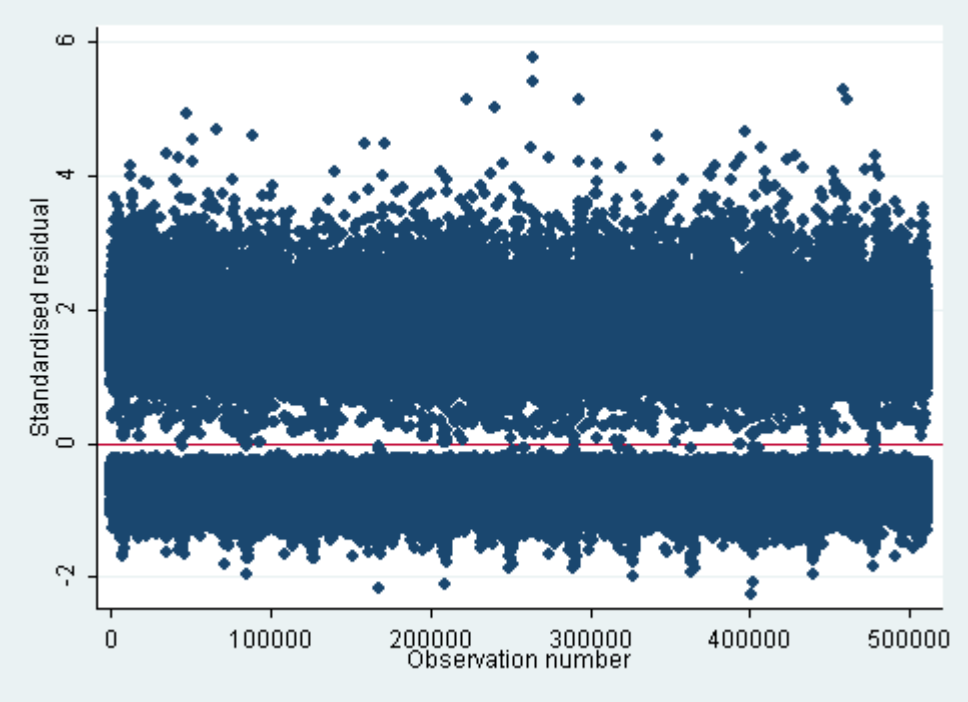
Again, this provided evidence that the model fit was relatively poor for observations from Hillingdon hospital, so the final model was re-run without the 99 influential observations. This made virtually no difference to the vast majority of the model's odds ratios, and made only a small difference to the odds ratio for Hillingdon hospital. The exception was the odds ratio for the interaction between Watford hospital and developing complications during labour, for which the odds ratio went up from 0.8457 to 3.4973. Although this was a relatively large change, because the odds ratios for the main effects for Watford hospital and developing complications during labour were virtually unaffected, it would have made no difference to the substantive conclusions of the model. Therefore, the influential observations were retained.

G.5 Safety: foetal distress model

For the model with foetal distress as the outcome, LRχ^2=31,892.87 with 120 degrees of freedom and p=0.0000.

Figure G.9 plots the standardised residuals; 16,995 observations (3.3% of the total) had residuals outside the range -2 to 2, and no standardised residuals were very large.

Figure G.9: Standardised residuals for foetal distress model

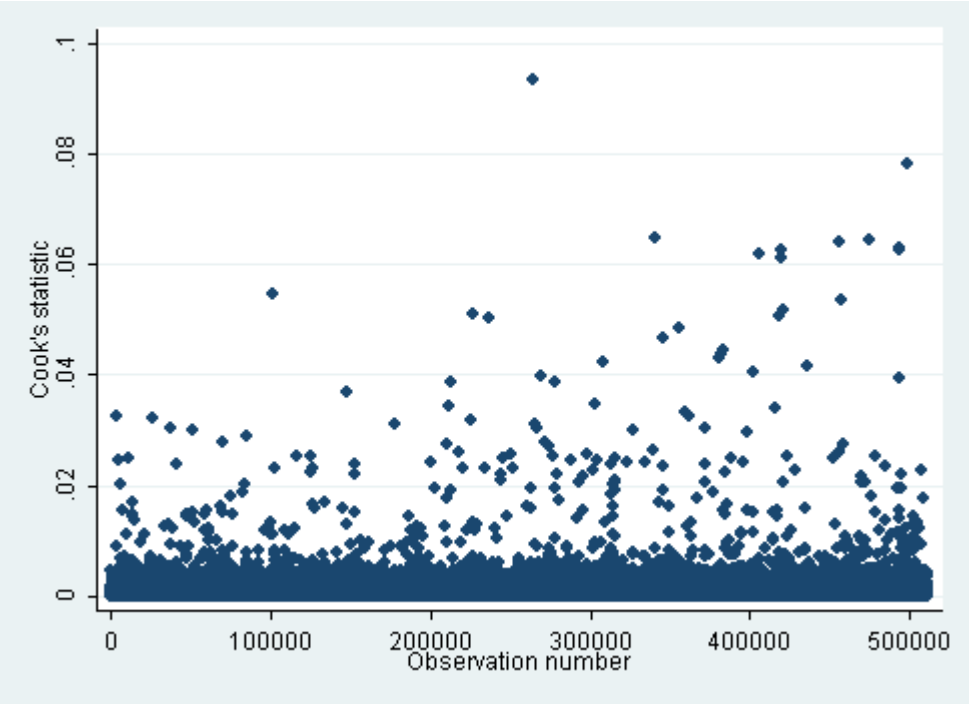


Some groups were over-represented in the group of cases with residuals outside the range -2 to 2, indicating that the model fit was relatively poor for these groups:

- Those experiencing foetal distress (this is to be expected in binary logistic regression involving relatively rare events, because the outcome variable can only take the value 0 or 1, so any case which experiences the outcome (i.e. outcome variable = 1) will have a predicted probability which is much lower than 1, and will therefore have a large standardised residual)
- Those giving birth in 1988
- Those giving birth between 06:00 and 07:59 or between 10:00 and 11:59
- Those receiving care from the Hillingdon or Welwyn Garden City maternity units
- Those having their second baby
- White European mothers
- Those with at least one high-risk condition evident in pregnancy
- Those giving birth to girls

Figure G.10 plots Cook's statistic for every observation, and shows that Cook's statistic was small for all observations. This indicates that no observations had a particularly large effect on the model's coefficients. For this reason, no further action was taken to try to reduce the proportion of observations with large standardised residuals.

Figure G.10: Cook's statistics for foetal distress model

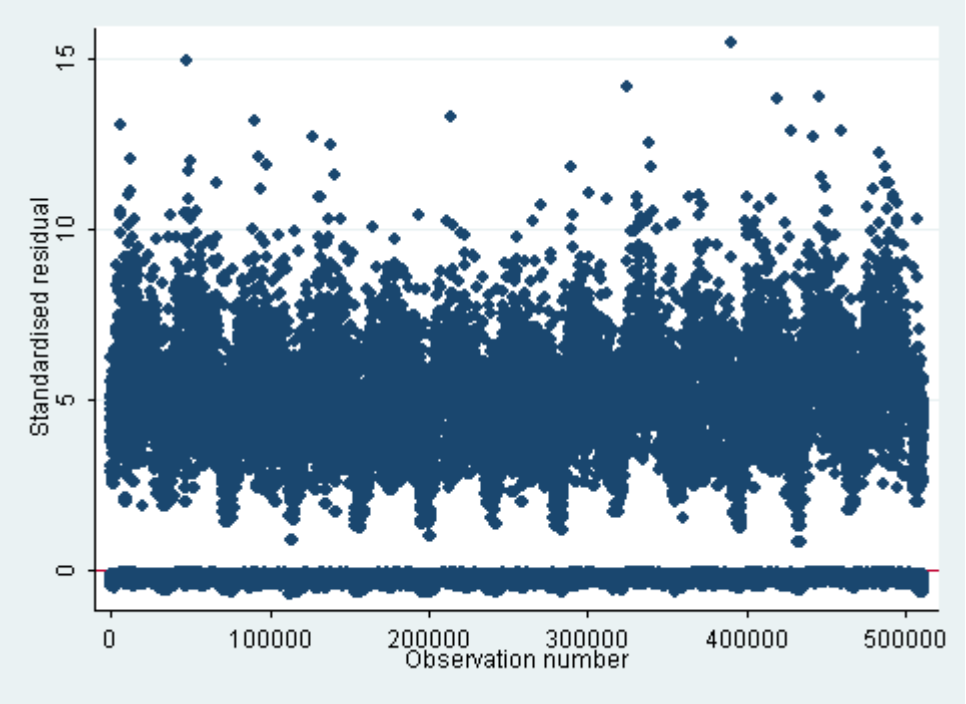


G.6 Safety: failure to progress in stage 1 of labour model

For the model with failure to progress in stage 1 of labour as the outcome, LRχ^2=4,096.97 with 97 degrees of freedom and p=0.0000.

Figure G.11 plots the standardised residuals; 17,781 observations (3.7% of the total) had residuals outside the range -2 to 2.

Figure G.11: Standardised residuals for failure to progress in stage 1 of labour model

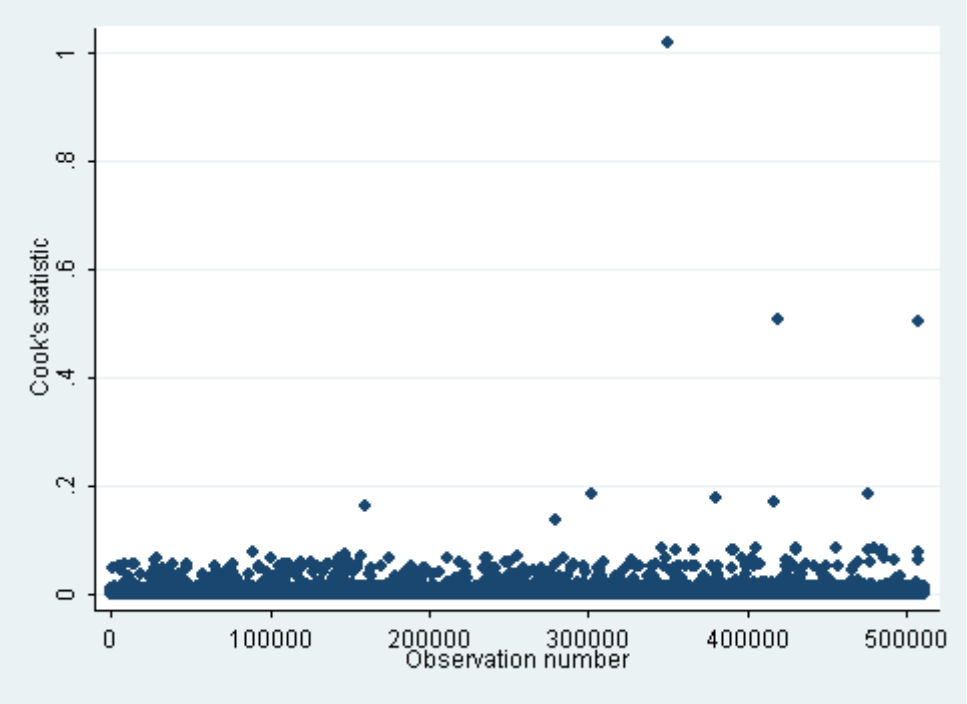


Some groups were over-represented in the group of cases with residuals outside the range -2 to 2, indicating that the model fit was relatively poor for these groups:

- Those experiencing delay in stage 1 (this is to be expected in binary logistic regression involving rare events, because the outcome variable can only take the value 0 or 1, so any case which experiences the outcome (i.e. outcome variable = 1) will have a predicted probability which is much lower than 1, and will therefore have a large standardised residual)
- Those receiving care from the Bedford and Luton & Dunstable units
- Those giving birth between 4pm and midnight
- Parity 1
- Not low birthweight
- Fewer than 3 ultrasound scans
- Patient category not 'normal'

Figure G.12 plots Cook's statistic for every observation, and shows that Cook's statistic was small for all observations. This indicates that no observations had a particularly large effect on the model's coefficients. For this reason, no further action was taken to try to reduce the proportion of observations with large standardised residuals.

Figure G.12: Cook's statistics for failure to progress in stage 1 of labour model

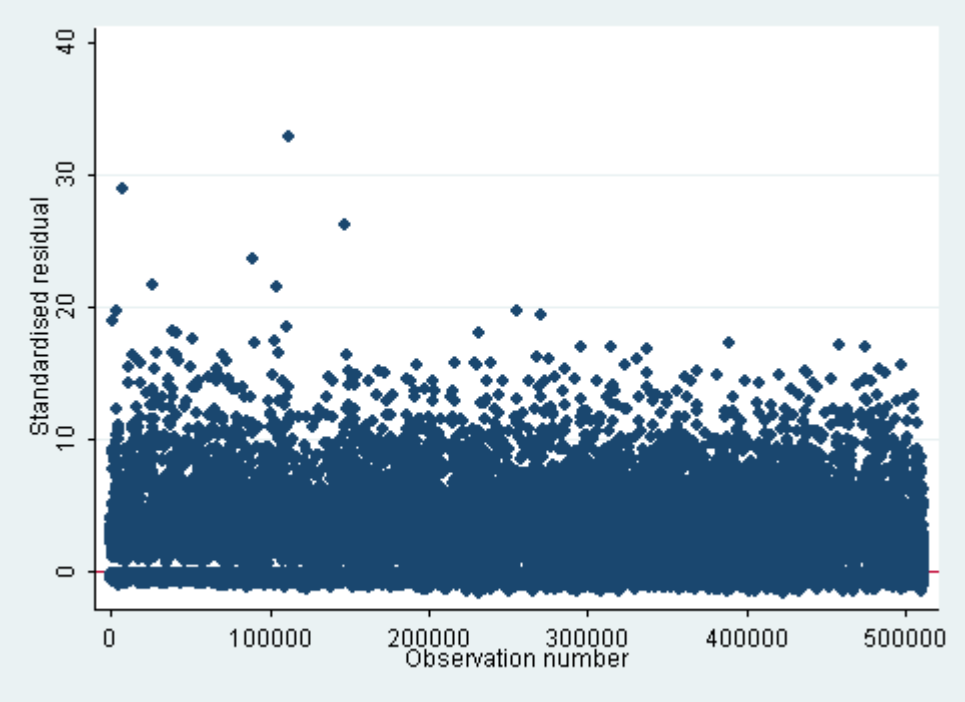


G.7 Safety: failure to progress in stage 2 of labour model

For the model with failure to progress in stage 2 of labour as the outcome, LRχ^2=45,593.60 with 117 degrees of freedom and p=0.0000.

Figure G.13 plots the standardised residuals; 24,817 observations (5.2% of the total) had residuals outside the range -2 to 2, which is slightly more than is ideal, and a handful of observations had very large standardised residuals.

Figure G.13: Standardised residuals for failure to progress in stage 2 of labour model

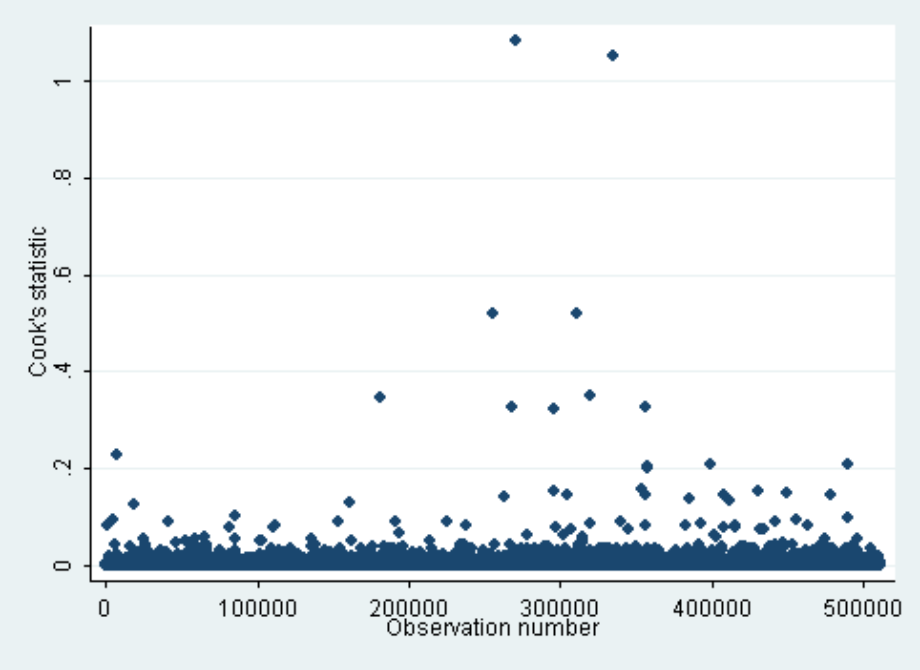


Some groups were over-represented in the group of cases with residuals outside the range -2 to 2, indicating that the model fit was relatively poor for these groups:

- Those with delay in stage 2 of labour (this is to be expected in binary logistic regression involving rare events, because the outcome variable can only take the value 0 or 1, so any case which experiences the outcome (i.e. outcome variable = 1) will have a predicted probability which is much lower than 1, and will therefore have a large standardised residual)
- Parity 0 (first baby)
- Mother aged under 30

Figure G.14 plots Cook's statistic for every observation, and shows that Cook's statistic was small for all observations. This indicates that very few observations had much effect on the model's coefficients. For this reason, no further action was taken to improve the fit of the model.

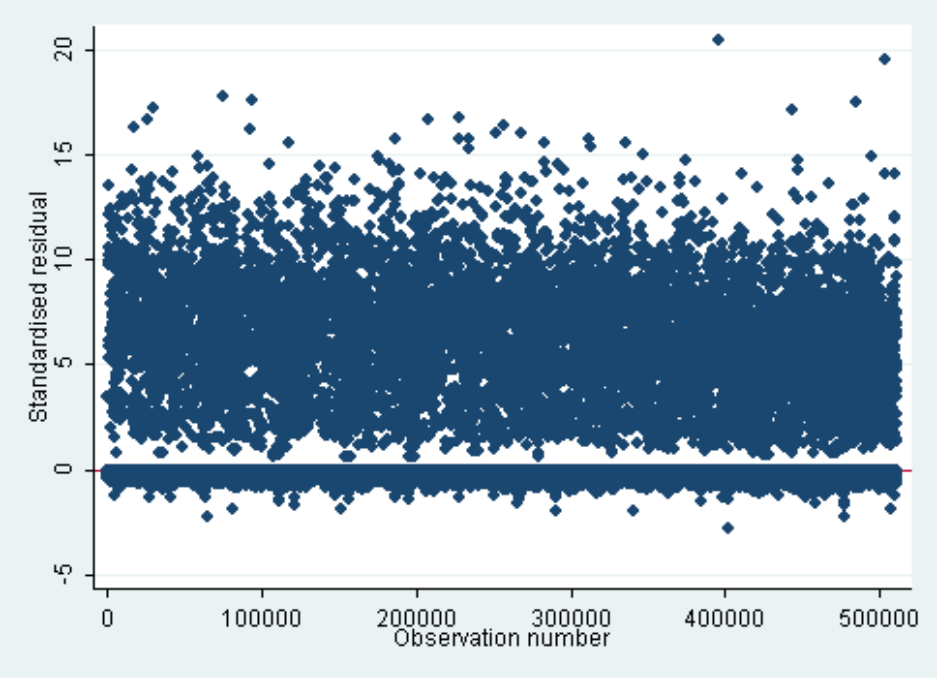
Figure G.14: Cook's statistics for failure to progress in stage 2 of labour model



G.8 Safety: PPH model

For the model with PPH as the outcome, LRχ^2=7,661.08 with 89 degrees of freedom and p=0.0000. The Hosmer-Lemeshow statistic (assuming 10 groups) was 35.30, with p=0.0000. Figure G.15 plots the standardised residuals; 11,848 observations (2.3% of the total) had residuals outside the range -2 to 2, and very few standardised residuals were large.

Figure G.15: Standardised residuals for PPH model

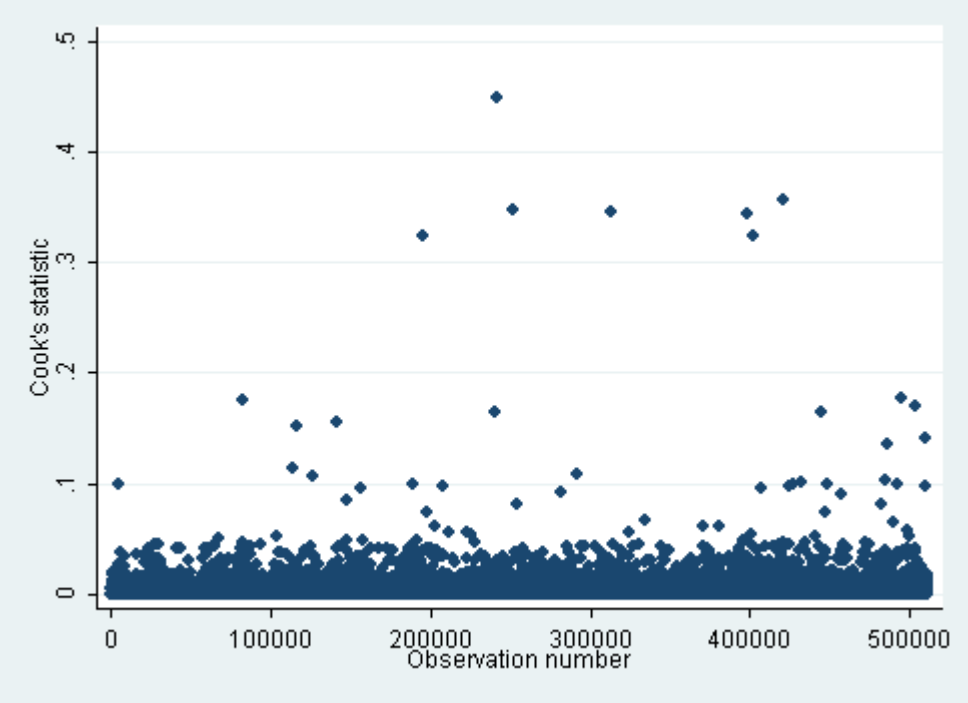


Some groups were over-represented in the group of cases with residuals outside the range -2 to 2, indicating that the model fit was relatively poor for these groups:

- Those experiencing PPH (this is to be expected in binary logistic regression involving rare events, because the outcome variable can only take the value 0 or 1, so any case which experiences the outcome (i.e. outcome variable = 1) will have a predicted probability which is much lower than 1, and will therefore have a large standardised residual)
- Those receiving care from the Hillingdon maternity unit
- Those having their first baby
- Those aged 30+
- Those with at least one high-risk condition evident in pregnancy
- Those having more than three ultrasound scans
- Those giving birth babies weighing more than 4000g

Figure G.16 plots Cook's statistic for every observation, and shows that Cook's statistic was small for all observations. This indicates that no observations had a particularly large effect on the model's coefficients. For this reason, no further action was taken to try to reduce the proportion of observations with large standardised residuals.

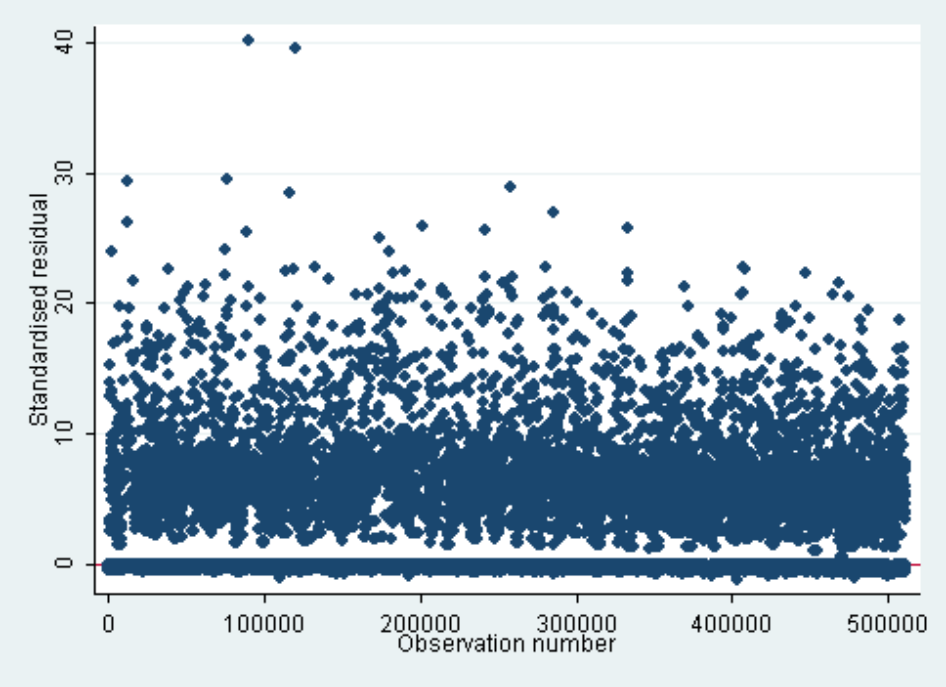
Figure G.16: Cook's statistics for PPH model



G.9 Safety: pyrexia model

For the model with pyrexia as the outcome, LRχ^2=5943.96 with 83 degrees of freedom and p=0.0000. The Hosmer-Lemeshow statistic (assuming 10 groups) was 66.18, with p=0.0000. Figure G.17 plots the standardised residuals; 9,218 observations (1.9% of the total) had residuals outside the range -2 to 2, and very few standardised residuals were large.

Figure G.17: Standardised residuals for pyrexia model

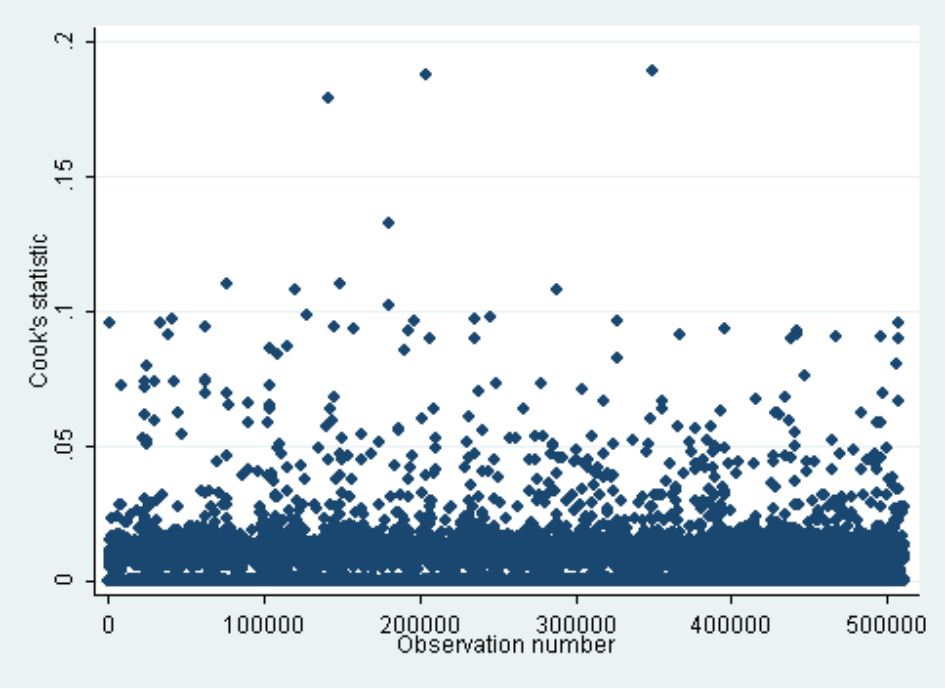


Some groups were over-represented in the group of cases with residuals outside the range -2 to 2, indicating that the model fit was relatively poor for these groups:

- Those with pyrexia (this is to be expected in binary logistic regression involving rare events, because the outcome variable can only take the value 0 or 1, so any case which experiences the outcome (i.e. outcome variable = 1) will have a predicted probability which is much lower than 1, and will therefore have a large standardised residual)
- Parity 0
- Those receiving care from the Chelsea & Westminster, Northwick Park and St Mary's units
- Those giving birth between 8pm and 2am
- Those giving birth between 1997 and 2000
- Nonsmokers

Figure G.18 plots Cook's statistic for every observation, and shows that Cook's statistic was small for all observations. This indicates that no observations had a particularly large effect on the model's coefficients. For this reason, no further action was taken to try to reduce the proportion of observations with large standardised residuals.

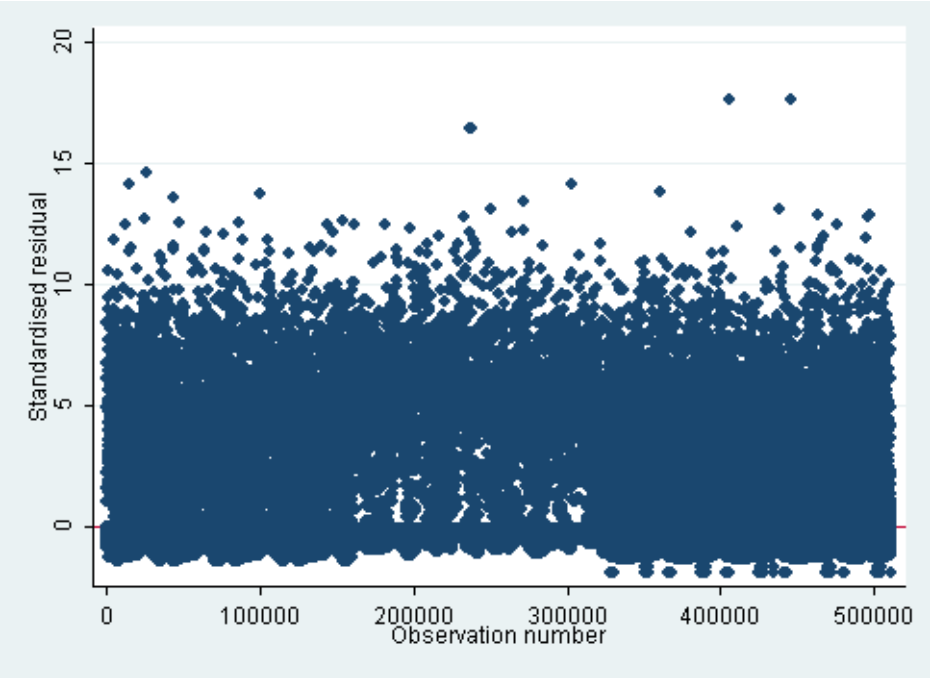
Figure G.18: Cook's statistics for pyrexia model



G.10 Safety: retained placenta model

For the model with retained placenta as the outcome, LRχ^2=2,101.69 with 73 degrees of freedom and p=0.0000. The Hosmer-Lemeshow statistic (assuming 10 groups) was 6.32, with p=0.6118. Figure G.19 plots the standardised residuals; 18,412 observations (3.8% of the total) had residuals outside the range -2 to 2, and few standardised residuals were large.

Figure G.19: Standardised residuals for retained placenta model

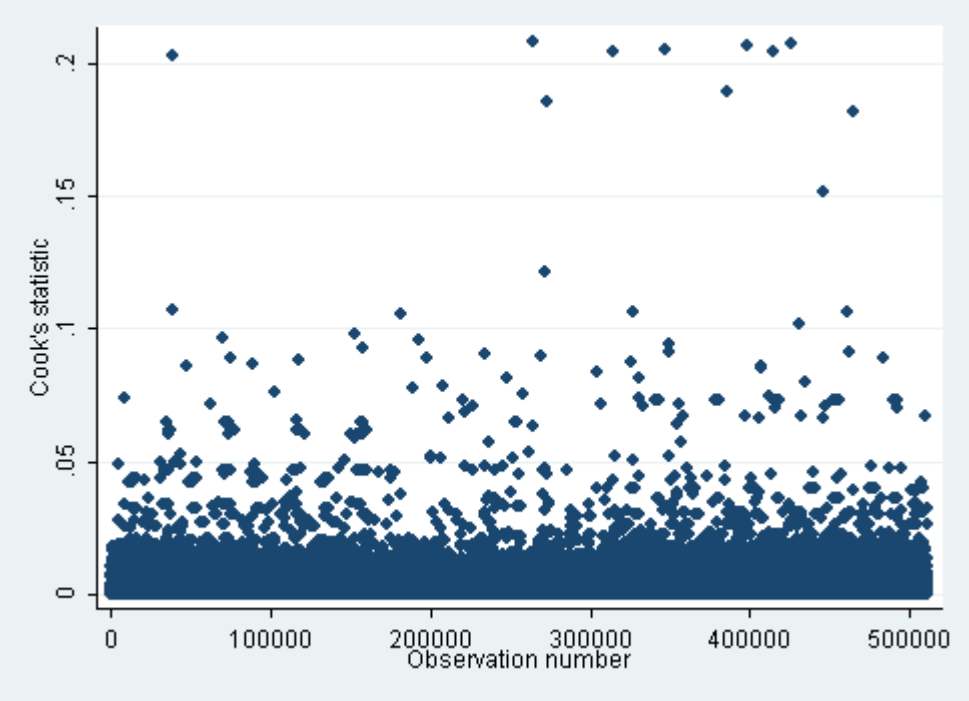


Some groups were over-represented in the group of cases with residuals outside the range -2 to 2, indicating that the model fit was relatively poor for these groups:

- Those experiencing retained placenta (this is to be expected with rare events, because the outcome variable can only take the value 0 or 1, so any case which experiences the outcome (i.e. outcome variable = 1) will have a predicted probability which is much lower than 1, and will therefore have a large standardised residual)
- Parity 0 or 1
- Low-risk pregnancies
- Those having baby girls
- Those who intended a hospital birth

Figure G.20 plots Cook's statistic for every observation, and shows that Cook's statistic was small for all observations. This indicates that no observations had a particularly large effect on the model's coefficients. For this reason, no further action was taken to try to reduce the proportion of observations with large standardised residuals.

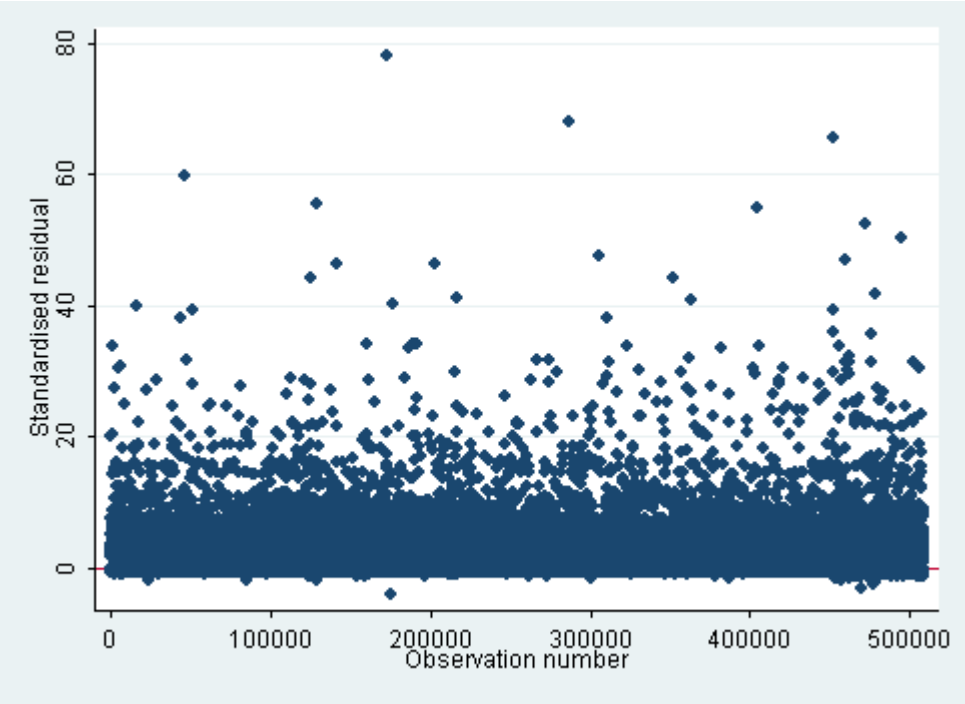
Figure G.20: Cook's statistics for retained placenta model



G.11 Safety: perinatal mortality models

For the model with perinatal mortality as the outcome and containing no interactions, LRχ^2=5916.09 with 58 degrees of freedom and p=0.0000. Figure G.21 plots the standardised residuals for this model; 12,211 observations (2.40% of the total) had residuals outside the range -2 to 2.

Figure G.21: Standardised residuals for perinatal mortality model containing no interactions

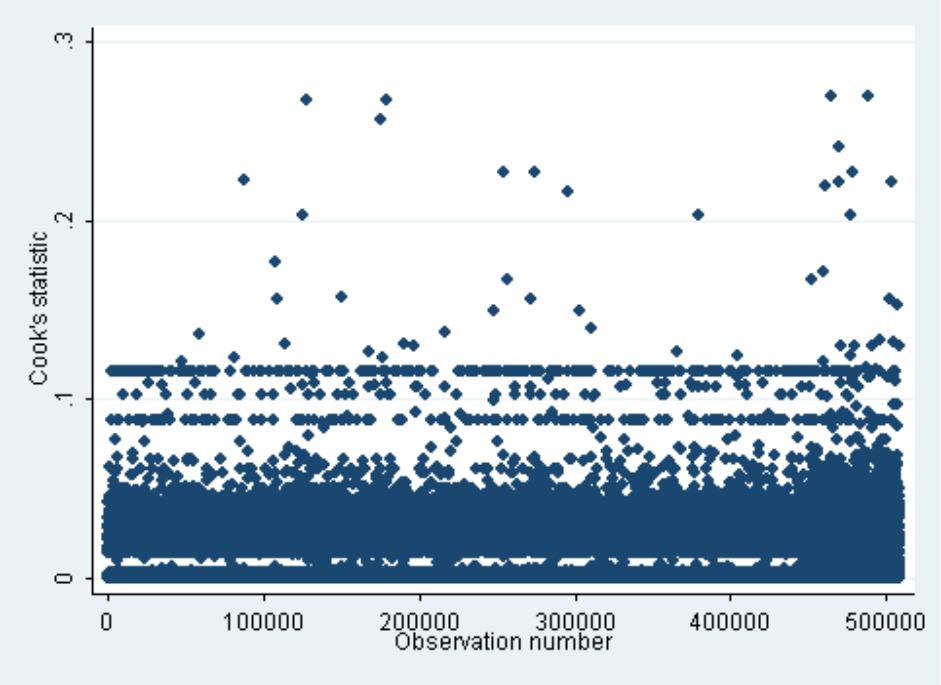


Some groups were over-represented in the group of cases with residuals outside the range -2 to 2, indicating that the model fit was relatively poor for these groups:

- Cases involving perinatal death (this is to be expected with rare events, because the outcome variable can only take the value 0 or 1, so any case which experiences the outcome (i.e. outcome variable = 1) will have a predicted probability which is much lower than 1, and will therefore have a large standardised residual)
- Those giving birth in 1998
- Birthweight <1500g
- Low-risk pregnancies
- Time of birth was between 8am and 8pm
- Those receiving care from the Chelsea & Westminster, Edgware and Welwyn Garden City units

Figure G.22 plots Cook's statistic for every observation, and shows that Cook's statistic was small for all observations. This indicates that no observations had a large effect on the model's coefficients. For this reason, no further action was taken to try to reduce the number of observations with large standardised residuals.

Figure G.22: Cook's statistics for perinatal mortality model containing no interactions



For the model with perinatal mortality as the outcome and containing the interaction between intended place of birth and infant resuscitation, LRχ^2=5978.89 with 60 degrees of freedom and p=0.0000. Figure G.23 plots the standardised residuals for this model; 9,220 observations (1.81% of the total) had residuals outside the range -2 to 2.

Figure G.23: Standardised residuals for perinatal mortality model containing interaction between intended place of birth and infant resuscitation

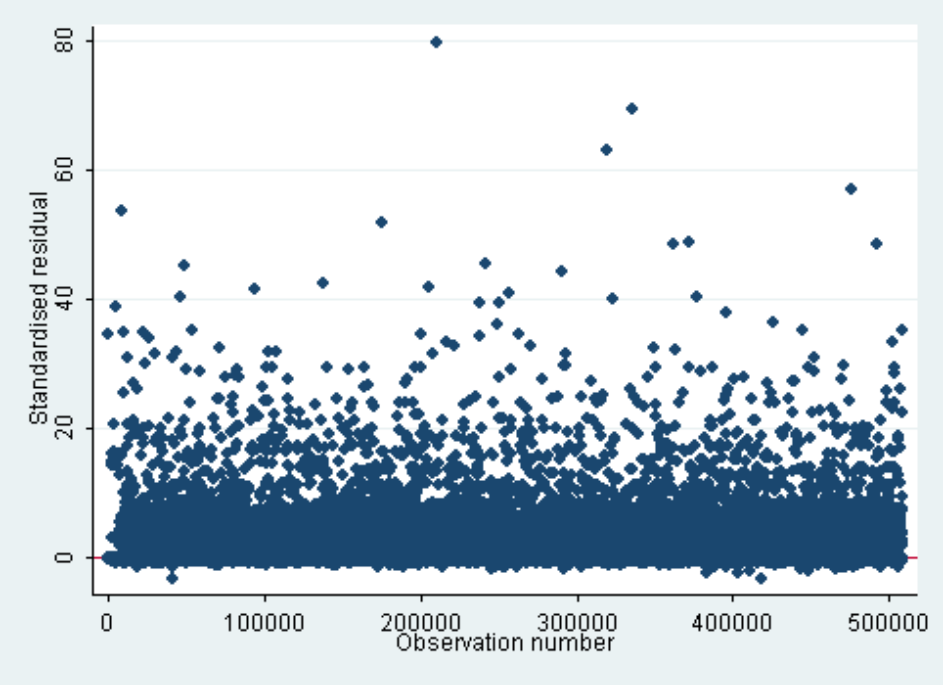
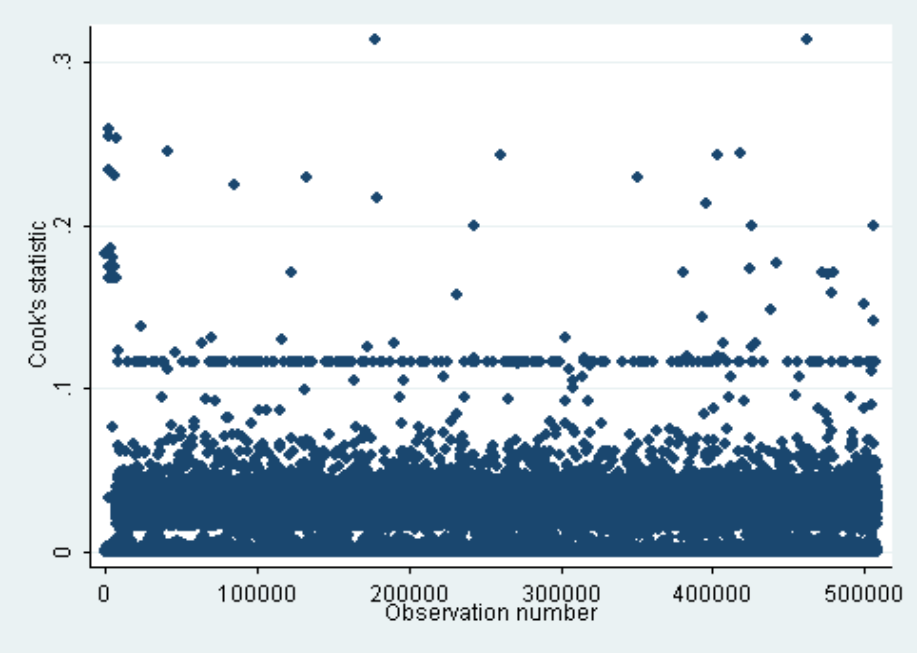


Figure G.24 plots Cook's statistic for every observation, and shows that Cook's statistic was small for all observations, i.e. none had a large effect on the model's coefficients. For this reason, no further action was taken to try to reduce the number of observations with large standardised residuals.

Figure G.24: Cook's statistics for perinatal mortality model containing interaction between intended place of birth and infant resuscitation



For the model with perinatal mortality as the outcome and containing the interaction between intended place of birth and malpresentation, LRχ^2=5919.61 with 59 degrees of freedom and p=0.0000. Figure G.25 plots the standardised residuals for this model; 12,211 observations (2.4% of the total) had residuals outside the range -2 to 2.

Figure G.25: Standardised residuals for perinatal mortality model containing interaction between intended place of birth and malpresentation

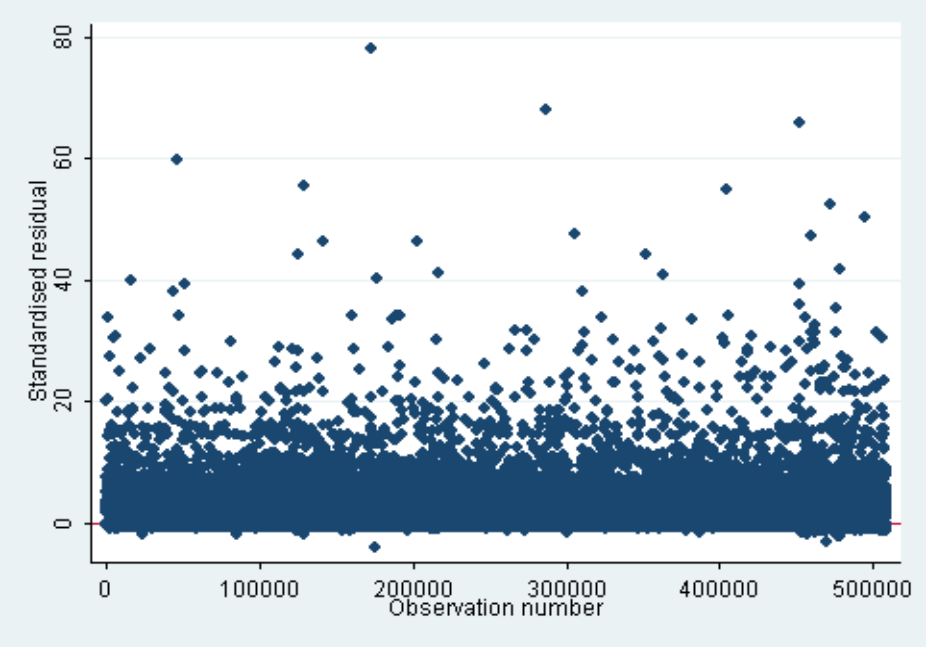
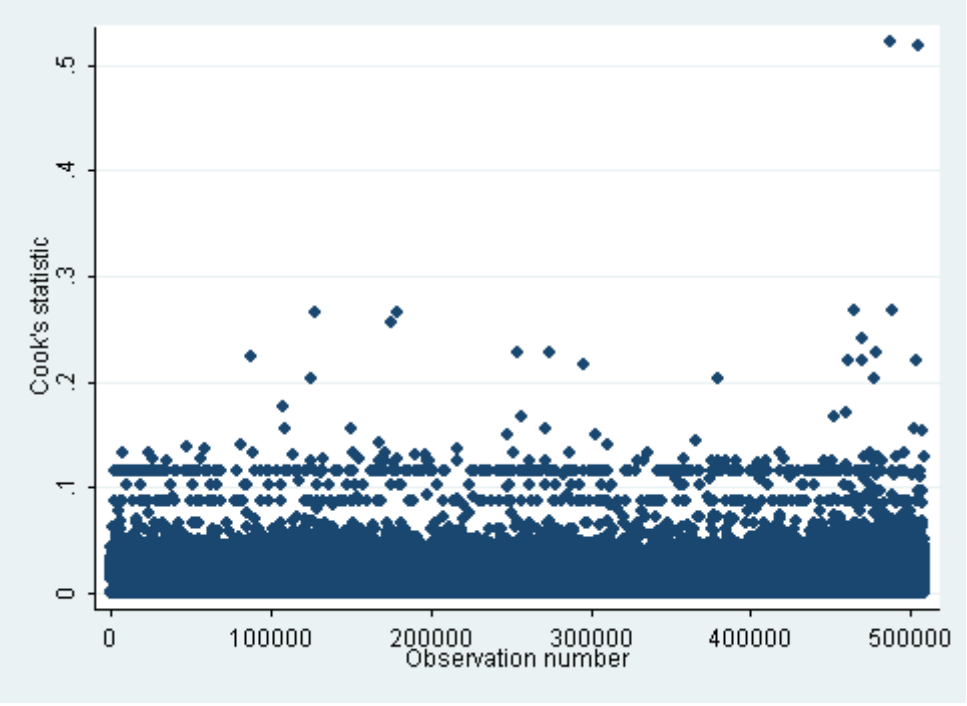


Figure G.26 plots Cook's statistic for every observation, and shows that Cook's statistic was small for all observations. This indicates that no observations had a large effect on the model's coefficients. The two observations with Cook's statistic >0.5 were both intended home births in which the baby suffered perinatal death, but in terms of absolute size, 0.5 was still just to be a small statistic, so no further action was taken to try to reduce the number of observations with large standardised residuals.

Figure G.26: Cook's statistics for perinatal mortality model containing interaction between intended place of birth and malpresentation



Appendix H: Other safety outcomes that could be modelled using SMMIS

In addition to the outcomes modelled in this thesis, other outcomes which have been identified as important measures of safety and/or found to vary according to place of birth are summarised in Tables H.1 and H.2. These tables also show references for publications from developed countries which have found or suggested an association between that outcome and place of birth, or have put forward the view that the outcome is an important measure of safety. No attempt has been made to exclude low-quality studies from these tables, mainly because there have been very few studies looking at this topic, and also because they all suffered from similar problems. However, most of them did attempt to take intended place of birth into account when comparing home and hospital births, i.e. they compared planned home births against planned hospital births.

Table H.1: Maternal outcomes that are important measures of safety and/or may vary by intended/actual place of birth

Outcome	Possible relationship with place of birth	Reference(s)
Maternal death (within 42 days of end of pregnancy)	Unknown	National Perinatal Epidemiology Unit (NPEU) (2007b)
Induction of labour	Lower rate among home births	Shearer (1985)
Augmentation of labour	Unknown	NPEU (2007b)
Use of pharmacological pain relief	Lower rate among home births	Chamberlain et al (1997); Ackermann-Liebrich et al (1996); Janssen et al (2002)
Duration of labour	Shorter among home births	Chamberlain et al (1997); Ford et al (1991)
	Longer among primiparae having home births	Pang et al (2002)
Normal birth (spontaneous vaginal delivery without the aid of an epidural, spinal or general anaesthesia, forceps or ventouse)	Higher rate among home births	Chamberlain et al (1997); Ackermann-Liebrich et al (1996); Olsen (1997); NCCWCH (2004)
Episiotomy	Lower rate among home births	Chamberlain et al (1997); Shearer (1985)
Physiological third stage of labour	Unknown	NPEU (2007b)
Perineal damage	Lower rate among home births	Chamberlain et al (1997); Shearer (1985); Olsen (1997)

Table H.2: Infant outcomes that are important measures of safety and/or may vary by intended/actual place of birth

Outcome	Possible relationship with place of birth	Reference(s)
Apgar score	None at 5 minutes	Hutton et al (2009)
	Lower incidence of low score among home births	Chamberlain et al (1997); Shearer (1985); Ackermann-Liebrich et al (1996); Olsen (1997)
	Higher incidence of low score among home births	Pang et al (2002)
Kernicterus	Higher rate among home births	Chamberlain et al (1978); NPEU (2007b)
Minor infections	Higher rate among home births	Chamberlain et al (1978)
Fits/seizures	Lower rate among home births	Chamberlain et al (1978); NPEU (2007b)
Cerebral palsy	Lower rate among home births	Chamberlain et al (1978)
Admission to intensive care/ SCBU	None	de Jonge et al (2009); Hutton et al (2009)
Neonatal encephalopathy	Unknown	NPEU (2007b)
Meconium aspiration	Unknown	NPEU (2007b)
Birth injury (e.g. brachial plexus injury, fractured clavicle)	Unknown	NPEU (2007b)
Neonatal sepsis	Unknown	NPEU (2007b)

Table H.3 shows the incidence of individual maternal pregnancy outcomes according to intended/actual place of birth and whether or not there were labour complications.

Table H.3: Incidence of individual maternal pregnancy outcomes, by intended/ actual place of birth and existence of labour complications

	Transferred from home to hospital in labour		Planned home birth		Unplanned home birth		Planned hospital birth	
Labour complications?	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**
Outcome	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Induction of labour (including ARM)	23 (4.49)	53 (12.86)	3 (0.37)	8 (0.15)	0 (0.00)	3 (0.12)	42,749 (21.37)	46,535 (15.42)
Augmentation of labour	217 (42.38)	101 (24.51)	27 (3.35)	208 (3.89)	11 (3.47)	43 (1.76)	61,806 (30.90)	41,718 (13.82)
Epidural/spinal in labour	184 (35.94)	60 (14.56)	5 (0.62)	19 (0.36)	3 (0.95)	2 (0.08)	80,408 (40.19)	43,250 (14.33)
General anaesthetic in labour	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	513 (0.26)	284 (0.09)
Any pharmacological pain relief in labour	426 (83.20)	307 (74.51)	442 (54.77)	2,717 (50.82)	94 (29.65)	644 (26.33)	175,729 (87.84)	225,907 (74.85)
Duration of labour <4 hours	54 (10.55)	120 (29.13)	250 (30.98)	2,138 (39.99)	168 (53.00)	1,542 (63.04)	24,615 (12.30)	76,703 (25.42)
Duration of labour >8 hours	282 (55.08)	106 (25.73)	287 (35.56)	795 (14.87)	62 (19.56)	164 (6.70)	90,329 (45.15)	64,652 (21.42)
Normal birth	224 (43.75)	316 (76.70)	790 (97.89)	5,321 (99.53)	300 (94.64)	2,433 (99.47)	83,053 (41.52)	212,397 (70.38)
Spontaneous vaginal birth	293 (57.23)	354 (85.92)	800 (99.13)	5,343 (99.94)	315 (99.37)	2,444 (99.92)	114,141 (57.06)	244,572 (81.04)
Instrumental vaginal birth	123 (24.02)	14 (3.40)	4 (0.50)	1 (0.02)	2 (0.63)	1 (0.04)	50,240 (25.11)	9,649 (3.20)
Caesarean section	96 (18.75)	44 (10.68)	3 (0.37)	1 (0.02)	0 (0.00)	1 (0.04)	35,667 (17.83)	47,580 (15.77)
Blood transfusion	7 (1.37)	6 (1.46)	6 (0.74)	12 (0.22)	8 (2.52)	22 (0.90)	6,152 (3.08)	3,918 (1.30)
Eclampsia	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	7 (*)	23 (*)
Puerperal sepsis	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (0.04)	324 (0.16)	307 (0.10)
Episiotomy	125 (24.41)	40 (9.71)	34 (4.21)	83 (1.55)	20 (6.31)	33 (1.35)	73,328 (36.66)	37,947 (12.57)
3rd or 4th degree perineal trauma	5 (0.98)	5 (1.21)	2 (0.25)	5 (0.09)	0 (0.00)	4 (0.16)	1,537 (0.77)	1,026 (0.34)

* Less than 0.01 but greater than zero

It is surprising that a few home births were recorded as having epidural/spinal anaesthesia, instrumental birth or Caesarean sections. It is possible that these cases were misclassified, or perhaps there were exceptional circumstances under which these interventions took place at home. It was not possible to determine the more likely explanation, so these cases were left unaltered in the dataset. This will not affect any substantive conclusions, because (a) for outcomes such as this, the comparison should be between planned hospital births and transfers from home to hospital in labour and (b) the numbers involved are extremely small.

The data in Table H.3 suggest that certain maternal outcomes should not be modelled due to small numbers, namely: general anaesthetic in labour, eclampsia, puerperal sepsis and 3rd/4th degree perineal trauma. However, it would be possible to model 'use of pharmacological pain relief', which includes general anaesthetic, and 'state of perineum' which includes '3rd/4th degree perineal trauma'. Variations in incidence of eclampsia and puerperal sepsis were not statistically significant ($p>0.05$), whether or not there were labour complications, so inability to model these two outcomes is not cause for great concern.

With the exceptions of eclampsia and puerperal sepsis, the variations in outcome incidence by intended/actual place of birth as set out in Table H.3 were significant ($p<0.01$) for those who did *not* experience labour complications, and for all outcomes except general anaesthesia, retained placenta and 3rd/4th degree perineal trauma they were highly significant for those who *did* experience labour complications.

Based on the premise that it is 'better' to avoid interventions except when absolutely necessary[78], have a short labour and not experience morbidity, those who gave birth at home (whether planned or unplanned) were more likely than those who gave birth in hospital to have positive maternal outcomes, regardless of whether or not there were complications in labour. The two exceptions were postnatal blood transfusion and retained placenta, for which incidence was relatively high among unplanned home births with labour complications.

Among those giving birth in hospital, on some measures the outcomes were better for those who intended a hospital birth and on others the outcomes were better among those among those who intended a home birth but transferred to hospital in labour. These patterns are summarised in Table H.4. If an outcome is not mentioned in Table H.4, it means there was no significant difference ($p>0.1$) in incidence according to intended place of birth.

[78] Research has found interventions to be associated with negative outcomes further down the line, e.g. induction is associated with increased risk of Caesarean section (Glantz, 2010).

Table H.4: Summary of significant variations in incidence of maternal outcomes according to intended place of birth at end of pregnancy, hospital births only

Labour complications		No labour complications	
Outcomes better if hospital birth intended	**Outcomes better if home birth intended**	**Outcomes better if hospital birth intended**	**Outcomes better if home birth intended**
Labour augmentation	Labour induction	Labour augmentation	Normal birth
Labour duration	Pharmacological pain relief	Labour duration	Caesarean section
	Blood transfusion	$3^{rd}/4^{th}$ degree perineal trauma	Episiotomy
	Episiotomy	Retained placenta	

Given that 'failure to progress' was one of the factors used to define labour complications (see Section 6.1), it is not surprising that transfers from home to hospital tended to have longer labours. In this context, therefore, it is perhaps wrong to consider labour duration as an outcome – it is plausible that longer labour led to transfer to hospital and that transfer to hospital led to longer labour.

The above analysis suggests that the following maternal outcomes would be suitable for modelling:

1. Induction of labour
2. Augmentation of labour
3. Epidural/spinal anaesthesia as pain relief in labour
4. Any pharmacological pain relief in labour
5. Duration of labour
6. Normal birth
7. Instrumental vaginal birth
8. Caesarean section
9. Blood transfusion
10. State of perineum

Table H.5 details variations in incidence of individual infant outcomes according to intended/actual place of birth.

Table H.5: Incidence of individual infant pregnancy outcomes, by intended/actual place of birth and existence of labour complications (including indeterminate stillbirths)

	Transferred from home to hospital in labour		Planned home birth		Unplanned home birth		Planned hospital birth	
Labour complications?	Yes	No	Yes	No	Yes	No	Yes	No
Outcome	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Apgar score <7 at 5 minutes	10 (1.95)	8 (1.94)	9 (1.12)	30 (0.56)	9 (2.84)	22 (0.90)	4,129 (2.06)	2,426 (0.80)
Apgar score <4 at 5 minutes	2 (0.39)	2 (0.49)	2 (0.25)	6 (0.11)	5 (1.58)	11 (0.45)	708 (0.35)	459 (0.15)
Admission to SCBU for >3 days	9 (1.72)	3 (0.74)	0 (0.00)	1 (0.03)	3 (0.89)	11 (0.45)	3,242 (1.59)	3,268 (1.09)
Kernicterus	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	5 (*)	2 (*)
Neonatal encephalopathy or seizures	2 (0.39)	0 (0.00)	1 (0.12)	5 (0.09)	1 (0.32)	2 (0.08)	267 (0.13)	96 (0.03)
Meconium aspiration	3 (0.59)	0 (0.00)	4 (0.50)	2 (0.04)	1 (0.32)	0 (0.00)	516 (0.26)	61 (0.02)
Birth injury	3 (0.59)	1 (0.24)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	395 (0.20)	223 (0.07)
Neonatal sepsis	0 (0.00)	0 (0.00)	0 (0.00)	1 (0.03)	0 (0.00)	2 (0.08)	461 (0.23)	425 (0.14)

* Less than 0.01 but greater than zero

Note: the results excluding indeterminate stillbirths were virtually identical to those including indeterminate stillbirths so are not shown.

For most of these outcomes, there was no significant variation in incidence by actual/intended place of birth among those who experienced labour complications. The exceptions were 'Apgar score <4 at 5 minutes' (p=0.003) and 'admission to SCBU for >3 days' (p=0.002). Unplanned home births with labour complications were most likely to have an Apgar score of <4, whereas those born in hospital with labour complications were more likely to be admitted to SCBU for at least four days than those born at home with labour complications, whether planned or unplanned.

For most of the outcomes, there was significant variation (p<0.1) among those who did *not* experience labour complications, the exceptions being kernicterus (p=0.997) and meconium aspiration (p=0.717). Where there were no labour complications, incidence of low Apgar scores and birth injuries was highest among those who transferred to hospital after attempting a home birth;

incidence of neonatal encephalopathy/seizures was highest among home births; and incidence of neonatal sepsis and admission to SCBU for >3 days was highest among planned hospital births.

Table H.5 suggests that it would be inadvisable to model most of the individual infant outcomes due to small numbers experiencing that outcome in all or some cells of the table, the exceptions being: Apgar score <7 at 5 minutes and admission to SCBU for >3 days. Among those with labour complications, there was no difference between the planned hospital birth group and the transferred from home to hospital group in terms of incidence of these two outcomes. Among those *without* labour complications, however, Apgar scores were higher in the planned hospital birth group and rates of admission to SCBU were lower in the planned home birth group.

Appendix I References

Abraham-Van der Mark, E. (1993). Introduction to the Dutch System of Home Birth and Midwifery. Successful Home Birth and Midwifery. E. Abraham- Van der Mark. Amsterdam, Het Spinhuis.

Ackermann-Liebrich, U., T. Voegell, et al. (1996). "Home versus hospital deliveries: follow up study of matched pairs for procedures and outcome." BMJ **313**: 1313-8.

Adelusi, B., M. H. Soltan, et al. (1997). "Risk of retained placenta: multivariate approach." Acta Obstetricia et Gynecologica Scandinavica **76**(5): 414-8.

Agarwal, N. (2010). Infant and perinatal mortality in England and Wales by social and biological factors, 2009. London, Office for National Statistics.

Agresti, A. (1996). An Introduction to Categorical Data Analysis. New York, Wiley.

Alehagen, S., B. Wijma, et al. (2005). "Fear, pain and stress hormones during childbirth." Journal of Psychosomatic Obstetrics & Gynaecology **26**(3): 153-165.

Allison, J. (1996). Delivered At Home. London, Chapman & Hall.

Amato, J. J., J. Zelen, et al. (1995). "Single-Stage Repair of Thoracic Ectopia Cordis." Annals of Thoracic Surgery **59**: 518-20.

American College of Obstetricians and Gynecologists Committee on Obstetric Practice (2011). "Committee Opinion: Planned Home Birth." Obstetrics & Gynaecology **117**(2): 425-428.

American College of Obstetricians and Gynecologists (ACOG). (2005). "Position Paper on Midwifery Licensure." Retrieved 5 August 2008, from http://www.acog.org/acog_sections/dist_notice.cfm?recno=17&bulletin=1713.

Anthony, S., S. E. Buitendijk, et al. (2005). "Maternal factors and the probability of a planned home birth." BJOG: an International Journal of Obstetrics and Gynaecology **112**: 748-53.

Arvidsson, C.-G., H. Hamberg, et al. (1986). "A Boy with Complete Triploidy and Unusually Long Survival." Acta Paediatrica **75**(3): 507-10.

Association for Improvements in the Maternity Services. (2007). "AIMS Campaigns." Retrieved 12 May 2009, from http://www.aims.org.uk/.

Aubrey, W. R. and C. W. Yoxall (2001). "Evaluation of the role of the neonatal nurse practitioner in resuscitation of preterm infants at birth." Archives of Disease in Childhood: Fetal and Neonatal Edition **85**(2): F96-F99.

Baird, S. D. and A. M. Thomson (1969). Geographical Differences in Perinatal Mortality by Clinico-pathological Cause. Perinatal Problems: The Second Report of the 1958 British Perinatal Mortality Survey. N. R. Butler and E. D. Alberman. London, E & S Livingstone Ltd.

Bais, J. M. J., M. Eskes, et al. (2004). "Postpartum haemorrhage in nulliparous women: incidence and risk factors in low and high risk women. A Dutch population-based cohort study on standard (≥500 ml) and severe (≥1000 ml) postpartum haemorrhage." European Journal of Obstetrics & Gynaecology **115**(2): 166-72.

Bais, J. M. J. and M. Pel (2007). "The basis of the Dutch obstetric system: risk selection." European Clinics in Obstetrics and Gynaecology **2**: 209-12.

Bakker, R. H. C., P. P. Groenewegen, et al. (1996). "'Burnout' among Dutch midwives." Midwifery **12**: 174-81.

Balchin, I., J. C. Whittaker, et al. (2007). "Racial variation in the association between gestational age and perinatal mortality: prospective study." BMJ **334**: 833-7.

Balchin, I., J. C. Whittaker, et al. (2004). "Are reported preterm birth rates reliable? An analysis of interhospital differences in the calculation of the weeks of gestation at delivery and preterm birth rate." BJOG An International Journal of Obstetrics and Gynaecology **111**: 160-3.

Bastian, H., M. J. N. C. Keirse, et al. (1998). "Perinatal death associated with planned home birth in Australia: population based study." BMJ **317**: 384-8.

Bastian, H. (1993). "Personal beliefs and alternative childbirth choices: a survey of 552 women who planned to give birth at home." Birth **20**: 186-92.

BBC (2010). "Midwife shortage hits home births ". Retrieved 16 August 2010, 2010, from http://news.bbc.co.uk/1/hi/england/sussex/8576115.stm.

BBC News (2004). "Call for more help on home births." Retrieved 9 June 2010, from http://news.bbc.co.uk/1/hi/health/4033051.stm.

Beake, S. and D. Bick (2007). "Maternity services policy: does the rhetoric match the reality?" British Journal of Midwifery **15**(2): 89-93.

Begley, C., D. Devane, et al. (2009). An evaluation of midwifery-led care in the Health Service Executive North Eastern Area. Dublin, Trinity College School of Nursing and Midwifery

Berghs, G., E. Spanjaards, et al. (1995). "Neonatal neurological outcome after low-risk pregnancies." European Journal of Obstetrics & Gynaecology **62**: 167-71.

BirthChoiceUK. (2009). "Basic Maternity Statistics." Retrieved 11 May 2009, from http://www.birthchoiceuk.com/.

Birth Trauma Association (2008). "Birth Stories." Retrieved 25 July 2008, from http://www.birthtraumaassociation.org.uk/birth_stories.htm.

Borquez, H. A. and T. A. Wiegers (2006). "A comparison of labour and birth experiences of women delivering in a birthing centre and at home in the Netherlands." Midwifery **22**: 339-47.

Boucher, D., C. Bennett, et al. (2009). "Staying Home to Give Birth: Why Women in the United States Choose Home Birth." Journal of Midwifery & Women's Health **54**(2): 119-26.

British College of Obstetricians and Gynaecologists (1936). "Memorandum on the Reorganisation of the Maternity Services." London, D Wilson.

British Medical Association (1936). "The BMA and Maternity Services." British Medical Journal **1**: 656.

Bugg, G. J., G. S. Atwal, et al. (2002). "Grandmultiparae in a modern setting." BJOG An International Journal of Obstetrics and Gynaecology **109**: 249-53.

Buitendijk, S. E. (1993). How Safe Are Dutch Home Births? Successful Home Birth and Midwifery: The Dutch Model. E. Abraham- Van der Mark. Amsterdam, Het Spinhuis.

Bull, J., C. Mulvihill, et al. (2003). Prevention of low birth weight: assessing the effectiveness of smoking cessation and nutritional interventions: Evidence briefing. London, Health Development Agency.

Bull, M. J. V. (1994). Selection of women for community obstetric care. The Future of the Maternity Services. G. Chamberlain and N. Patel. London, RCOG Press**:** 73-81.

Butler, N. R. and D. G. Bonham (1963). Perinatal Mortality: The first report of the 1958 British Perinatal Mortality Survey. London, E & S Livingstone Ltd.

Campbell, M. K., T. Østbye, et al. (1997). "Post-Term Birth: Risk Factors and Outcomes in a 10-Year Cohort of Norwegian Births." Obstetrics & Gynaecology **89**(4): 543-8.

Campbell, R. (1999). "Review and assessment of selection criteria used when booking pregnant women at different places of birth." British Journal of Obstetrics and Gynaecology **106**: 550-6.

Campbell, R. (1986). Home births survey. Perinatal mortality by intended place of delivery for births occurring at home. England and Wales, 1979. London, London University. PhD.

Campbell, R. and A. J. Macfarlane (1994). Where To Be Born? The Debate and the Evidence. Oxford, National Perinatal Epidemiology Unit.

Campbell, R. and A. Macfarlane (1990). Recent Debate on the Place of Birth. The Politics of Maternity Care: Services for Childbearing Women in Twentieth-Century Britain. J. Garcia, R. Kilpatrick and M. Richards. Oxford, Clarendon Press.

Campbell, R., I. M. Davies, et al. (1984). "Home births in England and Wales, 1979: perinatal mortality according to intended place of delivery." British Medical Journal **289**(6447): 721-4.

Care Quality Commission (2010). "National NHS patient survey programme. Survey of women's experiences of maternity services 2010. Full national results tables." Retrieved 9 December 2010, from http://www.cqc.org.uk/_db/_documents/101006_MAT10_Historical_comparisons_tables_FINAL.pdf.

Care Quality Commission (2008). "Maternity." Retrieved 25 November 2010, from http://webarchive.nationalarchives.gov.uk/20100611090857/http://www.cqc.org.uk/publications.cfm?widCall1=customDocManager.search_do_2&tcl_id=2&top_parent=4513&tax_child=4514&tax_grand_child=4524&tax_great_grand_child=4541&search_string=&pageNum=1.

Carne, V. (2008). "Place of birth." Retrieved 12 May 2009, from http://www.midirs.org/midirs/midszone.nsf/RSSEssArt/DACDA5F3FD4DEEB880257419003557 9F.

Carstairs, V. and R. Morris (1991). Deprivation and Health in Scotland. Aberdeen, Aberdeen University Press.

Cartwright, E. and J. Thomas (2001). Constructing Risk. Birth by Design: Pregnancy, Maternity Care, and Midwifery in North America and Europe. R. DeVries, C. Benoit, E. van Teijlingen and S. Wrede. New York, Routledge.

Centre for Longitudinal Studies (2006a). "Born in Bradford (UK)." Retrieved 19 November 2007, from http://www.cls.ioe.ac.uk/text.asp?section=00010001000500090013.

Centre for Longitudinal Studies (2006b). "Gateshead Millennium Study." Retrieved 19 November 2007, from http://www.cls.ioe.ac.uk/text.asp?section=00010001000500090012.

Centre for Longitudinal Studies (2006c). "Growing Up in Scotland." Retrieved 29 October 2008, from http://www.cls.ioe.ac.uk/text.asp?section=00010001000500090003.

Centre for Longitudinal Studies (2006d). "Isle of Wight Birth Cohort Study." Retrieved 19 November 2007, from http://www.cls.ioe.ac.uk/text.asp?section=00010001000500090006.

Centre for Longitudinal Studies (2005). "Millennium Cohort Study." Retrieved 20 November 2007, from http://www.cls.ioe.ac.uk/studies.asp?section=000100020001.

Centre for Maternal and Child Enquiries (2009). Perinatal Mortality Report 2008: Feedback Report: Anywhere NHS Trust. London, CMACE.

Chamberlain, G., A. Wraight, et al. (1997). Home Births: The Report of the 1994 Confidential Enquiry by the National Birthday Trust Fund. Carnforth, The Parthenon Publishing Group.

Chamberlain, G., E. Philipp, et al. (1978). British Births 1970. Volume 2: Obstetric Care. London, Heinemann.

Cleary, R., R. W. Beard, et al. (1994). "The quality of routinely collected maternity data." BJOG An International Journal of Obstetrics and Gynaecology **101**(12): 1042-7.

Clement, S. (2001). "Psychological aspects of Caesarean section." Best Practice & Research: Clinical Obstetrics & Gynaecology **15**(1): 109-26.

Combs, C. A. and R. K. Laros (1991). "Prolonged Third Stage of Labor: Morbidity and Risk Factors." Obstetrics & Gynaecology **77**(6): 863-7.

Confidential Enquiry into Maternal and Child Health (2009). Perinatal Mortality 2007. London, CEMACH.

Confidential Enquiry into Stillbirths and Deaths in Infancy (1999). 6th Annual Report. London, Maternal and Child Health Research Consortium.

Corbett, J., L. Marryat, et al. (2008). Growing Up In Scotland Sweep 1 - 2005: User Guide. Edinburgh, Scottish Centre for Social Research.

Cranbrook, Lord (1959). Report on the Maternity Services. London, HMSO.

Cunningham, J. D. (1993). "Experiences of Australian mothers who gave birth either at home, at a birth centre, or in hospital labour wards." Social Science and Medicine **36**: 475-83.

Curtis, P. A., L. Ball, et al. (2006). "Why do midwives leave? (Not) being the kind of midwife you want to be." British Journal of Midwifery **14**(1): 27-31.

Davies, L. (2004). ""Allowed" shouldn't be allowed." MIDIRS Midwifery Digest **14**(2): 151-6.

Davies, J., E. Hey, et al. (1996). "Prospective regional study of planned home births." BMJ **313**: 1302-6.

Day-Stirk, F. (2005). "The big push for normal birth." Midwives: The official journal of the Royal College of Midwives **8**(1): 18-20.

Dearden, L., A. Mesnard, et al. (2006). "Ethnic Differences in Birth Outcomes in England." Fiscal Studies **27**(1): 17-46.

Declercq, E., R. DeVries, et al. (2001). Where to Give Birth? Politics and the Place of Birth. Birth by Design: Pregnancy, Maternity Care, and Midwifery in North America and Europe. R. DeVries, C. Benoit, E. van Teijlingen and S. Wrede. New York, Routledge.

Declercq, E., L. L. Paine, et al. (1995). "Home birth in the United States 1989-1992: A longitudinal descriptive report of national birth certificate data." Journal of Nurse-Midwifery **40**: 474-82.

de Jonge, A., B. Y. van der Goes, et al. (2009). "Perinatal mortality and morbidity in a nationwide cohort of 529 688 low-risk planned home and hospital births." BJOG An International Journal of Obstetrics and Gynaecology DOI: 10.1111/j.1471-0528.2009.02175.x.

Department of Communities and Local Government (2007). "Indices of Deprivation 2004: LA Summaries." Retrieved 5 March 2008, from http://www.communities.gov.uk/documents/communities/xls/lasummaries2004.

Department of Health, Royal College of Obstetricians and Gynaecologists, et al. (2010). "Maternity Services and Payment by Results – A Simple Guide – Updated 2010/11 Version." Retrieved 15 December 2010, from http://www.rcm.org.uk/EasySiteWeb/getresource.axd?AssetID=133079&type=full&servicetype=Attachment.

Department of Health (2007). Maternity Matters: Choice, access and continuity of care in a safe service. London, Department of Health.

Department of Health (1993). Changing Childbirth. Report of the Expert Maternity Group (Chairman Lady Julia Cumberlege). London.

Dodwell, M. and R. Gibson (2009). An Investigation into Choice of Place of Birth. London, National Childbirth Trust.

Downe, S., K. Finlayson, et al. (2009). "'Weighing up and balancing out': a meta-synthesis of barriers to antenatal care for marginalised women in high-income countries." BJOG An International Journal of Obstetrics and Gynaecology **116**: 518-29.

Dowswell, T., J. G. Thornton, et al. (1996). "Should there be a trial of home versus hospital delivery in the United Kingdom?" BMJ **312**: 753-7.

Draycott, T., T. Sibanda, et al. (2006). "Does training in obstetric emergencies improve neonatal outcome?" BJOG An International Journal of Obstetrics and Gynaecology **113**(2): 177-82.

Durand, A. M. (1992). "The Safety of Home Birth: The Farm Study." American Journal of Public Health **82**(3): 450-3.

Edwards, A. (2008). "Place of birth: can 'Maternity Matters' really deliver choice?" British Journal of Midwifery **16**(12): 771-5.

Edwards, N. P. (2005). Birthing Autonomy: Women's Experiences of Planning Home Births. Abingdon, Routledge.

Edwards, N. P. (2004). Why can't women just say no? And does it really matter? Informed Choice in Maternity Care. M. Kirkham. Basingstoke, Palgrave Macmillan.

Evers, A. C. C., H. A. A. Brouwers, et al. (2010). "Perinatal mortality and severe morbidity in low and high risk term pregnancies in the Netherlands: prospective cohort study." BMJ **341**: c5639 doi:5610.1136/bmj.c5639.

Ezra, Y., S. R. Strasberg, et al. (2003). "Does cord presentation on ultrasound predict cord prolapse?" Gynecologic and Obstetric Investigation **56**: 6-9.

Feinstein, U., E. Sheiner, et al. (2002). "Risk factors for arrest of descent during the second stage of labour." International Journal of Gynaecology and Obstetrics **77**(1): 7-14.

Ford, C., S. Iliffe, et al. (1991). "Outcome of planned home births in an inner city practice." BMJ **303**: 1517-9.

Fordham, S. (1997). "Women's views of the place of confinement." British Journal of General Practice **47**: 77-80.

Fox, J. (2002). An R and S-Plus Companion to Applied Regression. Thousand Oaks, California, Sage.

Fullerton, J. T. and A. M. Navarro (2007). "Outcomes of planned home births: An integrative review." Journal of Midwifery & Women's Health **52**(4): 323-32.

General Register Office (2004). "Registering a birth." Retrieved 29 October 2008, from http://www.gro.gov.uk/gro/content/births/registeringabirth/whatinformation.asp.

Glantz, J. C. (2010). "Term Labor Induction Compared With Expectant Management." Obstetrics & Gynaecology **115**(1): 70-6.

Gnanalingham, M. G., C. Robinson, et al. (2001). "A national review of neonatal resuscitation programmes for midwives (letter)." Archives of Disease in Childhood: Fetal and Neonatal Edition **85**(2): F145.

Golding, J., M. Pembrey, et al. (2001). "ALSPAC - The Avon Longitudinal Study of Parents and Children I: Study Methodology." Paediatric and Perinatal Epidemiology **15**: 74-87.

Green, J. M. and H. A. Baston (2003). "Feeling in Control During Labor: Concepts, Correlates, and Consequences." Birth **30**(4): 235-47.

Green, J. M., V. A. Coupland, et al. (1998). Great Expectations: A Prospective Study of Women's Expectations and Experiences of Childbirth (2nd ed). Hale, Books for Midwives Press.

Gyte, G. M. L., M. Newburn, et al. (2010). Critique of a meta-analysis by Wax and colleagues which has claimed that there is a three times greater risk of neonatal death among babies without congenital anomalies planned to be born at home. London, National Childbirth Trust.

Gyte, G. M. L., M. Dodwell, et al. (2009). "Estimating intrapartum-related perinatal mortality rates for booked home births: when the 'best' available data are not good enough." BJOG An International Journal of Obstetrics and Gynaecology **116**(7): 933-42.

Hall, J. (2003). Free-standing maternity units in England. Birth Centres: A Social Model for Maternity Care. M. Kirkham. [Great Britain], Books for Midwives Press.

Hannah, M. E., W. J. Hannah, et al. (2000). "Planned caesarean section versus planned vaginal birth for breech presentation at term: a randomised multicentre trial." The Lancet **356**: 1375-83.

Hansard. (2007a). "House of Commons Written Answers for 02 March 2007: Home Births." Retrieved 1 September 2008, from http://www.publications.parliament.uk/pa/cm200607/cmhansrd/cm070302/text/70302w0005.htm.

Hansard (2007b). "General Registry Office." Retrieved 29 October 2008, from http://www.parliament.the-stationery-office.co.uk/pa/cm200607/cmhansrd/cm070605/text/70605w0037.htm.

Harrison, J. (2008). Personal communication by email with Juliette Harrison of the Healthcare Commission, dated 4 March 2008.

Hatem, M., J. Sandall, et al. (2008). "Midwife-led versus other methods of care for childbearing women." Cochrane Database of Systematic Reviews 2008 Issue 4: Article number CD004667. DOI: 10.1002/14651858.CD004667.pub2.

Hayden, E. C. (2011). "Home-birth study investigated." Nature. Retrieved 21 March 2011, from http://www.nature.com/news/2011/110318/full/news.2011.162.html?s=news_rss.

Health and Social Care Information Centre (2009). "Method of Delivery." Retrieved 29 September 2009, from http://www.hesonline.nhs.uk/Ease/servlet/ContentServer?siteID=1937&categoryID=1024.

Healthcare Commission (2008). Towards better births: A review of maternity services in England. London, Healthcare Commission.

Healthcare Commission (2007a). Women's Experiences of Maternity Care in the NHS in England: Key Findings from a Survey of NHS Trusts carried out in 2007. London, Healthcare Commission.

Healthcare Commission (2007b). "Maternity survey: results by trust." Retrieved 6 November 2008, from http://www.healthcarecommission.org.uk/_db/_documents/MAT07_6_Labour_and_the_birth_v4.xls.

Healthcare Commission and Picker Institute Europe (2008). Maternity Survey 2007 [computer file]. 2nd edition. Colchester, Essex, UK Data Archive [distributor]. SN:5785.

Hendrix, M., M. van Horck, et al. (2009). "Why women do not accept randomisation for place of birth: feasibility of a RCT in the Netherlands." BJOG An International Journal of Obstetrics and Gynaecology **116**(4): 537-44.

Herbst, A., P. Wølner-Hanssen, et al. (1995). "Risk Factors for Fever in Labor." Obstetrics & Gynaecology **86**(5): 790-794.

Hoff, G. A. and L. J. Schneiderman (1985). "Having Babies at Home: Is It Safe? Is It Ethical?" The Hastings Center Report **15**(6): 19-27.

Hofmeyr, G. J. and L. W. M. Impey (2006). The Management of Breech Presentation: Green-Top Guideline No. 20b. London, Royal College of Obstetricians and Gynaecologists.

Home Birth Aotearoa (2007). "Home Birth Statistics." Retrieved 17 November 2008, from http://www.homebirth.org.nz/statistics.html.

Horn, A. (2010). "Home Birth Reference Site: Can I have a homebirth, if...?". Retrieved 2 July 2010, from http://www.homebirth.org.uk/.

Hosmer, D. W. and S. Lemeshow (2000). Applied Logistic Regression (Second Edition). New York, Wiley.

Hundley, V., A.-M. Rennie, et al. (2000). "A national survey of women's views of their maternity care in Scotland." Midwifery **16**: 303-13.

Hutton, E. K., A. H. Reitsma, et al. (2009). "Outcomes Associated with Planned Home and Planned Hospital Births in Low-Risk Women Attended by Midwives in Ontario, Canada, 2003-2006: A Retrospective Cohort Study." Birth **36**(3): 180-9.

Impey, L., C. Greenwood, et al. (2001). "Fever in labour and neonatal encephalopathy: a prospective cohort study." British Journal of Obstetrics and Gynaecology **108**: 594-7.

Independent Midwives' Association. (2005). "IMA Statistics: Records from 31 March 2003 to 31 March 2004." Retrieved 21 August 2008, from http://www.independentmidwives.org.uk/files/ima_statistics_2003-2004.pdf.

Jabaaij, L. and W. Meijer (1996). "Home births in the Netherlands: midwifery-related factors of influence." Midwifery **12**: 129-35.

Jaddoe, V. W. V., E.-J. W. M. Troe, et al. (2008). "Active and passive maternal smoking during pregnancy and the risks of low birthweight and preterm birth: the Generation R Study." Paediatric and Perinatal Epidemiology **22**(2): 162-71.

Janni, W., B. Schiessl, et al. (2002). "The prognostic impact of a prolonged second stage of labor on maternal and fetal outcome." Acta Obstetricia et Gynecologica Scandinavica **81**(2): 214-21.

Janssen, P. A., L. Saxell, et al. (2009). "Outcomes of planned home birth with registered midwife versus planned hospital birth with midwife or physician." Canadian Medical Association Journal **181**(6-7): 377-83.

Janssen, P. A., E. M. Ryan, et al. (2007). "Outcomes of planned hospital birth attended by midwives compared with physicians in British Columbia." Birth **34**(2): 140-147.

Janssen, P. A., S. K. Lee, et al. (2002). "Outcomes of planned home births versus planned hospital births after regulation of midwifery in British Columbia." Canadian Medical Association Journal **166**(3): 315-23.

Johnson, K. C. and B.-A. Daviss (2005). "Outcomes of planned home births with certified professional midwives: large prospective study in North America." BMJ **330**: 1416-22.

Jowitt, M. (2009). "Save the Albany." Retrieved 25 October 2010, from http://www.midwifery.org.uk/index.php?option=com_content&view=article&id=59:save-the-albany&catid=35:magazine-winter-2009&Itemid=29.

Julian-Reynier, C., N. Philip, et al. (1994). "Impact of prenatal diagnosis by ultrasound on the prevalence of congenital anomalies at birth in southern France." Journal of Epidemiology and Community Health **48**: 290-6.

Kennare, R. M., M. J. N. C. Keirse, et al. (2010). "Planned home and hospital births in South Australia, 1991-2006: differences in outcomes." Medical Journal of Australia **192**(2): 76-80.

King's College Hospital (2009). "Albany Midwifery Practice." Retrieved 25 October 2010, from http://www.kch.nhs.uk/news/archive/2009/albany-midwifery-practice/.

Kirkham, M. and H. Stapleton (2004). The culture of maternity services as a barrier to informed choice. Informed Choice in Maternity Care. M. Kirkham. Basingstoke, Palgrave Macmillan.

Kirkham, M. and H. Stapleton (2000). "Midwives' support needs as childbirth changes." Journal of Advanced Nursing **32**(2): 465-72.

Kirkham, M. (1999). "The culture of midwifery in the National Health Service in England." Journal of Advanced Nursing **30**(3): 732-9.

Kitzinger, S. (2000). "Home Birth Matters." Birth **27**(1): 61-3.

Kleiverda, G., A. M. Steen, et al. (1990). "Place of delivery in the Netherlands: maternal motives and background variables related to preferences for home or hospital confinement." European Journal of Obstetrics and Gynaecology and Reproductive Biology **36**: 1-9.

Lander, T. A., G. Schauer, et al. (2004). "Tracheal Agenesis in Newborns." The Laryngoscope **114**(September): 1633-6.

Lauritzen, S. O. and L. Sachs (2001). "Normality, risk and the future: implicit communication of threat in health surveillance." Sociology of Health & Illness **23**(4): 497-516.

Lavender, T. and J. Chapple (2004). "An exploration of midwives' views of the current system of maternity care in England." Midwifery **20**: 324-34.

Lavender, T., S. A. Walkinshaw, et al. (1999). "A prospective study of women's views of factors contributing to a positive birth experience." Midwifery **15**: 40-6.

Leap, N. (1996). "'Persuading' women to give birth at home - or offering real choice?" British Journal of Midwifery **4**(10): 536-8.

Lewis, J. (1990). Mothers and Maternity Policies in the Twentieth Century. The Politics of Maternity Care: Services for Childbearing Women in Twentieth-Century Britain. J. Garcia, R. Kilpatrick and M. Richards. Oxford, Clarendon Press.

Leyshon, L. (2004). "Integrating caseloads across a whole service: the Torbay model." MIDIRS Midwifery Digest Supplement **14**(Supplement 1): S9-S11.

Lindgren, H. E., I. J. Rådestad, et al. (2008). "Outcome of planned home births compared to hospital births in Sweden between 1992 and 2004. A population-based register study." Acta Obstetricia et Gynecologica Scandinavica **87**: 751-9.

Long, J. S. and J. Freese (2006). Regression Models for Categorical Dependent Variables Using Stata (Second Edition). College Station, Texas, Stata Press.

Loudon, I. (1992). Death in Childbirth: An International Study of Maternal Care and Maternal Mortality 1800-1950. Oxford, Clarendon Press.

Lumey, L. H. (1993). Illness versus Natural Process: Competing Paradigms in Great Britain and the Netherlands. Successful Home Birth and Midwifery: The Dutch Model. E. Abraham- Van der Mark. Amsterdam, Het Spinhuis.

Macfarlane, A. J. (1996). "Trial would not answer key question, but data monitoring should be improved." BMJ **312**: 754-5.

Macfarlane, A. J. and M. Mugford (2000). Birth Counts: Statistics of pregnancy & childbirth. Volume I. London, The Stationery Office.

McGuinness, B. J. and A. N. Trivedi (1999). "Maternal Height as a Risk Factor for Caesarean Section Due to Failure to Progress in Labour." Australia and New Zealand Journal of Obstetrics and Gynaecology **39**(2): 152-4.

McLachlan, H. and D. Forster (2009). "The safety of home birth: Is the evidence good enough?" Canadian Medical Association Journal **181**(6-7): 359-60.

Madi, B. C. and R. Crow (2003). "A qualitative study of information about available options for childbirth venue and pregnant women's preference for place of delivery." Midwifery **19**: 328-36.

Magill-Cuerdin, J. (2005). Report of issues arising from a document review to support recommendations for guidance for home births. London, Nursing & Midwifery Council.

Maresh, M., A. M. Dawson, et al. (1986). "Assessment of an on-line computerized perinatal data collection and information system." British Journal of Obstetrics and Gynaecology **93**: 1239-45.

Maternity Services Advisory Committee. (1984). Maternity Care in Action. Part II. Care During Childbirth (intrapartum care): A guide to good practice and a plan for action. London, HMSO.

Matthews, T. G., P. Crowley, et al. (2003). "Rising caesarean section rates: a cause for concern?" BJOG An International Journal of Obstetrics and Gynaecology **110**(4): 346-9.

Mehl-Madrona, L. and M. Mehl Madrona (1997). "Physician- and Midwife-Attended Home Births: Effects of Breech, Twin, and Post-Dates Outcome Data on Mortality Rates." Journal of Nurse-Midwifery **42**(2): 91-8.

Menage, J. (1993). "Post-traumatic stress disorder in women who have undergone obstetric and/or gynaecological procedures: A consecutive series of 30 cases of PTSD." Journal of Reproductive and Infant Psychology **11**(4): 221-8.

Mori, R., M. Dougherty, et al. (2008). "An estimation of intrapartum-related perinatal mortality rates for booked home births in England and Wales between 1994 and 2003." BJOG: An International Journal of Obstetrics and Gynaecology **115**(5): 554-9.

Morison, S., Y. Hauck, et al. (1998). "Constructing a home birth environment through assuming control." Midwifery **14**: 233-41.

Moser, K., A. Macfarlane, et al. (2007). "Introducing new data on gestation-specific infant mortality among babies born in 2005 in England and Wales." Health Statistics Quarterly **35**(Autumn): 13-27.

MRC Epidemiology Research Centre (2006). "Southampton Women's Survey." Retrieved 20 November 2007, from http://www.mrc.soton.ac.uk/index.asp?page=4.

Murphy, D. J. and I. Z. MacKenzie (1995). "The mortality and morbidity associated with umbilical cord prolapse." BJOG An International Journal of Obstetrics and Gynaecology **102**(10): 826-30.

Murphy, J. F., M. Dauncey, et al. (1984). "Planned and unplanned deliveries at home: implications of a changing ratio." British Medical Journal **288**: 1429-32.

Murphy-Lawless, J. (1998). Reading Birth and Death: A History of Obstetric Thinking. Cork, Cork University Press.

National Centre for Health Outcomes Development (2008). "St Mary's Maternity Information System." Retrieved 3 November 2008, from http://www.nchod.nhs.uk/NCHOD/DocDat_2.nsf/7eebdb44281f59a4882571d800180ec1/ec71b47120c01d716525725a002f9da9!OpenDocument.

National Childbirth Trust (2009a). Location, location, location: Making choice of place of birth a reality. London, National Childbirth Trust.

National Childbirth Trust (2009b). "The Albany Practice terminated." Retrieved 25 October 2010, from http://www.nct.org.uk/press-office/press-releases/view/190.

National Childbirth Trust (2008). NCT Briefing: Home Birth. London, National Childbirth Trust.

National Childbirth Trust (2007). NCT policy briefing: NICE Intrapartum Care Guideline: Care of healthy women and their babies during childbirth. London, National Childbirth Trust.

National Childbirth Trust (2001). Home Birth in the United Kingdom. London, National Childbirth Trust.

National Collaborating Centre for Women's and Children's Health (2007). Intrapartum Care: Care of healthy women and their babies during labour. NICE Clinical Guideline 55. London, RCOG Press.

National Collaborating Centre for Women's and Children's Health (2004). Caesarean Section. Clinical Guideline. London, RCOG Press.

National Institute for Health and Clinical Excellence (2008). "Antenatal care: Routine care for the healthy pregnant woman." Retrieved 5 August 2008, from http://www.nice.org.uk/CG062.

National Perinatal Epidemiology Unit. (2008). "Birthplace in England Research Programme." Retrieved 7 May 2008, from http://www.npeu.ox.ac.uk/birthplace.

National Perinatal Epidemiology Unit (2007a). "The Birthplace in England Research Programme (Birthplace)." Retrieved 20 November 2007, from https://www.npeu.ox.ac.uk/birthplace/.

National Perinatal Epidemiology Unit (2007b). "National Prospective Cohort Study of Planned Place of Birth: Protocol version 2." Retrieved 13 January 2010, from http://www.npeu.ox.ac.uk/downloads/birthplace/Birthplace-protocol.pdf.

Nelson, M. K. and R. Popenoe (2001). Looking Within: Race, Class and Birth. Birth by Design: Pregnancy, Maternity Care, and Midwifery in North America and Europe. R. DeVries, C. Benoit, E. van Teijlingen and S. Wrede. New York, Routledge.

Neuhaus, W., C. Piroth, et al. (2002). "A psychosocial analysis of women planning birth outside hospital." Journal of Obstetrics and Gynaecology **22**(2): 143-9.

NHS Quality Improvement Scotland (2005). Clinical standards - maternity services. Edinburgh, NHS Quality Improvement Scotland.

Nolan, M. (2002). The consumer view. Clinical Risk Management in Midwifery: The Right to a Perfect Baby? J. H. Wilson and A. Symon. Oxford, Books for Midwives Press.

Northern Region Perinatal Mortality Survey Coordinating Group (1996). "Collaborative survey of perinatal loss in planned and unplanned home births." BMJ **313**: 1306-9.

Nove, A., A. Berrington, et al (2011). "Characteristics associated with intending and achieving a planned home birth in the UK: An observational study of 515,777 maternities in the North West Thames region, 1988-2000." International Journal of Childbirth **1**(2): 100-10.

Nove, A., A. Berrington, et al. (2008). "Home births in the UK, 1955 to 2006." Population Trends **133**: 20-7.

Nursing & Midwifery Council (2006). Midwives and home birth: Circular 8-2006.

Oakley, A. (1980). Women Confined: Towards a Sociology of Childbirth. Oxford, Martin Robertson.

Obstetric Working Group of the National Health Insurance Board of the Netherlands (2000). Obstetric Manual (abridged version). Amstelveen, National Health Insurance Board of the Netherlands.

O'Connor, B. B. (1993). "The home birth movement in the United States." Journal of Medicine and Philosophy **18**: 147-174.

Office for National Statistics (2010a). Cohort fertility: 2009. London, Office for National Statistics.

Office for National Statistics (2010b). Live births in England and Wales by characteristics of birth. London, Office for National Statistics.

Office for National Statistics (2009). Birth Statistics 2008. Series FM1.

Office for National Statistics (2008a). Birth Statistics 2007. Series FM1.

Office for National Statistics (2008b). "Total International Migration (TIM) tables: 1991- latest." Retrieved 6 November 2008, from http://www.statistics.gov.uk/statbase/Product.asp?vlnk=15053.

Office for National Statistics (2007). "Report of the Inter-departmental Task Force on Migration Statistics." Retrieved 5 November 2008, from http://www.statistics.gov.uk/about/data/methodology/specific/population/future/imps/updates/downloads/TaskForceReport151206.pdf.

Office for National Statistics (2004). "Breastfeeding." Retrieved 20 November 2008, from http://www.statistics.gov.uk/cci/nugget.asp?id=923.

Ogden, J., A. Shaw, et al. (1997). "Deciding on a homebirth: help and hindrance." British Journal of Midwifery **5**(4): 212-5.

Olde, E., O. van der Hart, et al. (2006). "Posttraumatic stress following childbirth: A review." Clinical Psychology Review **26**(1): 1-16.

Olsen, O. (1997). "Meta-analysis of the Safety of Home Birth." Birth **24**(1): 4-13.

Olsen, O. and M. D. Jewell (1998). Home versus hospital birth (Review). Cochrane Reviews. London, The Cochrane Collaboration.

Options UK (2009). Maternity Matters in Camden. London, Camden Local NHS.

Owen, P., A. J. Harrold, et al. (1997). "Fetal size and growth velocity in the prediction of intrapartum caesarean section for fetal distress." British Journal of Obstetrics and Gynaecology **104**: 445-9.

Page, L. A. (1994). Balancing risks and choice: discussion. The Future of the Maternity Services. G. Chamberlain and N. Patel. London, RCOG Press**:** 89-91.

Pang, J. W. Y., J. D. Heffelfinger, et al. (2002). "Outcomes of Planned Home Births in Washington State: 1989-1996." Obstetrics & Gynaecology **100**(2): 253-9.

Parliamentary Office of Science and Technology (2002). Postnote number 184: Caesarean Sections. London, Parliamentary Office of Science and Technology.

Pasupathy, D., A. M. Wood, et al. (2010). "Time of birth and risk of neonatal death at term: retrospective cohort study." BMJ **341**(3498).

Patel, R. R., P. J. Steer, et al. (2003). "Does gestation vary by ethnic group? A London-based study of over 122 000 pregnancies with spontaneous onset of labour." International Journal of Epidemiology **33**: 107-13.

Peel, J. (1970). Domiciliary Midwifery and Availability of Hospital Beds. London, HMSO.

Philip, J., J. M. Alexander, et al. (1999). "Epidural Analgesia during Labor and Maternal Fever." Anesthesiology **90**(5): 1271-5.

Pitchforth, E., V. Watson, et al. (2007). "Models of intrapartum care and women's trade-offs in remote and rural Scotland: a mixed-methods study." BJOG: An International Journal of Obstetrics and Gynaecology **115**: 560-9.

Pope, R., L. Graham, et al. (2001). "Woman-centred care." International Journal of Nursing Studies **38**(2): 227-38.

Pregibon, D. (1981). "Logistic regression diagnostics." Annals of Statistics **9**: 705-24.

Queenan, J. T., J. C. Hobbins, et al., Eds. (2010). Protocols for High-Risk Pregnancies (5th edition). London, Wiley-Blackwell.

Ramin, S. M., D. R. Gambling, et al. (1995). "Randomized Trial of Epidural Versus Intravenous Analgesia During Labor." Obstetrics & Gynaecology **86**(5): 783-9.

Redshaw, M., R. Rowe, et al. (2007). Recorded delivery: A national survey of women's experience of maternity care 2006. Oxford, National Perinatal Epidemiology Unit.

Richmond, S. and J. Wyllie (2010). "Resuscitation Guidelines: Newborn Life Support." Retrieved 14 December 2010, from http://www.resus.org.uk/pages/nls.pdf.

Roberts, T., M. Mugford, et al. (1998). "Choosing options for ultrasound screening in pregnancy and comparing cost effectiveness: a decision analysis approach." BJOG An International Journal of Obstetrics and Gynaecology **105**: 960-970.

Robinson, T. (2009). "Us 'n' them." The Practising Midwife **12**(3): 25-6.

Rogers, J., T. Barber, et al. (2005). Birth Place Choices Project: Final Report.

Royal College of Midwives (2010). "RCM speaks out on Albany Midwifery Practice." Retrieved 25 October 2010, from http://www.rcm.org.uk/college/media-centre/press-releases/rcm-speaks-out-on-albany-midwifery-practice/.

Royal College of Midwives (2010b). "RCM in the news: Home Birth." Retrieved 15 December 2010, from http://www.rcm.org.uk/college-archive/media-centre/rcm-in-the-news/.

Royal College of Obstetricians and Gynaecologists (2009). RCOG Green-top Guideline No. 52: Prevention and Management of Postpartum Haemorrhage. London, Royal College of Obstetricians and Gynaecologists.

Royal College of Obstetricians and Gynaecologists (1944). A National Maternity Service. London, RCOG.

Royal College of Obstetricians and Gynaecologists / Royal College of Midwives. (2007). "Joint Statement no. 2: Home Births." Retrieved 5 August 2008, from http://www.rcog.org.uk/index.asp?PageID=2023.

Salkeld, G., M. Ryan, et al. (2000). "The Veil of Experience: Do Consumers Prefer What They Know Best?" Health Economics **9**: 267-70.

Sandall, J., C. Homer, et al. (2011). Staffing in Maternity Units: Getting the right people in the right place at the right time. London, The King's Fund.

Sandall, J. (2007). Who Decides What Women Get in Childbirth? Power and Birth: A Savage Enquiry Revisited. W. Savage. London, Middlesex University Press**:** 187-97.

Sandall, J., J. Davies, et al. (2001a). Evaluation of the Albany Midwifery Practice: Final Report March 2001. London, King's College London.

Sandall, J., I. L. Bourgeault, et al. (2001b). Deciding Who Cares: Winners and Losers in the Late Twentieth Century. Birth by Design: Pregnancy, Maternity Care, and Midwifery in North America and Europe. R. DeVries, C. Benoit, E. van Teijlingen and S. Wrede. New York, Routledge.

Sandall, J. (1995). "Choice, continuity and control: changing midwifery towards a sociological perspective." Midwifery **11**: 201-9.

Savage, W. (2007a). Birth and Power. Birth and Power: A Savage Enquiry Revisited. W. Savage. London, Middlesex University Press**:** 27-34.

Savage, W. (2007b). What Women Want. Birth and Power: A Savage Enquiry Revisited. W. Savage. London, Middlesex University Press**:** 171-8.

Scottish Centre for Social Research (2008). Growing Up in Scotland: Sweeps 1 and 2, 2005-2007 [computer file]. 4th edition. Colchester, Essex, UK Data Archive [distributor]. SN:5760.

Scottish Executive (2004). "Scottish Executive Urban Rural Classification 2003-2004." Retrieved 7 November 2008, from http://www.scotland.gov.uk/Publications/2004/06/19498/38784.

Scottish Executive (2001). A Framework for maternity services in Scotland. Edinburgh, Scottish Executive.

Scottish Public Health Observatory (2007). "Overview of key data sources: Maternity record." Retrieved 20 November 2007, from http://www.scotpho.org.uk/home/resources/OverviewofKeyDataSources/Nationaldataschemes/SMR02.asp.

Sebire, N. J., M. Jolly, et al. (2001). "Maternal obesity and pregnancy outcome : a study of 287213 pregnancies in London." International Journal of Obesity **25**(8): 1175-82.

Serjeant, G. R., L. Look Loy, et al. (2004). "Outcome of Pregnancy in Homozygous Sickle Cell Disease." Obstetrics & Gynaecology **103**(6): 1278-1285.

Shaw, R. and C. Kitzinger (2005). "Calls to a home birth helpline: Empowerment in childbirth." Social Science & Medicine **61**: 2374-83.

Shearer, J. M. L. (1985). "Five year prospective study of risk of booking for a home birth in Essex." British Medical Journal **291**: 1478-80.

Sheiner, E., A. Levy, et al. (2004). "Maternal obesity as an independent risk factor for caesarean delivery." Paediatric and Perinatal Epidemiology **18**(3): 196-201.

Sheldon, T. (2008). "Obstetric care must change if Netherlands is to regain its reputation for safe childbirth." BMJ **336**(7638): 239.

Siassakos, D., R. Fox, et al. (2008). Umbilical Cord Prolapse: Green-Top Guideline No. 50. London, Royal College of Obstetricians and Gynaecologists.

Singh, D. and M. Newburn (2000). Access to Maternity Information and Support. London, National Childbirth Trust.

Singh, J., S. Santosh, et al. (2006). "Effects of a course in neonatal resuscitation - evaluation of an educational intervention on the standard of neonatal resuscitation." Resuscitation **68**: 385-9.

Singh, S. and S. Paterson-Brown (2003). "Malpresentations in labour." Current Obstetrics & Gynaecology **13**: 300-6.

Smith, L. F. P. and C. P. Smith (2005). "UK childbirth delivery options in 2001-2002: alternative to consultant unit booking and delivery." British Journal of General Practice **April**: 292-7.

Soltan, M. H. and T. Khashoggi (1997). "Retained placenta and associated risk factors." Journal of Obstetrics and Gynaecology **17**(3): 245-7.

Springer, N. P. and C. Van Weel (1996). "Home birth: Safe in selected women, and with adequate infrastructure and support (editorial)." BMJ **313**: 1276-7.

Steer, P. J. (2010). Personal communication by email, dated 5 March 2010.

Steer, P. J. (2008a). Personal communication by email, dated 5 December 2008.

Steer, P. J. (2008b). Personal communication by email, dated 28 November 2008.

Steer, P. J. (2008c). "How safe is home birth?" BJOG An International Journal of Obstetrics and Gynaecology **115**(5): i-ii.

Steer, P. J., M. P. Little, et al. (2004). "Maternal blood pressure in pregnancy, birth weight, and perinatal mortality in first births: prospective study." BMJ **329**: 1312-8.

Stephens, L. (2005). "Worrying truth behind home birth figures (editorial)." British Journal of Midwifery **13**(1): 4-5.

Stevenson, D. K., J. Verter, et al. (2000). "Sex differences in outcomes of very low birthweight infants: the newborn male disadvantage." Archives of Disease in Childhood: Fetal and Neonatal Edition **83**: F182-5.

Stones, R. W., C. M. Paterson, et al. (1993). "Risk factors for major obstetric haemorrhage." European Journal of Obstetrics, Gynecology, & Reproductive Biology **48**(1): 15-8

Symon, A., C. Winter, et al. (2009). "Outcomes for births booked under an independent midwife and births in NHS maternity units: matched comparison study." BMJ **338**: b2060.

Tew, M. (1998). Safer Childbirth? A Critical History of Maternity Care (3rd ed). London, Free Association Books.

Tew, M. (1986). "Do obstetric intranatal interventions make birth safer?" British Journal of Obstetrics and Gynaecology **93**: 659-74.

Tew, M. (1977). "Where to be Born?" New Society **39**: 120-1.

Tongsong, T. and J. Srisomboon (1993). "Amniotic fluid volume as a predictor of fetal distress in postterm pregnancy." International Journal of Gynaecology and Obstetrics **40**(3): 213-7.

Treffers, P. E. and R. Laan (1986). "Regional perinatal mortality and regional hospitalisation at delivery in the Netherlands." British Journal of Obstetrics and Gynaecology **93**: 690-3.

Tromans, N., E. Natamba, et al. (2008). "Have national trends in fertility between 1986 and 2006 occurred evenly across England and Wales?" Population Trends **133**: 7-19.

Turnbull, D., A. Holmes, et al. (1996). "Randomised, controlled trial of efficacy of midwife-managed care." The Lancet **348**: 213-8.

University College London Hospitals NHS Foundation Trust (2009). "High Risk Obstetrics." Retrieved 15 December 2010, from http://www.instituteforwomenshealth.ucl.ac.uk/clinical_units/maternity/highrisk.

Van Lerberghe, W. and V. De Brouwere (2001). Of Blind Alleys and Things that Have Worked: History's Lessons on Reducing Maternal Mortality. Safe Motherhood Strategies: a Review of the Evidence (Supplement to volume 17 of Studies in Health Services Organisation & Policy). V. De Brouwere and W. Van Lerberghe. Antwerp, ITG Press.

Vedam, S. (2003). "Home Birth versus Hospital Birth: Questioning the Quality of the Evidence on Safety." Birth **30**(1): 57-63.

Wagner, M. (2007). Birth and Power. Birth and Power: A Savage Enquiry Revisited. W. Savage. London, Middlesex University Press**:** 35-44.

Walsh, D. (2000). "Evidence-based care series 1: Birth environment." British Journal of Midwifery **8**(5): 276-8.

Ward, S. (2009). "The promotion of home birth as a holy grail of quality belittles the professionalism of highly trained staff (letter)." Retrieved 29 April 2009, from http://www.timesonline.co.uk/tol/comment/letters/article6142979.ece.

Waterstone, M., S. Bewley, et al. (2001). "Incidence and predictors of severe obstetric morbidity: case-control study." BMJ **322**: 1089-93.

Wax, J. R., F. L. Lucas, et al. (2010a). "Maternal and newborn outcomes in planned home birth vs planned hospital births: a metaanalysis." American Journal of Obstetrics & Gynecology **203**:243.e1-243.e8.

Wax, J. R., M. G. Pinette, et al. (2010b). "Maternal and newborn morbidity by birth facility among selected United States 2006 low-risk births." American Journal of Obstetrics & Gynecology **202**: 152-6.

Weiner, Z., G. Farmakides, et al. (1994). "Computerized analysis of fetal heart rate variation in postterm pregnancy: prediction of intrapartum fetal distress and fetal acidosis." American Journal of Obstetrics & Gynecology **171**(4): 1132-8.

Welsh Assembly (2002). Realising the potential: A strategic framework for nursing, midwifery and health visiting in Wales into the 21st century. Briefing paper 4: Delivering the future in Wales: A framework for realising the potential of midwives in Wales. Cardiff, Welsh Assembly Government.

Welsh Assembly (2005). National Service Framework for Children, Young People and Maternity Services in Wales. Cardiff, Welsh Assembly Government.

Wickham, S. (1999). "Home birth: What are the issues?" Midwifery Today (50): 16-8.

Woodcock, H. C., A. W. Read, et al. (1994). "A matched cohort study of planned home and hospital births in Western Australia 1981-1987." Midwifery **10**(3): 125-35.

World Health Organisation (1992). International statistical classification of diseases and related health problems: 10th revision. Geneva, World Health Organisation.

Young, G. L. (1994). Place of Birth. The Future of the Maternity Services. G. Chamberlain and N. Patel. London, RCOG Press**:** 53-60.

Zamzami, T. Y. Y. (2006). "Prelabor rupture of membranes at term in low-risk women: induce or wait?." Archives of Gynaecology & Obstetrics **273**(5): 278-82.