Which women are at an increased risk of operative birth in the UK?

Volume 1 of 2

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Abstract

Introduction

In the UK, as in many other developed countries there has been a dramatic rise in the caesarean section rate, with no associated decrease in the number of instrumental births. Women who experience an operative birth are at an increased risk of adverse health outcomes, and poorer psychosocial wellbeing. Furthermore, operative births represent a substantial cost to the NHS.

Little is known about the maternal and fetal factors related to different modes of birth. This thesis explores these risk factors in a large contemporary population-based UK data source.

Aims

To explore the maternal and fetal risk factors for operative birth (including instrumental vaginal, emergency caesarean section and planned caesarean section) in a large UK sample.

Methods

The sample comprised 18,239 natural mother-infant pairs in the first wave of the Millennium Cohort Study, 2000-2002. Multivariable regression models were used to establish the independent socio-demographic, socio-economic, interpersonal, pregnancy and fetal predictors of mode of birth, stratified by parity where possible.

Findings

Women who were older, of some minority ethnic groups, non-UK born and of lower socio-economic status were generally at a higher risk of operative birth. Women of shorter stature, who experienced complications in pregnancy and who were obese pre-pregnancy were also at greater risk in most cases. Complications during labour, particularly malpresentation and fetal distress greatly increased the likelihood of operative birth. Finally, women who had infants with a gestational age or birth weight outside the normal range were at a higher risk of an unplanned operative birth, as were multiparous women with a male infant.

Discussion

Many characteristics of women and their infants independently predict the mode of birth they experience. Further research is needed to establish to what extent differences in mode of birth are a reflection of women's behaviours or health professional practice, and are therefore potentially modifiable.

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Author's Declaration

I confirm that the work submitted is my own and that appropriate acknowledgement has been given where reference is made to the work of others.

Introduction

The high rate of operative births in the UK has sparked great interest and debate, and there is a need to understand the determinants of operative birth in order to reverse the increasing trend. Very little is known about the maternal and fetal risk factors for mode of birth. This thesis explores which women are at highest risk of having an operative birth in the UK. In particular socio-demographic, socio-economic, interpersonal, pregnancy, health, labour and fetal risk factors are explored in relation to instrumental births, and both emergency and planned caesarean sections.

The overall aim of the study was to discover:

Which women are at an increased risk of operative birth in the UK?

The material of this thesis is organised into 11 chapters and 3 main sections:

Chapter 1 introduces the context of mode of birth in the UK, and discusses some of the consequences of operative birth.

In **Section A** the maternal and infant characteristics related to operative birth are examined. *Chapter 2* is an overview of the literature on the maternal and fetal risk factors for operative births. *Chapter 3* introduces the Millennium Cohort Study, the setting for all analyses for this study, and describes the methods for the thesis, including the variables chosen and the main analytical methods. *Chapters 4 through 7* present results. *Chapter 4* outlines the unadjusted relationship between each independent variable of interest, and mode of birth. *Chapters 5 through 7* have specific foci; maternal age and socio-economic status (5), ethnicity (6), and fetal sex (7).

In **Section B** the maternity service factors which relate to mode of birth are explored. *Chapter 8* reviews the literature of the impact of maternity services on mode of birth, including antenatal care, the birth environment, and the interventions which can be administered during labour. *Chapter 9* focuses specifically on antenatal care (and classes).

Section C describes the interplay of maternal, fetal and maternity service factors. *Chapter 10* is a synthesis of the preceding chapters, providing fully adjusted models including all factors found to be significant in previous analyses. *Chapter 11* is the final discussion chapter, including a brief comparison of findings with previous key UK studies, a critique of the methods used, and the implications of the study findings.

Tables labelled with ‘A’ are included in Volume 2 (e.g. Table A2.2).

CHAPTER 1: Background and focus of the thesis

1.1 Introduction

This chapter provides a context for childbirth in the UK. It describes how childbirth practices have changed over time, as well as the rise in operative births. The chapter then explores some of the reasons why operative birth rates are high in the UK and concludes the background with a discussion of the consequences of operative birth for women and their infants. Finally, a brief summary of the focus of the thesis is presented.

1.2 Changing childbirth practices

In Britain, the family home was the traditional place of birth for women until the early 20th century, but by the 1980s, a transition had been made to the hospital and only around 1% of births occurred in the home (Tew, 1990). Tew describes in detail the transition period, including the growth of obstetrician-managed care and how it changed midwifery practice, how mothers lost confidence in their reproductive abilities and how practice came to increasingly rely on the use of interventions in birth (Tew, 1990). This process has been commonly referred to as the medicalisation of childbirth (Cherniak and Fisher, 2008, Johanson et al., 2002, Wagner, 2001). Medicalisation has been described as the "process by which non-medical problems become defined and treated as medical problems, usually as illness or disorders" (Conrad et al., 2010 p. 1943). The medicalisation of normal pregnancy and birth is a key example, and incurs enormous health care costs (Conrad et al., 2010).

1.2.1 Operative births

Although many interventions have been introduced to labour and childbirth (see Chapter 8 for further discussion), the most significant interventions, in terms of impact, are those which are used for the actual birth. In the UK women give birth by several methods which will be referred to throughout the thesis as the *mode of birth*:

a) **Caesarean section:** the baby is delivered surgically through an incision in the abdominal and uterine wall.
b) **Instrumental vaginal birth:** can only occur in the second stage of labour when the babies scalp is visible, or when the head is not visible but is engaged. Two types of instrument are used;
    a. Forceps (surgical instrument with two blades) which can be used to deliver the baby's head, and
    b. Ventouse or vacuum extraction where a silicone cap is attached to the baby's head via suction.
c) An **unassisted vaginal birth:** (a birth without operative assistance).

The term '*operative birth*' will be used in this thesis to refer to any birth which is not an unassisted vaginal birth.

Caesarean sections and forceps have been documented for hundreds of years. Caesarean sections began as a procedure carried out to save the life of a baby, when the mother had died in childbirth. The use of forceps meant that for the first time, a technique to deliver a stuck baby could save the life of both mother and infant (Gawande, 2006). To this day operative births play a key role in saving lives when there are complications during pregnancy and labour (Johanson et al., 2002).

1.2.2 Classification of caesarean sections

In the UK caesarean sections have traditionally been divided into either planned (elective) or emergency. According to the most recent guidelines from the National Institute for Health and Clinical Excellence (NICE), a planned (or elective) caesarean section is; *a CS that is scheduled before the onset of labour for a specific clinical indication* (National Institute for Health and Clinical Excellence, 2004b p.xiv). However, by that definition all other caesarean sections are referred to as emergency, regardless of the urgency of the procedure.

In 2000 a new classification system was proposed with 4 grades of urgency (Lucas et al., 2000). The Lucas classification has been widely accepted, and a recent guideline published by the UK Royal College of Obstetricians and Gynaecologists (RCOG) has recommended universal use of the grades (RCOG, 2010): The new guidelines have also proposed a colour scale from red to green to indicate the 'continuum of risk':

1. Immediate threat to the life of a woman or fetus.
2. Maternal or fetal compromise not immediately life threatening.
3. No maternal or fetal compromise but needs early delivery.
4. Delivery timed to suit woman and staff.

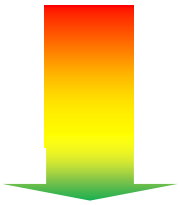
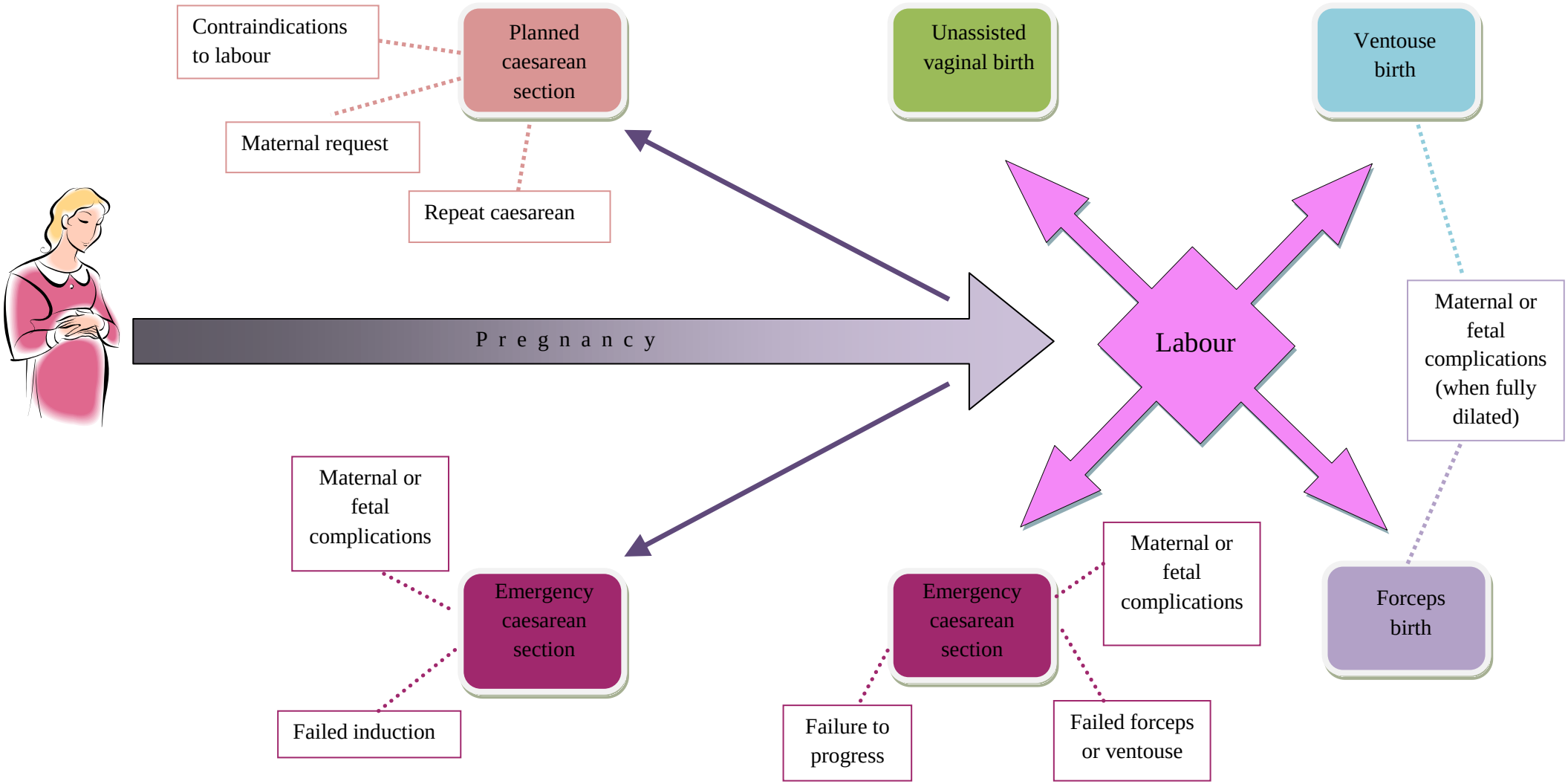


Figure 1.1 illustrates the modes of birth that women may experience, from my own interpretation of the causal network. According to the National Sentinel Caesarean Section Audit report (NSCSA), the most frequently cited indications for caesarean section (in order of frequency) were; presumed fetal compromise, failure to progress (dystocia), repeat caesarean section and breech presentation (Thomas and Paranjothy, 2001).

Figure 1.1: Mode of birth



1.2.3 Increasing rates of operative births in the UK

Caesarean sections in the UK have been increasing year on year. Figures 1.2 and 1.3 show data from the English Hospital Episode Statistics (HES) on mode of birth from 1980-2009 (The Information Centre, 2009b). Although there are some quality and coverage issues with the data, the graphs give a good sense of the changes in mode of birth over time in NHS hospitals. The total caesarean section rate was 9% in 1980. However by 2008-09 almost 1 in 4 women (24.6%) experienced a caesarean section.

The total instrumental vaginal birth rate has remained fairly constant over time, fluctuating between around 9-12% of the total births. However, the use of vacuum extraction increased over the period, whereas the use of forceps decreased, and in 2008-09 each represented around half of the total instrumental rate, although the rate of vacuum extraction was slightly higher (6.6% vs. 5.5%). The reasons for the fluctuations in instrument use over time are numerous, and each procedure is recognised to have different advantages and disadvantages (Patel and Murphy, 2004, RCOG, 2005).

Figure 1.2: Caesarean section rates in NHS hospitals in *England* 1980 to 2008-09 adapted from Hospital Episode Statistic data

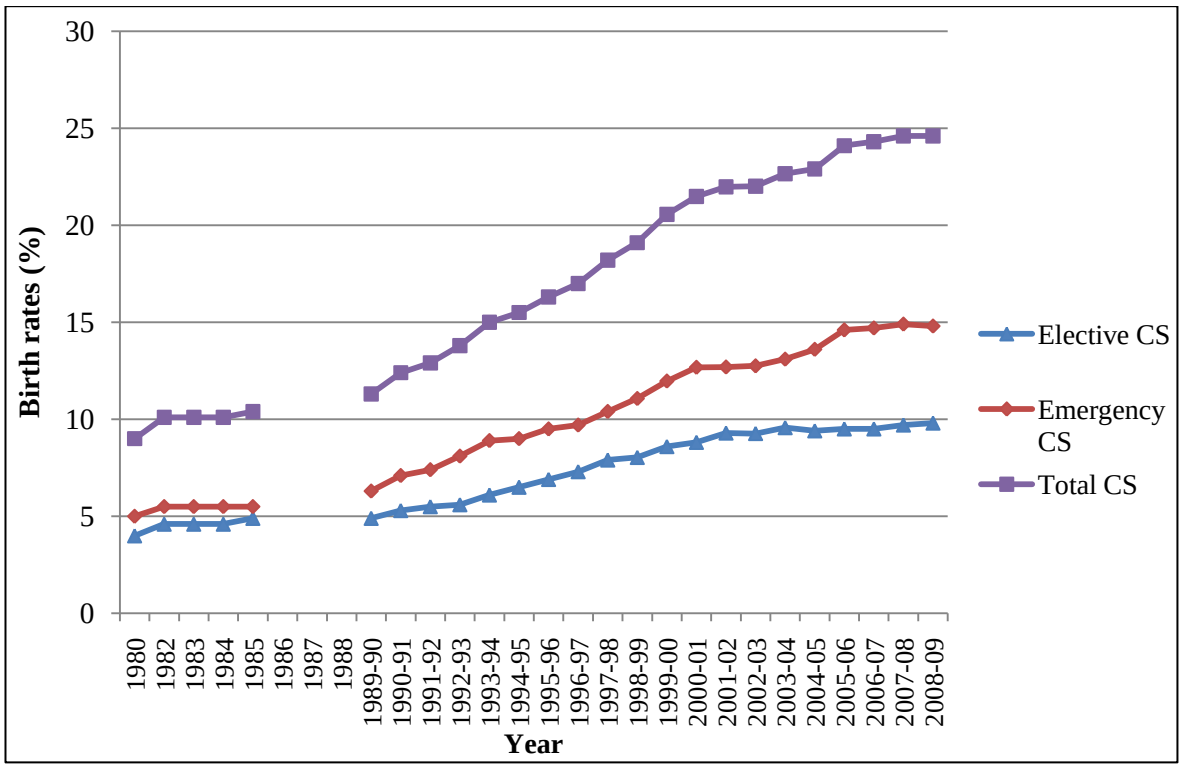
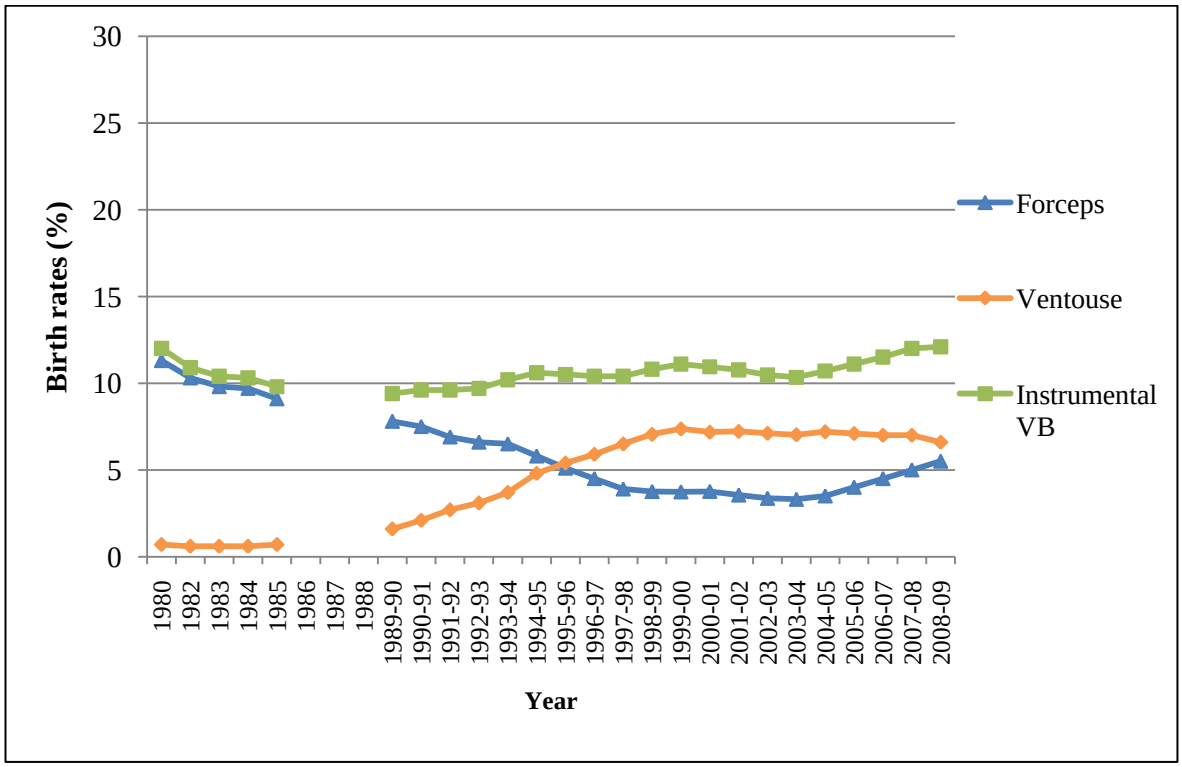


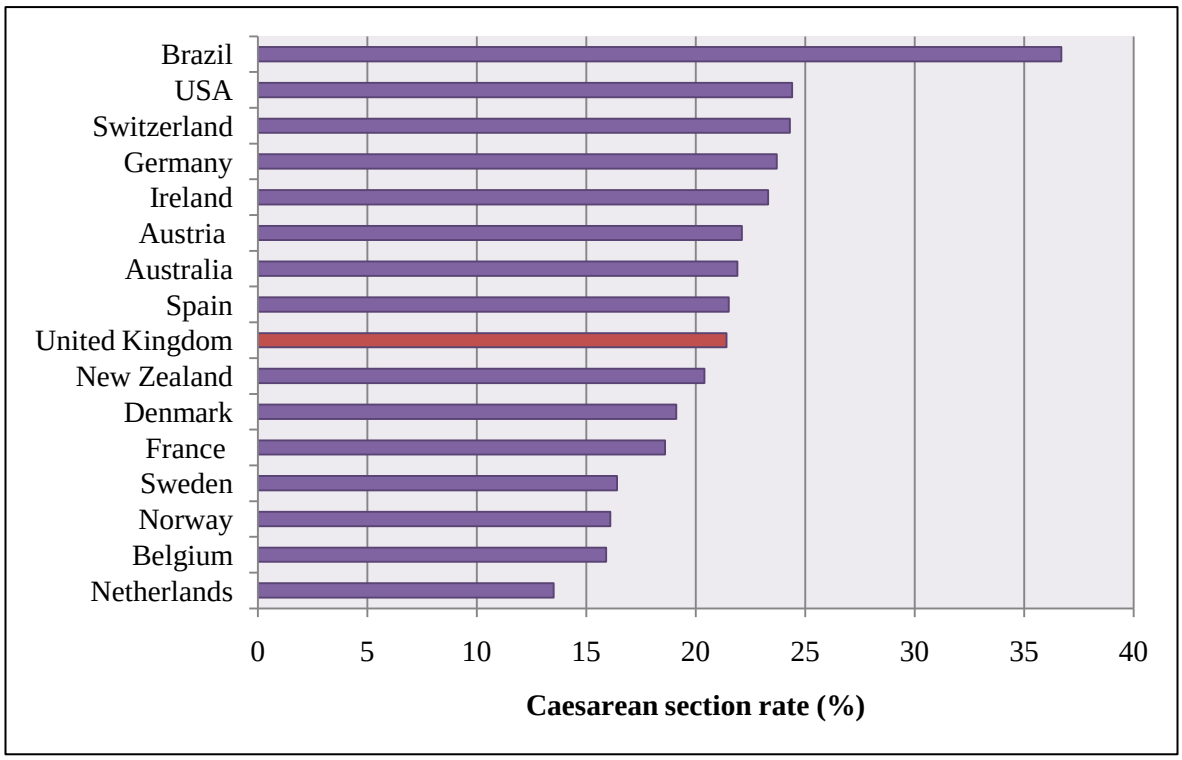
Figure 1.3: Instrumental birth rates in NHS hospitals in *England* 1980 to 2008-09 adapted from Hospital Episode Statistic data



1.2.4 Rates of caesarean section by country

Rates of caesarean section have been shown to vary hugely between countries (Notzon, 2008); however, not all countries have reliable data on national caesarean section rates, meaning that only a small group of countries are frequently discussed with regard to comparative caesarean section rates. Betràn and colleagues conducted a comparative study of global rates of caesarean section, comparing over 120 countries (Betran et al., 2007). Caesarean section rates were obtained from national health surveys, published vital statistics, searching electronic databases or government websites, or through contacting health authorities directly. In addition to variation in the methods needed to obtain national caesarean section rates, countries also varied in the way the rates were reported (as a proportion of all births, or of all live births) and in the timing of the most recent data. Data were collated by the authors in 2005, and the most reliable and recent data ranged from 1993-2003 between countries. Data used for the United Kingdom in this study came from the National Sentinel Caesarean Section Audit (NSCSA) from 2001, which gave an overall caesarean section rate of 21.4%. Figure 1.4 is adapted from the study by Betran and colleagues and shows how the UK rate compared to other developed countries.

Figure 1.4: Caesarean section rates for selected countries adapted from Betran et al (2007)



The Netherlands had the lowest caesarean section rate by far, at 13.5%; out of all the developed countries it was the only country to have a rate within the range of 10-15% recommended by the World Health Organization[1] (WHO, 2009). Scandinavian countries also had lower caesarean section rates compared to the UK, with Denmark, Sweden and Norway all with rates below 20%. Brazil and America had the highest rates overall, with almost a quarter of women having a caesarean section in America in 2001, and more than 36% of women in Brazil in 1996.

1.2.5 Why are caesarean section rates in the UK so high?

My thesis will explore the maternal and infant characteristics that contribute to operative birth rates; in addition I will explore some of the maternity service risk factors. However, there has also been much discussion and debate regarding other reasons for high caesarean section rates and these will be discussed here.

[1] As there was no empirical evidence for the original range, this recommendation has recently been updated pending further research, although the handbook states that users "might want to continue to use a range of 5–15% or set their own standards" (WHO, 2009 p.25).

1.2.5.1 Litigation

Fear of litigation or defensive practice has been suggested as a reason for the rising caesarean section rates, particularly for caesarean sections for fetal distress (O'Brien, 2005). Pay-outs in the UK for neurological handicap now exceed £3 million per annum (Robson, 2001), and failure or delay in intervening is the cause of 99% of obstetric litigation cases (Johanson et al., 2002). A 2009 survey of 5,644 American obstetricians found that 63% reported making changes to their practice due to fear of litigation, including increasing the number of caesarean sections they performed and stopping offering vaginal births after caesarean section (VBAC) (ACOG, 2009).

1.2.5.2 Repeat caesareans

Repeat caesarean sections made the greatest contribution to the overall caesarean section rate in the NSCSA (Thomas and Paranjothy, 2001). Vaginal births after caesarean section have been decreasing over time in the UK (Black et al., 2005), and in the NSCSA the rate was 33% (Thomas and Paranjothy, 2001).

1.2.5.3 Maternal request

There has been speculation around the role of maternal preference in the increase in caesarean sections. The report by the Department of Health, *Changing Childbirth*, suggested that care should be women-centred (Department of Health, 1993). However, a recent UK mixed-method study found that although women support the idea of choice, many would be uncomfortable making decisions about their care (Kingdon et al., 2009). Caesarean sections for maternal request remain low according to good quality studies, and the majority of women who do request caesareans do so for clinical or psychological reasons (McCourt et al., 2007, Weaver et al., 2007). In the NSCSA maternal request caesarean sections contributed 7% to the overall caesarean section rate, but these included all maternal requests, not just those for no clinical indication (Thomas and Paranjothy, 2001).

1.2.5.4 The medicalisation of childbirth

As discussed at the outset of this chapter, childbirth has become an increasingly medicalised process. Obstetrician involvement and medical interventions are now a routine part of normal childbirth (Johanson et al., 2002). Chapter 8 will explore the literature on interventions that are now commonly used during labour.

Increasing medicalisation has influenced women's views and experiences of childbirth. Health professionals also have less trust in women's ability to labour (Cherniak and Fisher, 2008), and women themselves may have lost confidence (Tew, 1990). Davis-Floyd has discussed in detail the technocratic model of childbirth, in which the body is viewed as a machine, separate from the mind, where birth is mechanical, and technology is more trustworthy than nature (Davis-Floyd, 2001, Davis-Floyd, 1994).

There is evidence that in the UK, women have become more willing to accept obstetric interventions (Green and Baston, 2007). In the views of professionals, women "go along with" interventions as they are fearful of the outcome if they do not, they trust their caregiver, they expect to be able to control their pain (and feel that intervention may be inevitable to this end) and they believe that technology is superior to nature (Kitzinger et al., 2006).

As one in four women in the UK have a caesarean section, the procedure is becoming more 'normal'. In fact, the term "natural caesarean" has been used to describe efforts to increase some of the more natural elements of vaginal birth for women who have a caesarean section, such as watching the birth and skin-to-skin contact (Smith et al., 2008b).

The media may also condition women to the possibility of intervention. A discourse analysis of top-selling childbirth advice books has recently been conducted in the USA (Kennedy et al., 2009). Findings were wide-ranging from those embracing natural childbirth, to those describing natural birth as a frightening experience, and depicting caesarean section as the safe option.

1.3 What is the cost of operative birth?

The next section of this chapter will outline the cost to women and their infants of having an operative birth, in terms of their wellbeing. However, in a publicly-funded health care system such as the NHS, the financial and subsequent opportunity costs of different modes of birth should also be considered. Petrou and Glazener (2002) estimated the costs of unassisted vaginal births, instrumental vaginal births and caesarean sections using a randomly selected sample from a Scottish hospital. Resource costs were calculated based on the cost of hospitalisation, as well as postnatal care costs. The cost was lowest for unassisted vaginal birth at £1,698, followed by instrumental births at £2,262 and the highest cost was for caesarean section at £3,200 per woman. The authors estimated a 1% decrease in the caesarean section rate would have resulted in an almost £9 million annual cost saving.

1.4 What are the consequences of different modes of birth?

In 1979 Archie Cochrane awarded the 'wooden spoon' to obstetrics for having the worst record for using randomised controlled trials to inform practice (Smith et al., 2004). Goer (1995) in her book *Obstetric Myths Versus Research Realities* outlined many examples of routine obstetric procedures which persisted despite a lack of evidence, or in some cases, a substantial volume of literature documenting increased risks. There has often been a mismatch between evidence and obstetric practice (Goer, 1995, Langer and Villar, 2002). It has been suggested that promoting evidence-based practice could help to reduce operative births (Wagner, 2001), however, researchers have reported having problems getting studies published which do not support established obstetrical procedures (Klein, 2010). In addition, a critique of three key studies which have provided evidence for the use of caesarean section has revealed a lack of assessment of maternal subjectivity, newborn and long-term outcomes (Wendland, 2007).

The increasing familiarity with caesarean sections, and the developments in post-operative care for women who receive them, mean that the safety of the procedure is often taken for granted (Cherniak and Fisher, 2008, Mander, 2007). Although the risks of the operation are the same as for any major surgery, they may be disregarded as the procedure results in a positive outcome - childbirth (Mander, 2007).

There has been heated debate over the safety of caesarean section compared to vaginal birth. A leading UK obstetrician has suggested that the risks of vaginal birth are greater than those from "drink-driving or riding a motorbike without a helmet" (Feinmann, 2002 p.774). Many obstetricians are in favour of caesarean sections due to an alleged reduced risk of urinary and anal incontinence (Cherniak and Fisher, 2008). However, it has not been established whether damage to the pelvic floor results from the mode of birth itself or from pregnancy (Bewley and Cockburn, 2002, Cherniak and Fisher, 2008). Similarly in observational studies, mortality and morbidity from caesarean section is difficult to estimate, as complications often lead to the need for caesarean section (Goer, 1995).

The difficulties with establishing the risks of operative birth fuel debates around their use. Unlike many other areas of health research, a randomised controlled trial, considered the gold standard in research, is rarely deemed ethical due to the issues of randomising women to undergo one mode of birth or another. A Cochrane review most recently updated in 2009 identified no trials assessing the risks and benefits of caesarean sections for non-medical reasons (Lavender et al., 2006). A recent qualitative study found that women were strongly opposed to a hypothetical trial of planned vaginal birth versus planned caesarean section, and only 3 of the 64 women interviewed would have considered participating (Lavender and Kingdon, 2009).

1.4.1 Outcomes following caesarean section

The National Institute for Health and Clinical Excellence reviewed the available evidence on the risk of caesarean section compared to vaginal birth in the 2004 guideline for caesarean section (National Institute for Health and Clinical Excellence, 2004b). Table 1.1 summarises the results of the review. It should be noted that due to the difficulties with conducting randomised trials as noted above, the conclusions for over two-thirds of the outcomes came from well designed observational studies.

From the available evidence in the 2004 review, women who have a caesarean section are at higher risk of short-term morbidities and death. They are also at a higher risk of problems in later pregnancies, and their infants had a higher risk of respiratory morbidities.

Table 1.1: Review of outcomes for caesarean section compared to vaginal birth from the 2004 NICE guidelines

Increased with caesarean section	**No difference**	**Decreased with caesarean section**
Short-term effects Abdominal pain Bladder injury Uteretic injury Need for further surgery Hysterectomy Admission to intensive care Thromboembolic disease Longer hospital stay Readmission to hospital Maternal death	***Short-term effects*** Haemorrhage Infection Genital tract injury	***Short-term effects*** Perineal pain
Long-term effects	***Long-term effects*** Faecal incontinence Back pain Post-natal depression Dyspareunia	***Long-term effects*** Urinary incontinence (3 months) Utero-vaginal prolapse
Implications for future pregnancies Placenta praevia Uterine rupture Antepartum stillbirth Having no more children	***Implications for future pregnancies***	***Implications for future pregnancies***
Infant Respiratory morbidity	***Infant*** Mortality (excluding breech) Intracranial haemorrhage Brachial plexus injuries Cerebral palsy	***Infant***

What is not considered in the NICE review is the psychological impact of caesarean section on women. There is evidence that women who experience a caesarean section are at increased risk of: being less satisfied with their birth experience (Baston, 2006, Borders, 2006, Lobel and DeLuca, 2007), feeling a loss (Clement, 2001), experiencing symptoms of post-traumatic stress disorder (PTSD) (Olde et al., 2006), having less infant contact after birth (Chalmers et al., 2010), early breast feeding cessation (Chalmers et al., 2010, Smith, 2007) and exhibiting poorer parenting behaviours (Lobel and DeLuca, 2007, Mutryn, 1993), than women who have a vaginal birth.

1.4.2 Outcomes following instrumental vaginal birth

Although there has been less research on the effects of instrumental births on the health and wellbeing of women, the literature suggests that women who have an instrumental birth fare worse than women who have an unassisted vaginal birth. The main health issue reported is that of morbidity from pelvic floor injury (Borders, 2006, RCOG, 2005), which can lead to problems with sexual function (Abdool et al., 2009, Borders, 2006). In addition, as with caesarean section, instrumental births have been linked to negative psychosocial outcomes including; low satisfaction with the birth experience (Baston, 2006, Borders, 2006), PTSD (Olde et al., 2006), and early cessation of breast feeding (Smith, 2007).

As discussed previously, establishing the consequences of operative birth is complicated. The reasons for associations are likely to be multifactorial. For example, if we take the example of lower rates of breast feeding for mothers who have had an operative birth, several factors could explain the association, e.g.:

- The physical and psychological effect of operative birth on the mother could impact on her ability to breast feed.
- The baby may have experienced physical trauma and stress, or have a pre-existing medical condition.
- Babies may be more likely to be taken to a neonatal unit and separated from mother initially.
- The decreased bonding and skin-to-skin contact could impede breast feeding.

Another possible explanatory factor for the relationship between operative birth and breast feeding relates to the socio-demographic characteristics of women who are less likely to breast feed. Women's age, ethnic background, marital status and socio-economic position have been found to predict their breast feeding behaviour (Thulier and Mercer, 2009), and if these factors are also related to mode of birth this might explain the connection. In addition to generating better understanding of the risk factors for operative birth, a secondary aim of this thesis is to generate

knowledge of the potential confounding factors that should be considered when exploring the consequences of mode of birth.

1.5 Summary

In the UK, as in many other developed countries, childbirth has become a predominantly medicalised process. Part of the medicalisation has been the dramatic rise in the caesarean section rate, with no associated decrease in the number of instrumental births. Women who experience an operative birth are at an increased risk of adverse health outcomes, and poorer psychosocial wellbeing. Furthermore, operative births represent a substantial cost to the NHS.

1.6 The focus of the thesis

Little is known about the maternal and fetal risk factors for mode of birth, particularly in the UK. Two UK-based studies have previously examined these risk factors in relation to caesarean section in large samples using multivariate techniques. The first utilised data from over 12,000 women who had taken part in the Avon Longitudinal Study of Parents and Children (ALSPAC), conducted in Avon, England the early 1990s (Golding et al., 2001, Patel et al., 2005). The second was based upon the results of the National Sentinel Caesarean Section Audit Report (NSCSA) conducted in a three-month period in 2000 and 2001 in all NHS maternity units, covering 99% of the births in the period (Paranjothy et al., 2005, Thomas and Paranjothy, 2001).

Since these studies were conducted, data from a large, contemporary population-based study have become available. The first wave of the Millennium Cohort study (MCS) contained information on over 18,000 families sampled from almost 400 electoral wards. The sampling design over-sampled for wards with high numbers of ethnic minority families and areas with high levels of child poverty (see Chapter 3 for further details on sampling methodology).

An overall research question was formulated based on the opportunity to use the MCS data:

> *What can we learn about the risk factors for operative birth from a large, contemporary population-based sample, with over-sampling of disadvantaged and ethnic minority areas?*

Compared to the previous two large studies, the MCS had several strengths which could help to further understanding of the risk factors for mode of birth:

1. An opportunity to distinguish not only between emergency and planned caesarean sections, but also to examine the risk factors for instrumental vaginal births.

2. A chance to examine in detail both ethnicity and socio-economic factors in relation to mode of birth.
3. The possibility to explore the independent effect and interplay of a wealth of factors on mode of birth. In addition to allowing comparison by examining many factors previously included in the NSCSA and ALSPAC studies, the MCS also included numerous factors not explored in the two studies including: paternal age, language, migration status, educational level, height, BMI, interpersonal factors and fetal sex.

The following chapter is the first of Section A and reviews the available literature on the maternal and fetal risk factors for mode of birth.

Section A:

The maternal and fetal characteristics related to operative birth

CHAPTER 2: Literature review: Maternal and fetal characteristics associated with mode of birth

2.1 Introduction

Having decided upon conducting an investigation of the predictors of mode of birth in the Millennium Cohort Study, this chapter describes the literature on the maternal and fetal characteristics that have been associated with mode of birth. This chapter forms part of a wider literature review of the risk factors for operative birth; Chapter 8 is a review of maternity care characteristics.

Literature concerning characteristics of the mother, including demographic, socio-economic, health and medical factors and psychosocial factors, as well as characteristics of the infant at birth, were searched in Medline and the Cochrane databases using key word searches (see Appendix 1 for an example Medline search). Reference lists of the identified papers were also examined for other relevant literature.

Literature was considered for the review if it included mode of birth as an outcome (primary or other), and made comparisons between mothers who had an unassisted vaginal birth and mothers who had an operative birth.

Initial searches revealed a scarcity of literature regarding the demographics of mothers and their infants in relation to mode of birth. Consequently, rather than restricting the search to UK-based studies, studies from other developed countries were included for the majority of the review. Exceptions to this were sub-sections on socio-economic status, ethnicity and migration, which were restricted to UK studies to allow interpretation in a UK context. Developing countries were excluded for the most part due to the vast difference in the health outcomes and health systems between developed and developing countries. Brazil was the only exception. Although Brazil is an emerging economy, it has a high incidence of technological intervention in childbirth, and has the highest rate of caesarean sections in the world. Subsequently, much research has been conducted there in an attempt to understand the high rates.

Details extracted from each of the studies described in this review (including country of origin, study period, sample size, covariates controlled for and effect sizes) are included in supplementary tables A2.2 through A2.30.

2.2 Characteristics of the mother

2.2.1 Parity and maternal age

2.2.1.1 Parity

The point in life when a woman gives birth has significant physiological and psychological implications. Specifically, whether the baby is a woman's first (parity) and her age at birth are important. Parity refers to the number of babies of viable gestation a woman has given birth to in her life. Primiparous mothers are those who have given birth to one viable baby, and multiparous mothers have given birth to more than one viable baby (Tiran, 2008).

Few studies directly assessed, or adjusted for parity, in relation to mode of birth. However, this does not mean that parity is not assumed to be important. On the contrary, many researchers excluded multiparous women, or more rarely, primiparous women, to control the impact of parity on their results. One American study directly assessed the association between increasing parity and the type of birth a mother had (Simonsen et al., 2005). Eight studies included both primiparous and multiparous mothers, and subsequently adjusted for the effect of parity on mode of birth. Of these, three were English (Alves and Sheikh, 2005, Johnson and Slade, 2002, Patel et al., 2005), one American (Gareen et al., 2003), one Australian (Roberts et al., 2002), two Brazilian (Behague et al., 2002, Gomes et al., 1999) and one Canadian (Joseph et al., 2006) (see Table A2.2).

The majority of studies (7/9) showed that primiparous mothers were much more likely to have an operative birth than multiparous mothers. Of those, most compared primiparous to any multiparous mothers (Alves and Sheikh, 2005, Behague et al., 2002, Gareen et al., 2003, Johnson and Slade, 2002, Roberts et al., 2002), and two compared mothers with specific numbers of previous births (Joseph et al., 2006, Simonsen et al., 2005). Joseph and colleagues compared mothers who had had one previous birth, to mothers who had had none, 2 and 3. Mothers who had never had a previous birth were more likely to have a caesarean section or induction of labour, but mothers who had 2 or 3 previous births did not have significantly different rates of caesarean section or induction (Joseph et al., 2006). Simonsen and colleagues set out to directly assess the relationship between parity and labour and birth complications. They compared mothers who had had one previous birth to those who had had none, 2-4, 5-9 and 10 or more. Primiparous mothers had an increased risk of both primary and later repeat caesarean sections and instrumental births, whereas all other groups were less likely to have an operative birth (Simonsen et al., 2005).

The majority of studies assessed all caesarean sections, with only two distinguishing between elective and emergency caesarean sections (Patel et al., 2005, Roberts et al., 2002), or assessing

only elective (Alves and Sheikh, 2005), or emergency (Johnson and Slade, 2002) caesarean rates. Of the studies that assessed either overall or emergency caesarean sections, most (7/8) found that caesarean section rates were highest for primiparous mothers, or mothers of lower parity. The two studies which assessed either overall instrumental births, or forceps births, also found that primiparous mothers were at highest risk (Roberts et al., 2002, Simonsen et al., 2005). Conversely, the three studies which assessed elective caesarean sections found that multiparous mothers were at highest risk of elective caesarean section (Alves and Sheikh, 2005, Roberts et al., 2002), or that parity was unrelated (Patel et al., 2005).

Literature directly discussing the relationship between parity and mode of birth is sparse, possibly as the relationship is well known and therefore commonly accepted. Even the one study identified by Simonsen and colleagues directly assessing the impact of parity on operative birth rates did not discuss why increasing parity decreases intrapartum complications (Simonsen et al., 2005).

The relationship between parity and mode of birth is associated with the type of birth or births the mother has previously had (i.e. previous vaginal birth or a previous caesarean section). Mothers who have had a previous vaginal birth are more likely to have a subsequent vaginal birth. This makes sense on a physical level as the body has successfully undergone the childbirth process previously. A paper published in 1968 on the epidemiology of human pregnancy discusses the higher risk of perinatal mortality partly attributable to the "complications of labour and delivery occurring in an untried uterus and pelvis" (Barron, 1968 p. 1202). Equally a multiparous woman who has experienced a previous vaginal birth would likely be more prepared psychologically for the experience. Mothers who have had a previous caesarean section are at increased risk of having another caesarean, either due to increased biological risk, or due to the policies within the hospital environment (see further discussion in section 2.2.6). This may explain why, in the studies which have separated elective from emergency caesarean sections, elective caesarean sections were more likely for the multiparous mothers.

Another study which did show an increased risk of overall caesarean section with greater parity was Brazilian (Gomes et al., 1999). Brazil has the highest rate of caesarean sections in the world; therefore it is possible that in that particular study population, multiparous mothers may be more likely to have had a previous caesarean section than would be the case in some other countries with lower caesarean rates. Also, unlike all the other studies which either compared primiparous to multiparous mothers, or used a comparison group of mothers who had had one previous child (Joseph et al., 2006, Simonsen et al., 2005), the Brazilian study categorised mothers who had had 4 or more previous births as the reference group.

2.2.1.2 Maternal age

Multiparous women are likely to be older on average than women having their first child. However, an increasing number of women are delaying childbirth and giving birth in their 30s and 40s. In fact, the mean age of a mother at first birth in England and Wales in 2008, was 27.5 years (ONS, 2009). The decision to have children later in life may be for reasons relating to; careers, education, infertility and control over fertility, marriage and finance (Kirz et al., 1985). Interest around advancing maternal age has been increasing and many studies have assessed the impact of age on maternal and fetal health outcomes, as well as mode of birth.

Twenty-one studies examined age as a predictor of mode of birth (Table A2.3). The countries of origin were as follows; three English (Alves and Sheikh, 2005, Paranjothy et al., 2005, Patel et al., 2005), nine American (Braveman et al., 1995, Cleary-Goldman et al., 2005, Ecker et al., 2001, Gareen et al., 2003, Gould et al., 1989, Kirz et al., 1985, Linton et al., 2004, Main et al., 2000, Zahniser et al., 1992), two Canadian (Joseph et al., 2006, Martel et al., 1987), two Australian (Read et al., 1994, Roberts et al., 2002), one Italian (Cesaroni et al., 2008), one Greek (Lialios et al., 1999), one French (Guihard and Blondel, 2001), one Swedish (Cnattingius et al., 1998), and one Brazilian (Gomes et al., 1999).

All studies, regardless of country of origin, sample used or demographic or medical factors adjusted for, found that rates of caesarean section (including both elective and emergency if distinguished) increased with increasing maternal age. For almost all studies a gradient effect was apparent, with increases in risk of caesarean birth with each increase in age category, although in others an increased risk was observed only for mothers over 30 (Gareen et al., 2003, Guihard and Blondel, 2001, Main et al., 2000). In a well-adjusted American study, when age was adjusted only for medical factors and obstetric history, a gradient effect for overall caesarean section rate was observed for both primiparous and multiparous mothers (Gareen et al., 2003). However, when other social factors were included, age was no longer a significant factor for multiparous mothers, and for primiparous mothers, only those in age categories over 35 remained significantly more likely to have a caesarean section.

Around half of the studies included mothers under the age of twenty. Teenage pregnancy in Britain has been labelled as a major public health problem (Lawlor et al., 2002). However, it has been suggested that detrimental outcomes for teenage mothers occur due to their socio-economic position, rather than due to biological factors relating to their age (Lawlor et al., 2002). In fact, of the studies that included teenage mothers, all found that the youngest mothers had the lowest rates of caesarean section (Braveman et al., 1995, Cnattingius et al., 1998, Gomes et al., 1999, Gould et

al., 1989, Joseph et al., 2006, Linton et al., 2004, Main et al., 2000, Paranjothy et al., 2005, Read et al., 1994, Zahniser et al., 1992).

Only six studies examined rates of instrumental vaginal births by age, either as an overall instrumental birth rate (including vacuum and forceps) (Cleary-Goldman et al., 2005, Main et al., 2000, Read et al., 1994), or by assessing vacuum extraction and forceps births separately (Kirz et al., 1985, Roberts et al., 2002, Zahniser et al., 1992). The relationship between age and instrumental births was not consistent between the studies. However in most, instrumental births were significantly more common with increasing age (Read et al., 1994, Roberts et al., 2002), or for women over the age of 35 (Kirz et al., 1985, Main et al., 2000). The remaining two studies, which were both American, found no significant association between maternal age and either overall instrumental vaginal birth rates (Cleary-Goldman et al., 2005), or vacuum extraction and forceps birth rates (Zahniser et al., 1992), despite large samples and high overall instrumental birth rates.

Maternal physiology has been suggested as a reason for the association between older maternal age and operative birth. Many studies have demonstrated that older mothers are more likely to suffer from health problems and to have problems during pregnancy and birth. Older maternal age has been linked to an increased risk of miscarriage, chromosomal abnormalities, fetal or neonatal congenital abnormalities, gestational diabetes, placenta praevia and macrosomia (Cleary-Goldman et al., 2005). Kirz and colleagues found that mothers aged over 35 were much more likely to have hypertension or diabetes (Kirz et al., 1985). Ecker and colleagues found that in a sample of over 3,000 American mothers, medical indications for elective caesarean section such as prior myectomy (removal of non-cancerous cells from the wall of the uterus) and malpresentation were much more prevalent in older mothers. Older mothers were also more likely to “fail to progress” or to be diagnosed with fetal distress, both of which are indications for caesarean section (Ecker et al., 2001). However, it should be noted that these indications involve clinical judgement and are therefore possibly subject to bias.

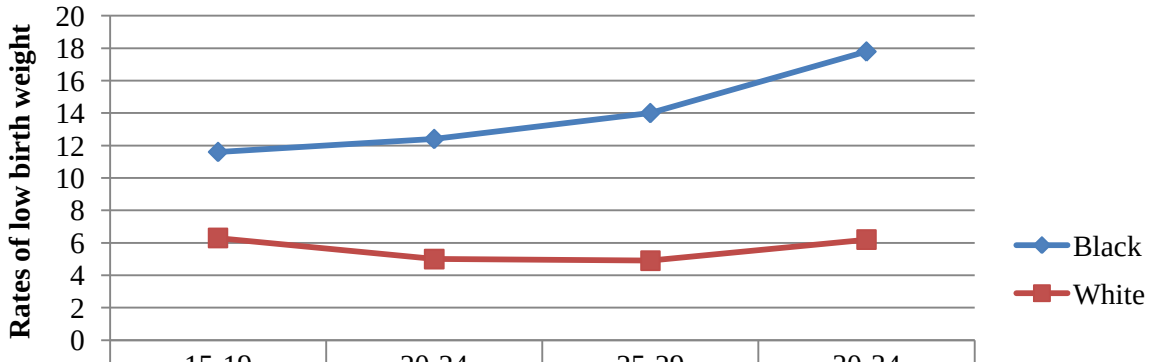
Another suggested biological explanation for why older mothers have more complications during pregnancy and birth is linked to the functionality of the uterus. Many muscles of the body become less effective with age, and the same has been suggested of the myometrium (the uterine muscle). Main and colleagues measured three indicators of myometrial function; duration of the first stage of labour, duration of the second stage of labour and need for oxytocin augmentation. Length of both stages of labour and need for oxytocin increased significantly with increasing age (Main et al., 2000).

Biological factors may not fully explain increasing operative birth rates with increasing age. Gareen and colleagues (2003) adjusted for more confounding factors than any other study to assess the effect of maternal age on caesarean section rates. Adjusting for obstetrical factors, including complications during pregnancy and labour, explained some of the variance in caesarean section rates for mothers in different age brackets. Other demographic factors appeared to be more important however, especially for multiparous mothers, as the age effect disappeared after full adjustment. For primiparous mothers however, even after adjusting for obstetrical and other factors, a residual effect of age on caesarean section rates did remain for mothers over the age of 35 (Gareen et al., 2003). Other studies have found that although caesarean section or instrumental birth rates were higher for older mothers, no one specific indication for caesarean section was more common in the older age group, and pregnancy and labour complications were not significantly more prevalent for older mothers (Kirz et al., 1985, Lialios et al., 1999).

Another possible explanation for the higher rates of operative births for older mothers could be related to the attitudes and consequent behaviours of mothers and their health care professionals. As the likelihood of conception decreases with increasing age, older women, especially those who are primiparous may be more anxious about their "premium pregnancies"(Main et al., 2000). Also, if the pregnancies and births of older mothers are assumed to be high risk, medical staff and mothers themselves may be more anxious and thus more cautious about unassisted vaginal birth. Kirz (1985) suggested there may be a "self-fulfilling prophecy" that the pregnancies of older mothers are assumed to be high risk and are therefore more likely to have intervention (Kirz et al., 1985). In support of this, Ecker (2001) identified an increase in elective inductions for older mothers in their data (Ecker et al., 2001), and Kirz and colleagues found that older mothers were also more likely to have epidural anaesthesia (Kirz et al., 1985).

Although almost all identified studies in this review found that rates of operative birth increased linearly with increasing age, the impact of age on mode of birth may not be equivalent for all groups of women. Arline Geronimus, when examining birth outcomes such as neonatal mortality and birth weight among mothers in the USA, found the effect of maternal age on adverse infant outcomes was dependent on the ethnic background of the mother (Geronimus, 1992, Geronimus, 1996). For example, Figure 2.1 displays the results from a study using birth records in Michigan, USA; rates of low birth weight are shown by age group. For White mothers a U shaped curve is apparent, with increased risk of low birth weight for the youngest and oldest mothers, whereas for Black mothers the effect of maternal age on rates of low birth weight is more linear in nature.

Figure 2.1: Rates of low birth weight by maternal age in Michigan, USA, 1989 (adapted from Geronimus, 1996)



	15-19	20-24	25-29	30-34
Black	11.6	12.4	14.0	17.8
White	6.3	5.0	4.9	6.2

Geronimus called this effect the "weathering hypothesis", suggesting that social and environmental stressors due to social inequalities and racial discrimination, may cause the health of Black women to begin to deteriorate at a younger age (Geronimus, 1992, Geronimus, 1996). Numerous studies have attempted to further investigate the weathering hypothesis, assessing health indicators such as birth weight (Buescher and Mittal, 2006, Rauh et al., 2001), preterm birth, (Ananth et al., 2001, Holzman et al., 2009), infant mortality (Buescher and Mittal, 2006, Wildsmith, 2002), post-reproductive mortality (Spence and Eberstein, 2009) and allostatic load (physiological stress indicators) (Geronimus et al., 2006). All the above studies were conducted within the context of Black women in America compared to White women, with the exception of one study which compared American born and foreign born Mexican women in America (Wildsmith, 2002). The studies provide further evidence for a disproportionate effect of maternal age on health, dependent on ethnic background.

There has been some evidence that the effect of age on mode of birth may be modified by ethnic background. Main and colleagues (2000) examined the effect of age on emergency caesarean sections in a sample of over 8,000 primiparous women in America, and stratified their analyses by ethnicity. The effect of age on the increase in caesarean sections for Asian women was much more pronounced than for White women, which could provide evidence of a weathering effect.

A final interesting study which adds further question to the relationship between advancing age and mode of birth is that of Tang and colleagues. In their large sample of over 300,000 Taiwanese mothers who gave birth between 1999 and 2001, age of the father of the baby was independently and significantly related to mode of birth. Paternal age was stratified into maternal age groups, and

after adjustment for paternal and maternal education, marital status, birth weight, gestation, infant sex and pregnancy and obstetric risk factors, significant increases in caesarean section rates were observed with increasing paternal age, within each maternal age group (Tang et al., 2006).

2.2.2 Socio-economic status

Social gradients in health are apparent for many outcomes, and the social determinants of health are now widely researched (Graham, 2007). People of low socio-economic position are generally at twice the risk of serious health problems or early death, compared to people of high socio-economic status, and there is a gradient of increasing risk with decreasing socio-economic position (Wilkinson and Marmot, 2003). The reasons for these gradients are numerous and include poorer living environment, increased stress, poorer diet and nutrition, a lack of social support, decreased access to healthcare and a higher likelihood of adverse health behaviours such as illicit drug use, higher alcohol consumption and higher rates of smoking among people of low socio-economic status (Graham, 2007, Wilkinson and Marmot, 2003). Specifically, women of lower socio-economic status have been found to have poorer health and health behaviours during pregnancy and at birth. Dowd found that in a sample of over 8,000 American women, those of low education or low income were more likely to be young, obese and of high parity (Dowd, 2007). During pregnancy these mothers were more likely to smoke and drink alcohol and were less likely to take multivitamins.

Caesarean section as an outcome may be a reflection of the health of a mother and her infant, and further literature later in this chapter confirms higher rates for mothers with health issues such as diabetes. However, caesarean sections and instrumental births are performed ultimately based on a decision by health professionals, and although these decisions are most frequently made due to health risks for the mother or her infant, this is not always the case.

Women's socio-economic status in relation to their mode of birth has gained much media attention. In the UK the term "too posh to push" has been used widely to refer to women from higher socio-economic positions having elective caesarean sections to avoid labour. However, these beliefs about more affluent women may be based more on the media portrayal of a few celebrities, rather than on good quality evidence. UK celebrities have been reported to have 'elected' to have a caesarean section. However, in many of these highly publicised cases the 'celebrities' have paid to have the operation privately (Asthana, 2005, Martin, 2001, McConnell, 2007), a rare occurrence in the UK with a publicly-funded healthcare system

The guidelines for caesarean section produced by the National Institute for Health and Clinical Excellence outline that maternal request is not an indication for caesarean section, and that the reasons for the request should be discussed. Furthermore, a clinician has the right to decline a request and the woman could then be referred for a second opinion (National Institute for Health and Clinical Excellence, 2004b).

Elective caesarean sections performed for maternal request are rare in the UK. Although there is a lack of good quality data on the number of maternal request caesareans, in the National Sentinel Caesarean Section Audit Report (NSCSA), caesarean sections for maternal request accounted for 7% of the overall caesarean section rate (Thomas and Paranjothy, 2001). However, this figure is not exclusive to caesarean sections conducted in the absence of maternal or fetal indications, rather it represents the 'most influential' reason reported for the caesarean section, of which there were 20 other reasons to choose from.

In countries with private health care, or private health insurance, the likelihood of an influence of socio-economic status on caesarean section rates is higher. Public and privately-funded women may receive different care, or be treated in different parts of the same hospital (Hurst and Summey, 1984). In Brazil, where caesarean section rates are high, differences by socio-economic status are prominent. Because caesarean sections are more often available only for women who can afford them in Brazil, a qualitative study found that women who could not afford a caesarean section desired one as the 'best quality care' available for childbirth, and would try to put pressure on the medical staff to get one (Behague et al., 2002).

Due to the vast differences in access to health care systems by country, only studies conducted in the UK will be considered in this section of the review.

2.2.2.1 Socio-economic status and mode of birth in the UK

Seven UK-based studies, five of which were English and two Scottish, assessed the relationship between socio-economic status and mode of birth (Alves and Sheikh, 2005, Barley et al., 2004, Bragg et al., 2010, Fairley et al., 2011, Patel et al., 2005, Redshaw et al., 2007, Wilkinson et al., 1998), predominantly differentiating between elective and emergency caesarean sections (see Table A2.4).

Six studies used a measure of area-level deprivation in order to estimate socio-economic status. Four English studies used the Index of Multiple Deprivation (IMD). The IMD measures overall area-level deprivation using six domains, including income, employment, health and disability, housing, education and geographical access to services (Department of the Environment, 2000).

The two Scottish studies used the Carstairs score which was developed using census data in Scotland including domains based on unemployment, not owning a car, low social class and overcrowding (Carstairs and Morris, 1991). Area-based measures of socio-economic status are widely used, as information is often unavailable at an individual level. The ability to link maternity data to area-level measures of deprivation most likely explains the large sample sizes in some of the studies: two included over 300,000 women (Barley et al., 2004, Fairley et al., 2011), another included over 500,000 women (Alves and Sheikh, 2005) and the most recent English study included over 600,000 women (Bragg et al., 2010).

Of the English studies, two with large samples found that mothers in the most affluent areas were more likely to have a caesarean section, after adjustment for maternal characteristics (Alves and Sheikh, 2005, Barley et al., 2004). Both found an increased likelihood of elective caesarean sections for mothers from the most affluent areas, compared to the most deprived areas. The later of the two studies, conducted in 2001-2002, also examined the effect of deprivation on emergency caesarean sections, but found no association (Barley et al., 2004). The largest and most recent study was also the most well adjusted and included adjustment for many health factors in addition to other maternal characteristics (Bragg et al., 2010). Although unadjusted rates of caesarean section had increased with increasing area affluence, after adjustment, deprivation was no longer a significant predictor of caesarean section. However, the study outcome was overall caesarean section rates, and as the previous two large studies found a relationship only for elective caesarean section, the outcome measure may have been too broad. The final study, part of a 2006 survey of maternity care in England, found that women in the most deprived area were more likely to have a 'normal' birth (compared to caesarean sections, forceps and vacuum extraction) than mothers from the four more affluent quintiles. Also, mothers were more likely to have a caesarean section due to 'unforeseen circumstances' if they were from a deprived area. The results from the study were unadjusted however, and unlike the other studies using area-based measures, were based on a sample of only around 3,000 mothers (Redshaw et al., 2007).

In 1994-1995 an audit was conducted of over 8,000 caesarean sections at 23 of the 24 consultant-led maternity units in Scotland (McIlwaine et al., 1998, Wilkinson et al., 1998). Although details of elective and emergency caesarean sections were collected in the audit, for deprivation, results are presented as unadjusted total caesarean section rates by deprivation quintile, which were 16.7% in the most affluent area, and 16.6% in the most deprived. A large and recent Scottish study used routinely collected data from all hospital births in the periods 1980-81, 1990-91 and 1999-2000 (Fairley et al., 2011). Results are presented as the relative index of inequality (RII), comparing the most deprived areas to the least. In 1980-81 women living in more deprived areas were at a higher risk of having an elective caesarean section compared to those in deprived areas, after adjustment

for several other factors, including age and social class. In 1900-91 there was no significant effect of deprivation on elective caesarean rates, and in 1999-2000 women in more disadvantaged areas were at an *decreased* risk compared to women in the most affluent areas. For emergency caesarean sections, in both 1980-81 and 1990-91 women in the more deprived areas were at an increased risk compared to those in more affluent areas. However in 1999-2000 there was no significant association between deprivation and emergency caesarean section rates. It seems from these results that there are different socio-economic patterns for emergency and elective caesarean sections, and over time. Interestingly, the most recent 1999-2000 results most closely reflect those from the other large English studies, which were conducted between 1996 and 2002 (Alves and Sheikh, 2005, Barley et al., 2004).

Overall, the findings from these area-based studies would seem to provide support for the idea that more affluent women are more likely to have an elective caesarean section, but there is little evidence for a relationship between socio-economic status and emergency caesarean sections. However, there are methodological issues which should be considered when interpreting the available evidence. Firstly, unadjusted studies investigating the relationship between socio-economic status and mode of birth should be interpreted with caution. One of the most important confounders of the relationship is that of maternal age. In a large Canadian study, Leeb and colleagues (2005) found that unadjusted rates of caesarean section were higher for mothers living in more affluent areas. However, when the rates were adjusted for maternal age the finding reversed. This change highlights the strong confounding effect of age when considering the influence of socio-economic status on mode of birth. The unadjusted result most likely reflected the higher proportion of older mothers, who are at an increased risk of caesarean section, living in affluent areas. Consequently, when age was controlled for, a more accurate estimation of the effect of deprivation on caesarean section rates was revealed.

A second methodological consideration concerns the use of area-based measures of socio-economic status. Although area-level measures have been compared to individual level measures and have been found to be similarly associated to health outcomes (Krieger, 1992), area-based measures of affluence may not accurately represent the socio-economic position of the individual women. Although poor people tend to live in disadvantaged areas and rich people will tend to live in affluent areas, this will not always be the case. In addition, high levels of mobility mean that areas will continually change (Graham, 2007).

The poorer estimate of individual socio-economic status from area-based measures, compared to individual or household socio-economic status, may explain why Barley and colleagues (2004)

entitled their study in the BMJ "Social class and elective caesareans in the English NHS" when, as clearly noted by Macfarlane, the study was "not really about social class"(Macfarlane, 2004).

Patel and colleagues used the ALSPAC cohort study conducted in the early 1990s in Avon, England, to analyse the maternal risk factors for mode of birth for over 12,000 women (Patel et al., 2005). Two measures of socio-economic status were measured in the study: social class and housing tenure, both of which were found to be unrelated to mode of birth when adjusted for a variety of other factors explored in the study (see Tables A2.5 and A2.6). Social class was measured using the Registrar General's social class classification (where social class I is 'professional occupation' and social class IV is 'unskilled occupation') and was available for just less than 9,000 women in the study. However, the measure was termed 'maternal social class' which would seem to indicate that the social class was based on the occupation of the women. Measuring social class based on the woman's occupation may not represent fully the women's socio-economic circumstances. Men are usually the higher earners in a household (Graham, 2007), therefore, for the women with partners, social class may have been underestimated. In addition, data were collected during pregnancy, a time when women are less likely to work.

Recent work by Fairley and colleagues (2011) has used routinely collected Scottish data from three time periods, and measured both area-level deprivation and social class. As in ALSPAC, social class was captured using the Registrar General's classification, however, using the occupation of the father of the child if available, and mother of the child if not. For elective caesarean sections, in 1999-2000 women of lower social class were at a lower risk of the procedure, compared to their more advantaged counterparts, similar to the results for deprivation described previously. For emergency caesarean sections, results for social class were also very similar to those for deprivation; that in both 1980-81 and 1990-91 women in the lower social class bands were at an increased risk compared to those in higher social class bands, with no significant relationship in 1999-2000. Interestingly, however, as both social class and deprivation level were included in the same model, the only slight attenuation of each when adjusted for the other indicate that the two socio-economic measures have a separate and independent effect on caesarean section rates. This is further demonstrated in stratified analyses by previous caesarean section, where deprivation predicted elective caesarean among women with no previous caesarean section, whereas social class was predictive among women who had previously had a caesarean section.

There is little good quality evidence on the relationship between socio-economic status and caesarean sections in the UK. Several large studies have been identified, but three were based solely on area-level measures of socio-economic position, which may not be an accurate measure for individual women. A further study used maternal social class rather than household social class,

which equally may be a poor measure. A recently published large Scottish study used both area and individual-level measures of socio-economic status, and demonstrated that the two measures do capture different elements of socio-economic position in relation to mode of birth. In addition, there is no information on the association between socio-economic status and instrumental births.

2.2.3 Ethnic background and migration[2]

2.2.3.1 Ethnicity

Ethnicity and health in the UK

The Health Survey for England addresses specific issues each year, and in 2004 focused on the health of the seven largest minority ethnic groups; Black Caribbean, Black African, Indian, Pakistani, Bangladeshi, Chinese and Irish (Sproston and Mindell, 2006). Over 12,000 adults were interviewed across England with a boosted sample of minority ethnic groups, and additional height and weight measurements were taken. After adjusting for age, women of Black Caribbean, Pakistani and Bangladeshi origin were significantly more likely to self-report bad health. A higher prevalence of obesity, diabetes and hypertension among many of these groups may have contributed to their worse health. Table 2.1 shows the prevalence of several health problems which were found to be significantly higher among ethnic minority women when compared to White women in the survey. Overall, Pakistani women were found to have the most health problems and were also more likely to have psychiatric morbidity and a lack of social support.

Table 2.1: Health problems from the 2004 Health Survey for England: significantly higher prevalence among minority ethnic women compared to White women*

Health issues	BA	BC	P	B	In	Ch	Ir
Self-reported bad health		✓	✓	✓			
Limiting long-standing illness			✓				
Obese	✓	✓	✓				
Doctor-diagnosed diabetes		✓	✓	✓	✓		
Hypertension	✓	✓		✓			
Psychiatric morbidity			✓				
Lack social support			✓	✓			

* BA=Black African, BC= Black Caribbean, P = Pakistani, B = Bangladeshi, In = Indian, Ch = Chinese, Ir = Irish

[2] As with socio-economic status, ethnicity and migration literature were restricted to studies published using UK data to allow interpretation in a UK context.

Inequalities have also been identified in maternal and infant health outcomes for mothers of different ethnic backgrounds in the UK (Bharj and Salway, 2008). Although maternal deaths (deaths due to obstetric-related causes) are rare in the UK, a report on maternal deaths which occurred between 2003 and 2005 found a significantly higher mortality rate for Black African, Black Caribbean and Middle Eastern women, including recent asylum seekers and refugees (Lewis, 2007). A recent UK-based study, conducted between 2005 and 2006, assessed rates of severe maternal morbidities for mothers from different ethnic backgrounds (Knight et al., 2009). Five severe maternal morbidities were assessed which can cause maternal death in the UK; acute fatty liver, amniotic fluid embolism, antenatal pulmonary embolism, eclampsia and peripartum hysterectomy. A rate of 89 cases per 100,000 maternities of any one of the five severe morbidities was identified in the sample of over 775,000 women. Compared to White mothers, Black African and Black Caribbean mothers were around twice as likely and Pakistani mothers were around 1.5 times more likely to have a severe maternal morbidity. When the results were adjusted for other maternal characteristics including age, socio-economic background, smoking status, BMI and parity, non-White mothers remained more likely to have a severe maternal morbidity, with an increased risk of around 50%.

The reasons why mothers from different ethnic backgrounds may have different maternal and infant health outcomes are not well understood, and are likely to be multifactorial. Knight and colleagues suggested a combination of pre-existing medical conditions, differences in genetic and environmental influences, or differences in access to maternity care could explain the variation in severe maternal morbidities in their sample (Knight et al., 2009). Similarly, Bhopal has suggested that several social and biological forces generate ethnic health inequalities, including differences in: culture and lifestyle, socio-economic status, environment, genetic and generational, access to healthcare and following health advice (Bhopal, 2009)

Ethnicity and mode of birth in the UK

As discussed later in this chapter, mothers with particular health problems are more likely to have an operative birth. As women of certain minority ethnic groups have poorer health than White women in the UK, it is likely this could impact on the type of birth they experience. This is especially likely as problems such as obesity, diabetes and hypertension are more prevalent for women of some minority ethnic groups (Sproston and Mindell, 2006).

Most UK studies separated elective and emergency caesarean sections (Patel et al., 2005, Richardson and Mmata, 2007), although Ibison (2005) and Bragg and colleagues (2010) examined overall caesarean section rates (see Table A2.7). Paranjothy and colleagues (2005) examined caesarean section *during labour* and caesarean section *before labour* which may be slightly

different to the emergency and elective categories used by other studies. While it is likely that all the 'in labour' caesarean sections would be classified as 'emergency' by other studies, those 'before labour' will not all be 'elective', for example they may follow a failed induction. Further discussion regarding the categorisation of mode of birth is included in Chapter 11.

Overall, non-White mothers were more likely to have an emergency caesarean section. Paranjothy and colleagues utilised data from the NSCSA report, which includes information on over 150,000 women from all 216 maternity units in England and Wales, collected in a three-month period in 2000 (Paranjothy et al., 2005). After adjustment for other maternal characteristics, mothers of Black African, Black Caribbean, Black Other, Bangladeshi, Indian, Asian Other and Other origin were more likely to have a caesarean section during labour (Paranjothy et al., 2005). The highest risk was for Black African mothers who were 2.3 times more likely to have a caesarean section during labour than White mothers. Patel and colleagues found that non-White mothers were almost twice as likely to have an emergency caesarean section in unadjusted analyses of over 12,000 women from the ALSPAC study (Patel et al., 2005). However, after adjustment for a variety of other maternal factors, ethnic origin was no longer a significant factor. In the study assessing NHS maternity statistics from 2005-06, the rate of emergency caesarean section was highest for Black mothers compared to all other ethnic origins; however the results presented were unadjusted percentages (Richardson and Mmata, 2007), and as discussed below there were further problems with the categorisation of ethnic groups.

For elective caesarean sections, the results are less clear. Patel and colleagues found that ethnicity was not a significant predictor of elective caesarean section (Patel et al., 2005), but their analyses may have been underpowered to detect a difference due to small numbers of minority women (see further discussion below). The NHS maternity statistics presented unadjusted percentages with only small differences between ethnic groups; however Black women had the highest elective caesarean section rate (Richardson and Mmata, 2007). The third large and well-adjusted study however, indicated that non-White mothers (Black African, Black Caribbean, Bangladeshi, Indian, Pakistani, Chinese, Asian Other and Other) were significantly *less* likely to have a caesarean section before labour than White mothers (Paranjothy et al., 2005).

The final two studies examined data on *overall* caesarean section rates (including elective and emergency caesarean sections). One included data from three East London hospitals from 1988-1997 (Ibison, 2005) and the other most recent study used hospital episode statistic (HES) data from 2008 from those English maternity units which had more than 1,000 births annually (Bragg et al., 2010). Ibison found that African, West Indian, Bangladeshi, Indian and Pakistani mothers were at an increased risk of caesarean section compared to White mothers after adjustment for a selection

of maternal and hospital factors, whereas rates of caesarean section for oriental mothers were not significantly different. As in the large, representative study by Paranjothy (2005), the highest risk was for African mothers who were 2.8 times more likely than White mothers to have a caesarean birth. Bragg and colleagues found that Afro-Caribbean women were at a higher risk of caesarean section than White women after adjustment, but the rate of caesarean section for Asian and other ethnic minority women was not significantly different.

Paranjothy and colleagues (2005) identified an *increased* risk of caesarean section during labour, but a *decreased* risk of caesarean section before labour for non-White women compared to White women. By including elective caesarean sections in the overall rate, Ibison (2005) and Bragg and colleagues (2010) may therefore have diluted the effect of ethnicity, compared to the likely effect if emergency caesarean sections had been examined independently.

Ibison's study also included assessment of instrumental births (Ibison, 2005). After adjustment for maternal and hospital factors, Bangladeshi and Indian women were 1.3 times more likely to have an instrumental birth, whereas African and West Indian women were at half the risk compared to White women. The 2005-06 maternity statistics showed that 9% of White women with a spontaneous onset of labour went on to have an instrumental birth compared to 4% of Black mothers – the lowest rate. However the results presented are unadjusted and, in addition to categorisation problems discussed below, should consequently be treated with caution.

The way that respondents are coded as to their ethnicity is an important consideration when measuring outcomes according to ethnic background. A common problem is the use of categories which are too broad (Karlsen and Nazroo, 2006). Patel and colleagues used relatively large ethnic groups including White, Black, Asian and 'Other'. These larger groups may have been used due to the small proportion of non-White mothers in the sample (2.2%), an under-representation of non-White mothers for the county of Avon (4.1%), which in turn had a smaller population of ethnic minority mothers compared to the national average at the time (7.6%) (University of Bristol, 2008).

The NHS maternity statistics for 2005-06 and the HES data in the study by Bragg and colleagues similarly reported ethnicity using the large groups White, Black, Asian and other, and in both, ethnicity information was not available for around 20% of cases (Richardson and Mmata, 2007, Bragg et al., 2010). Furthermore, in the analyses by mode of birth in the NHS maternity statistics, the "not stated" women were grouped with the White women. The results should therefore be interpreted with caution when comparing the White and non-White groups, particularly as the likelihood of missing data for non-White women could be higher.

Ibison (2005) categorised ethnicity into eight categories. Although the groups were more specific than those used in the two aforementioned studies, the ethnicity of the women in the study was 'observer assigned' rather than self-reported, meaning some women may have been wrongly categorised.

2.2.3.2 Migration

The UK has become multicultural due to patterns of migration. Consequently minority groups in the UK are composed of recent migrants, and those who are second or third generation, and were born in the UK. Migration may have an effect on health over and above those observed between ethnic groups. Nazroo discusses the impact of migration on health (Nazroo, 1997). Firstly, migrants are likely to be different in terms of age, gender and socio-economic position to non-migrants, all of which can impact on health. Secondly, migration is more possible for those in better health – the 'healthy migrant effect'. However, migration is also likely to be stressful and the socio-economic position of the individual once in their new country may change. In addition, as discussed by Bhopal with reference to the NHS, there may be linguistic difficulties for migrant groups due to a lack of translation services in the health service, reflecting a barrier to accessing health care (Bhopal, 2007), and these barriers are likely to be apparent in other countries. Nazroo (1997) compared the health of British-born minority ethnic groups to foreign born. Across a range of health outcomes, the health of the migrants (those that had migrated to the UK after age 11) was better than the health of their British-born (or migrated under age 11) counterparts, after controlling for age.

In a survey of around 3,000 women who gave birth in England in 2006, there were no significant differences in mode of birth for mothers born in the UK or outside the UK, but the results were unadjusted and from a relatively small sample of around 3,000 women (Redshaw et al., 2007). No other UK studies were identified which assessed migration in relation to mode of birth (see Table A2.8).

2.2.4 Height

One review, mainly detailing studies from developing countries (Dujardin et al., 1996), and several primary studies from developing countries including Cameroon (Rozenholc et al., 2007), Thailand (Wongcharoenkiat and Boriboonhirunsarn, 2006), Guatemala (Merchant et al., 2001), South Africa (Van Bogaert, 1999) and Turkey (Kara et al., 2005), were excluded for the purposes of this review. Five studies from; Scotland (Mahmood et al., 1988), the USA (Gareen et al., 2003), Sweden (Cnattingius et al., 1998), New Zealand (McGuinness and Trivedi, 1999) and Australia (Read et al., 1994) were included (see Table A2.9).

All five studies indicated that risk of operative birth increased for shorter mothers. For those studies which included a range of height groups, a gradient effect was evident with risk of operative birth decreasing with increasing height (Cnattingius et al., 1998, Mahmood et al., 1988, McGuinness and Trivedi, 1999, Read et al., 1994). The effect of height was identified for studies examining overall caesarean section rates (Gareen et al., 2003), elective caesarean rates (Cnattingius et al., 1998), emergency caesarean rates (Cnattingius et al., 1998, Mahmood et al., 1988, McGuinness and Trivedi, 1999, Read et al., 1994), and operative vaginal birth rates (Read et al., 1994). In addition, three of the five studies found a significant effect of height after adjustment for other maternal characteristics (Cnattingius et al., 1998, Gareen et al., 2003, Read et al., 1994). The increase in risk of operative birth for shorter mothers was not small either. In fact, in the well adjusted Australian study, comparing mothers shorter than 160cm, to those 160-164cm and over 165cm, the risk associated with being a short mother (<160cm) was around 5 times that of the tallest mothers (Read et al., 1994).

Cephalopelvic disproportion (CPD) has also been suggested as a reason why shorter mothers are more likely to need operative birth. The suggestion being that there is a correlation between maternal height and pelvic measurements, with women of shorter stature having smaller pelvic measurements, and subsequently being less likely to give birth normally (Dujardin et al., 1996, Mahmood et al., 1988). In developing countries CPD is the cause of a high proportion of the mortality, maternal morbidity and perinatal deaths (Dujardin et al., 1996). However, infant birth weights have been found to increase with increasing maternal height (Mahmood et al., 1988). Two of the studies found a significant association between shorter height and higher rates of operative birth, after adjustment for birth weight (Gareen et al., 2003, Read et al., 1994).

2.2.5 Health and medical factors

Several general areas of health and medical factors are summarised in the following four sections:

- Mothers' weight
- Mothers' health during pregnancy
- Smoking during pregnancy
- Complications during labour

For some of the health factors, few studies were identified. This is likely to be because the factors are well known to be indications for operative birth, so little published literature is available. Consequently, in many of the following sections, studies included are those which adjusted for factors, rather than studies which explicitly aimed to assess their relationship with mode of birth. In

cases where few studies were identified, if possible, references are made to UK guidelines and reports regarding mode of birth.

2.2.5.1 Weight

Obesity is a major public health concern. In the UK, over 50% of all women are over the recommended weight for their height (Bhattacharya et al., 2007). As rates of obesity are increasing for women of reproductive age (Poobalan et al., 2009), the possible impact on maternal health outcomes has sparked much research. Two reviews of primary studies (Chu et al., 2007, Poobalan et al., 2009) and eight separate primary studies (Cnattingius et al., 1998, Cnattingius and Lambe, 2002, Gareen et al., 2003, Guihard and Blondel, 2001, Joseph et al., 2006, Naftalin and Paterson-Brown, 2008, Rosenberg et al., 2005, Weiss et al., 2004) either directly assessed the effect of mothers' weight on mode of birth, or adjusted for weight amongst other factors. Two other primary studies were included in the review papers, but were retained for extra information (Baeten et al., 2001, Bhattacharya et al., 2007) (Table A2.10).

Studies were from a range of countries, but the majority were American (see Table A2.10). Mothers' weight was measured either through actual weight measurements in kg or lb before pregnancy, weight gain during pregnancy, or, more commonly, body mass index (BMI). BMI is a statistical measurement of weight which takes into account height and is calculated by weight/height^2. Regardless of outcome measure used, all studies showed that compared to mothers who were a lean or normal weight, heavier mothers were more likely to have an operative birth. For most studies a gradient effect was noted, with an increased likelihood of operative birth for mothers in higher weight categories.

The majority of studies examined overall caesarean section rates, with all studies which included overall caesarean rates showing a gradient effect. Few studies separated elective and emergency caesarean sections (Bhattacharya et al., 2007, Cnattingius et al., 1998, Poobalan et al., 2009), included only emergency caesareans (Naftalin and Paterson-Brown, 2008), or included instrumental vaginal births (Naftalin and Paterson-Brown, 2008, Weiss et al., 2004). Of the studies which separated emergency caesarean sections, a gradient effect was apparent for all. Of the studies which separated out elective caesarean sections however, this was not always the case. For example, Bhattacharya and colleagues found that when compared to women with a normal BMI, mothers who were morbidly obese were more likely to have an elective caesarean section, but overweight and obese mothers were not significantly different (Bhattacharya et al., 2007). A similar effect was noted for instrumental births; Weiss and colleagues found that compared to

normal or overweight mothers, morbidly obese mothers were more likely to have an instrumental birth, but obese mothers were not significantly different (Weiss et al., 2004).

The results for underweight mothers were mixed. Many of the studies included lean or underweight mothers in the "normal" category. Of the four studies that included underweight mothers separately, two found that they had a decreased risk of having a caesarean birth (Baeten et al., 2001, Joseph et al., 2006), compared to normal weight mothers, and one found that their caesarean section rates were not significantly different to those of normal weight mothers (Rosenberg et al., 2005). The final study examined both elective and emergency caesarean rates. Underweight mothers were less likely to have an emergency caesarean birth, but for elective caesareans there was no significant difference between underweight mothers and those of a normal weight (Cnattingius et al., 1998).

Various explanations have been suggested for why mothers of increasing weight are more likely to have an operative birth. Mothers who are overweight and obese have been found in several studies to be more likely to be of lower socio-economic position, to partake in risky health behaviours and to have other maternal health problems such as diabetes, hypertension and pre-eclampsia (Baeten et al., 2001, Chu et al., 2007, Cnattingius and Lambe, 2002, Poobalan et al., 2009, Rosenberg et al., 2005, Weiss et al., 2004). However, many of the included studies adjusted for these health factors, amongst other maternal factors, and found that obesity still had a residual effect (Bhattacharya et al., 2007, Gareen et al., 2003, Joseph et al., 2006, Rosenberg et al., 2005, Weiss et al., 2004). Overweight and obese mothers are also more likely to have large for gestational age babies (Chu et al., 2007, Cnattingius and Lambe, 2002, Poobalan et al., 2009, Rosenberg et al., 2005, Weiss et al., 2004), but many of the studies also adjusted for birth weight, and still found an independent effect of maternal weight on mode of birth (Gareen et al., 2003, Guihard and Blondel, 2001, Joseph et al., 2006, Naftalin and Paterson-Brown, 2008, Weiss et al., 2004). A further suggestion is that obesity increases pelvic soft tissue, which narrows the birth passage and increases the risks associated with dystocia or cephalopelvic disproportion (Chu et al., 2007, Poobalan et al., 2009).

Overall, maternal weight appears to be a significant risk factor for operative birth, with extensive literature documenting the relationship. Pooled estimates from both large reviews suggested that mothers who were overweight, obese and severely obese, were around 1.5, 2 and 3 times more likely to have a caesarean birth than mothers of a normal weight, respectively (Chu et al., 2007, Poobalan et al., 2009). Overweight mothers who do have an operative birth are also likely to experience more problems during the postpartum period with wound healing, infections and other complications leading to longer recovery periods and hospital stays (Chu et al., 2007).

2.2.5.2 Mothers' health during pregnancy

Mothers who experience poorer health during pregnancy may be at an increased risk of an operative birth, particularly if they experience specific problems such as diabetes or hypertension.

Along with rising obesity rates, diabetes is also increasing globally (Metzger et al., 2007), and is now the most common pregnancy complication (Rosenberg et al., 2005). Diabetes contributes to complications during pregnancy such as hypertension and pre-eclampsia, and complications during labour such as obstructed labour and shoulder dystocia (Feig et al., 2006). Diabetic mothers have also been found to be more likely to have preterm births (Rosenberg et al., 2005), and high birth weight infants (Jensen et al., 2004), all of which are independently associated with operative births. Mothers with diabetes (either pre-gestational or gestational) have been found to be more likely to have a caesarean section than mothers without diabetes (Feig et al., 2006, Gareen et al., 2003, Hawthorne et al., 1997, Jensen et al., 2004, Joseph et al., 2006, Patel et al., 2005, Rosenberg et al., 2005) (see Table A2.11). One study which distinguished between elective and emergency caesareans (Patel et al., 2005), found that after adjustment, mothers with diabetes were more than 4 times more likely to have an elective caesarean section, than those without. However, diabetes was not an independent predictor of emergency caesarean section.

Hypertension (or abnormally high blood pressure) can occur during pregnancy (pregnancy hypertension in conjunction with other bodily changes such as oedema and protein in the urine is known as pre-eclampsia). Mothers who experience hypertension or pre-eclampsia have been found to be at an increased risk of caesarean section, after adjustment for other maternal and medical factors (Gareen et al., 2003, Joseph et al., 2006, Rosenberg et al., 2005) (see Table A2.13).

Other issues such as herpes infection can contraindicate vaginal birth. The 2004 NICE guidelines on caesarean section recommend that mothers with a primary (rather than a recurrent) herpes infection in the third trimester of pregnancy should be offered a caesarean birth to reduce the risk of transferring the infection to the infant (National Institute for Health and Clinical Excellence, 2004b). One American study adjusted for the presence of herpes infection when assessing risk factors for operative birth. After adjusting for the numerous factors, mothers with herpes were more than 5 times more likely to have a caesarean birth than mothers without (Gareen et al., 2003) (see Table A2.12).

2.2.5.3 Smoking during pregnancy

Smoking during pregnancy is a major public health concern. Both maternal smoking and environmental tobacco smoke (ETS) have been found to be causally associated with low birth

weight and preterm births (Cnattingius and Lambe, 2002, Ward et al., 2007), and maternal smoking has also been associated with stillbirth and placental abruption (Cnattingius and Lambe, 2002), all of which have been associated with operative birth. However, smoking during pregnancy is also associated with a decreased risk of pre-eclampsia, a major pregnancy complication which is associated with operative birth. The more recent Swedish study discussed earlier, found that mothers who smoked between 1 and 9 cigarettes per day, were significantly less likely to have pre-eclampsia than non-smoking mothers, and mothers who smoked 10 or more were even less likely (Cnattingius and Lambe, 2002).

Three studies, two Swedish (Cnattingius et al., 1998, Cnattingius and Lambe, 2002) and one English (Patel et al., 2005), assessed the impact of a mother's smoking status on subsequent mode of birth (Table A2.14). Of the three studies, the most recent and large Swedish study, found, after adjustment for some other maternal factors, a very slight increased risk of caesarean birth in mothers who were smoking 1-9 cigarettes per day at their first antenatal visit, compared to mothers who were not smoking (Cnattingius and Lambe, 2002). Of the two remaining studies, neither found smoking to be significantly related to mode of birth, after adjustment for other maternal characteristics. In the earlier Swedish study, smoking was not significantly related to mode of birth in univariate analyses (Cnattingius et al., 1998). In the English study, smoking was not significantly related to either overall or emergency caesarean rates in unadjusted analyses, but mothers who had an elective caesarean birth smoked significantly fewer cigarettes per day than mothers who had a vaginal birth. When the results were adjusted for other maternal characteristics however, the relationship disappeared (Patel et al., 2005). Smoking is more common among mothers of lower socio-economic status, so it is possible that the relationship observed in the unadjusted analyses is a reflection of the socio-economic position of the mother, rather than as a result of the smoking behaviour itself. This hypothesis is supported by the finding that the association no longer remains when other maternal characteristics, including social class, are included in the model.

2.2.5.4 Complications during labour

Complications during labour can be indicative of a need for operative birth, including factors such as placental problems, fetal distress, fetal presentation and multiple birth.

Placenta praevia (where the placenta is abnormally positioned in the lower uterine segment), and placental abruption (when the placenta separates prematurely), can cause uterine bleeding, which is dangerous for both mother and child (Hofmeyr et al., 2008). Mothers who experience both placenta praevia and placental abruption have been found to have a higher risk of caesarean section (Gareen et al., 2003, Joseph et al., 2006) (see Table A2.15). The 2004 NICE guidelines for caesarean section suggest that women with placenta praevia, where the placenta is partly or completely

covering the cervical opening should be offered a caesarean section (National Institute for Health and Clinical Excellence, 2004b).

In the NSCSA, of the primary emergency caesarean sections conducted for mothers with singleton cephalic presentation at term, fetal distress was one of the main indications (accounting for 40% of the primary emergency caesarean section rate for this group) (Thomas and Paranjothy, 2001). Two American studies adjusted for the impact of the presence of fetal distress on mode of birth (Braveman et al., 1995, Gareen et al., 2003). In both studies, mothers diagnosed with fetal distress were around 4 or 5 times more likely to have a caesarean section than those without (see Table A2.16).

Presentation refers to the part of the fetus entering the pelvis first, with the most favourable being cephalic, where the head enters the pelvis first. Malpresentation refers to any presentation that is not cephalic. Malpresented fetuses are much more likely to be born by caesarean section.(Gareen et al., 2003, Guihard and Blondel, 2001, Paranjothy et al., 2005, Patel et al., 2005) (see Table A2.17). According to the 2004 NICE guidelines on caesarean section, 88% of mothers with a breech baby have a caesarean section (National Institute for Health and Clinical Excellence, 2004b).

Multiple births are a fairly rare event with only 15 per 1000 in the UK (Thomas and Paranjothy, 2001), and most studies exclude mothers who do not have a singleton birth. One large American study found that after adjustment for all other maternal factors, mothers who had a multiple birth were almost twice as likely to have a caesarean section as mothers who had a singleton birth (Gareen et al., 2003) (Table A2.18). According to the 2004 NICE caesarean section guidelines, caesarean section for twin pregnancies should be offered when the first twin is breech. Otherwise, research is unclear as to whether caesarean section is better for twin births where the first twin is cephalic (National Institute for Health and Clinical Excellence, 2004b). In the UK NSCSA, the overall caesarean section rate for twin pregnancies was 58.5%, compared to 21.5% for all maternities (Thomas and Paranjothy, 2001).

2.2.6 Obstetric history

Unfortunately, data on previous obstetric history is not available in the MCS. However, a number of factors relating to mothers' obstetric history were identified in the literature in relation to mode of birth.

For a mother who has had a previous caesarean birth, there are risks and benefits of both a repeat caesarean birth and a vaginal birth after caesarean (VBAC). The risks of having a VBAC include

uterine rupture and perinatal death, whereas the risks with a repeat caesarean birth include damage to the bladder and bowel and the risks of surgery relating to adhesions (Dodd et al., 2004). According to the 2004 NICE guidelines for caesarean section, decisions regarding what type of birth a mother should have if she has had a previous caesarean section should be made on an individual basis, as the risks and benefits of VBAC compared with repeat caesarean birth are uncertain (National Institute for Health and Clinical Excellence, 2004b). In the 2001 NSCSA report, the rate of caesarean section for multiparous women with a previous caesarean section was 67.2% compared to 10.3% for women with no history of caesarean section (Thomas and Paranjothy, 2001), whereas women who had had a previous vaginal birth were comparatively less likely to have a caesarean section than women who had never had a vaginal birth (Paranjothy et al., 2005) (see Tables A2.19 and A2.20). A more recent study using English hospital episode statistics from 2008 found a slightly higher caesarean section rate of 71% for multiparous women with a history of caesarean section compared to 9% of multiparous women with no previous history (Bragg et al., 2010).

Other studies have shown that the outcome of previous births can impact on the current mode of birth. For example, previous stillbirth or perinatal death has been linked to an increased risk of caesarean section (Gomes et al., 1999, Joseph et al., 2006, Patel et al., 2005) (see Table A2.21) and previous miscarriage has been found to increase the risk of instrumental birth (Bhattacharya et al., 2008) (Table A2.22).

2.2.7 Pregnancies resulting from infertility treatment

One review and four primary studies examined treatment for infertility in relation to mode of birth. The review included 19 studies; two English, one American, one Belgian, two Finnish, two Dutch, one Swiss, three French, one Norwegian, four Israeli and one conducted in both Iceland and Scotland (Helmerhorst et al., 2004). The four primary studies included one Danish (Basso and Baird, 2003), one Australian (Chambers et al., 2007), one American (Gareen et al., 2003) and one English (Patel et al., 2005) (Table A2.23). All studies examined the effect of fertility treatment in the index pregnancy, except for the American study, which examined the effect of fertility treatment in a pregnancy preceding the index pregnancy.

The review of studies and the Australian study assessed overall caesarean section rates and found that mothers who had had treatment for infertility were more likely to have a caesarean section. The Danish and the English studies assessed fertility treatment in relation to both elective and emergency caesarean section rates. In the large Danish study, multiparous mothers were almost twice as likely to have an emergency caesarean section if they had had treatment for infertility;

however, there was no effect for primiparous mothers in relation to emergency caesarean section, and no effect for mothers who had an elective caesarean section, regardless of parity. These results included adjustment for some other maternal characteristics. Similarly, the English study found that mothers who had had fertility treatment were more likely to have an emergency caesarean section, but fertility treatment was not related to elective caesarean section. However, when treatment for infertility was included in a well-adjusted regression model, it was no longer a significant predictor of emergency caesarean section.

The growing use of assisted reproductive technology has been linked to an increase in multiple births due to the transfer of multiple embryos (Allen et al., 2006). Multiple births are more often by caesarean section. However, the review of studies and the Australian study found an increase among mothers who had both multiple and singleton births, the American study adjusted for multiple births in their analysis and the Danish and the English study included only singleton births in their analysis.

Any relationship identified between treatment for infertility and mode of birth could be explained by the characteristics of mothers who require treatment. For example, mothers who seek treatment for infertility are likely to be older and of higher social class (Basso and Baird, 2003), factors which could confound the relationship between treatment and mode of birth. Helmerhorst and colleagues (2004) gave separate overall risk estimates for studies in their review which had used matched control groups, to those with non-matched control groups. Most of the included matched studies in the review controlled for age and parity, and others controlled for a variety of other maternal characteristics. The overall risk estimate for all studies in the review indicated mothers who had had treatment for infertility were around twice as likely to have a caesarean section; however the risk was attenuated in the matched studies (OR=1.5) compared to the non-matched (OR=2.3).

The Danish study examined mothers who had a time to pregnancy (TTP) of greater than 12 months. Mothers who did have a TTP greater than 12 months, but did not receive treatment to conceive, were not significantly more likely to have either an elective or an emergency caesarean section (Basso and Baird, 2003). These results would seem to indicate that factors relating to the treatment for infertility, rather than the underlying characteristics of the mothers with fertility problems increased the risk of emergency caesarean section. However, a more recent Norwegian study compared sibling births of two consecutive pregnancies - with and without fertility treatment, in order to better control for maternal factors (Romundstad et al., 2008). Compared to the general population, infants born to mothers who had received fertility treatment had a lower mean birth weight and gestational age, and were at a higher risk of perinatal death. However, comparisons of

the same infant outcomes for siblings of mothers who had experienced both assisted and spontaneous conception were not significantly different. The American study by Gareen and colleagues (2003) found that mothers who had received fertility treatment in a pregnancy prior to the index pregnancy were more likely to have a caesarean section after adjustment for a range of maternal factors, and obstetric history including history of caesarean section.

2.2.8 Psychosocial factors

As questions in the MCS were asked retrospectively at nine months we do not have details of psychological wellbeing in pregnancy. However, interpersonal factors which were unlikely to have changed since pregnancy were examined (see Chapter 3). Studies related to four broad psychological factors were identified in the literature in relation to mode of birth;

- Anxiety or stress levels
- Unwanted pregnancy
- Depression
- Fear of childbirth

2.2.8.1 Stress and anxiety

Increased levels of stress and anxiety are commonly known to be associated with a variety of health problems, and have also been found to relate to a series of adverse birth outcomes. Reviews of the effect of anxiety and stress on birth outcomes have found more problems during pregnancy, complicated labour and births and preterm infants among mothers who had higher levels of stress and anxiety (Istvan, 1986, Crandon, 1979).

Possible biological pathways for the associations between increased stress or anxiety and adverse birth outcomes have been suggested. Direct pathways are those where anxiety or stressor have a direct physiological influence on the body. For example, a study measuring blood flow through uterine arteries using ultrasound found that mothers who were more anxious during pregnancy were more likely to have abnormal blood flow (Teixeira et al., 1999). Other research has also indicated that anxiety is related to levels of adrenaline and noradrenaline, which have been found to be associated with abnormal uterine contractions and subsequent obstetric complications (Johnson and Slade, 2002). The pathway could also be indirect, as stress is related to other adverse health outcomes and health behaviours which could consequently impact on birth outcomes, e.g. smoking (Istvan, 1986).

Four studies examined levels of anxiety or stress in pregnancy related to subsequent mode of birth (see Table A2.24); two English (Johnson and Slade, 2002, Perkin et al., 1993), one Australian (Crandon, 1979) and one Swedish (Ryding et al., 1998). Of the four studies, only one, including around 1,500 women, adjusted for other maternal factors, and found no significant association between anxiety and mode of birth (Perkin et al., 1993). Although two of the three remaining studies did find that mothers who were more anxious or stressed during pregnancy were more likely to have an operative birth (Crandon, 1979, Ryding et al., 1998), without adjustment for other factors it is impossible to ascertain if this relationship is independent, or whether it could be confounded by other maternal factors or health problems.

2.2.8.2 Unwanted pregnancy

One large American study adjusted for whether the pregnancy was unwanted. Compared to mothers that had wanted the pregnancy, mothers for whom the pregnancy had been unwanted were more likely to have a caesarean birth, even after adjusting for many other maternal factors (Gareen et al., 2003) (Table A2.25).

Although no further studies considering the effects of unwanted pregnancy on subsequent operative birth were identified, unwanted pregnancy has been studied in relation to other outcomes. A literature review of the effects of unintended and unwanted pregnancy on maternal and child health found that unintended pregnancy was related to more risky health behaviours such as smoking, alcohol and illicit drug use, delayed or decreased antenatal care, as well as detrimental birth outcomes such as congenital abnormalities, miscarriage, premature birth and low birth weight (Gipson et al., 2008).

2.2.8.3 Depression

Three studies assessed depression during pregnancy, and mode of birth: one English (Perkin et al., 1993), one American (Wu et al., 2002), and one from the Netherlands (Van de Pol et al., 2006) (Table A2.26). None of the studies found an association between depression in pregnancy and mode of birth, in either unadjusted or adjusted analyses. From only a small number of studies, using relatively small study populations, it is not possible to positively conclude that depression in pregnancy does not have an effect on mode of birth. Also, the depression measure used in two of the studies (Van de Pol et al., 2006, Wu et al., 2002) has not been validated in a pregnant population (Wu et al., 2002).

2.2.8.4 Fear of childbirth

Three studies assessed fear of childbirth and subsequent mode of birth; one English (Johnson and Slade, 2002) and two Swedish (Ryding et al., 1998, Waldenstrom et al., 2006) (Table A2.27). The earlier Swedish study found that mothers who had higher scores on the Wijma Birth Expectancy/Experience Questionnaire (W-DEQ), indicating greater fear of childbirth, were more likely to have an emergency caesarean section (electives were excluded) (Ryding et al., 1998). In a more recent and large Swedish study mothers who had negative feelings towards their forthcoming birth during pregnancy and those who had received counselling were at an increased risk of an *elective* caesarean section, but fear of childbirth was unrelated to emergency caesarean section rates (Waldenstrom et al., 2006). The English study found no relationship between scores on the English version of the W-DEQ and rates of unassisted vaginal, emergency caesarean, elective caesarean or instrumental births (Johnson and Slade, 2002).

Although both Swedish studies identified some relationship between fear of childbirth in pregnancy and mode of birth, neither controlled for other factors. In the later Swedish study mothers who reported very negative feelings were more likely to be from a disadvantaged background, to have an unwanted pregnancy, and to be more worried and depressed during pregnancy (Waldenstrom et al., 2006). The English study used the English version of the W-DEQ. Owing to translation from Swedish to English, the measure may not have accurately detected fear of childbirth, and the authors did report problems with two items which asked how ‘funny’ or ‘self-evident’ women would feel at the moment of birth (Johnson and Slade, 2002). In addition, the sample size of 346 women may have been underpowered to detect a difference, especially as four mode of birth categories were used.

2.2.8.5 Summary

Studies assessing psychosocial factors during pregnancy were sparse, and were often hampered by small sample sizes and a lack of statistical adjustment for other confounding factors.

2.3 Characteristics of the infant

Three ‘infant’ characteristics have been associated with mode of birth in the literature; gestational age, birth weight and sex. Although these characteristics are determined immediately after birth, they reflect characteristics of the fetus immediately prior to birth.

The UK has low rates of perinatal mortality; however, stillbirths and neonatal deaths increase with increasing prematurity and low birth weight (CMACE, 2010). The most recent NICE guidelines

recommend that caesarean sections should not be performed until after 39 weeks gestation (National Institute for Health and Clinical Excellence, 2004b). However, for a woman who goes into labour early, the most beneficial mode of birth for an immature small baby is controversial. A Cochrane review updated in 2009 concluded that from the six studies including only 122 women, there was insufficient evidence to support either elective caesarean section or expectant management for a small or immature baby (Grant and Glazener, 2010). Small babies are at an increased risk of asphyxia or trauma during the birth, and of complications after birth such as respiratory distress syndrome (Grant and Glazener, 2010).

2.3.1 Gestational age

A normal gestational period is between 37 completed weeks and less than 42 completed weeks since the first day of the last normal menstrual period. Mothers who give birth at less than 37 weeks are described as preterm and mothers who give birth at 42 completed weeks or more are described as post-term (Thomas and Paranjothy, 2001).

There are three primary clinical presentations of preterm birth. The first two are spontaneous in nature; (1) preterm labour following the spontaneous onset of contractions, (2) preterm premature rupture of membranes (PROM), and the third follows intervention; (3) medically indicated due to fetal or maternal contraindications to the continuation of the pregnancy (Pickett et al., 2000a).

The reasons why women go into labour preterm are not fully understood. However, Black ethnicity, low socio-economic status, old and young maternal age, physical exertion, nutritional intake, smoking and psychological or social stress have been found to increase the likelihood of preterm birth (Goldenberg et al., 2008).

Eight studies adjusted for gestational age in relation to mode of birth (Table A2.28). Three studies were from England (Alves and Sheikh, 2005, Paranjothy et al., 2005, Patel et al., 2005), one from Italy (Cesaroni et al., 2008), two from America (Gareen et al., 2003, Heffner et al., 2003), one from Brazil (Gomes et al., 1999) and one from Australia (Roberts et al., 2002).

Most (6/8 studies) used mothers who gave birth at term as the reference group. The Brazilian study used preterm mothers as the reference group (Gomes et al., 1999), and the English study by Patel and colleagues used gestational age as a continuous variable (Patel et al., 2005). Of the studies which included preterm mothers, all found that preterm mothers were more likely to have a caesarean section than term mothers (Cesaroni et al., 2008, Heffner et al., 2003, Paranjothy et al., 2005, Patel et al., 2005), although one English study found that mothers who were very preterm

were less likely to have a caesarean section (Paranjothy et al., 2005). Of the studies which included post-term mothers, all found that post-term mothers were more likely to have a caesarean section (Cesaroni et al., 2008, Gareen et al., 2003, Gomes et al., 1999, Heffner et al., 2003), or any type of operative birth (Roberts et al., 2002).

The three English studies separated elective and emergency caesarean sections in their analysis, either by including both types (Paranjothy et al., 2005, Patel et al., 2005), or by including only elective caesareans (Alves and Sheikh, 2005). Alves and Sheikh did not include preterm women in their study and only examined elective caesarean section rates. Compared to mothers who gave birth at 37 weeks, mothers who gave birth from 39 weeks were less likely to have an elective caesarean section with increasing gestation (Alves and Sheikh, 2005). Paranjothy and colleagues grouped together mothers who gave birth at 37 weeks or later and compared them to preterm mothers. Preterm mothers were more likely to have an elective or an emergency caesarean section (Paranjothy et al., 2005). Patel and colleagues used gestational age as a continuous variable in their analysis and found an increased risk of elective caesareans with decreasing gestation, but no significant effect of gestational age on emergency caesarean sections (Patel et al., 2005).

All but one of the included studies adjusted for other maternal factors (Cesaroni et al., 2008). Specifically, all studies that did adjust, adjusted for birth weight. Birth weight and gestational age are highly correlated with older gestational age infants commonly having higher birth weights. Consequently, it is clear that there is an effect of gestational age on caesarean section rates, over and above the effect of birth weight, with an increased risk of caesarean birth for both preterm and post-term infants.

2.3.2 Birth weight

Low birth weight results from being born either too early, or too small for gestational age and babies of low birth weight are at an increased risk of adverse health outcome in infancy and through to adulthood (Ashdown-Lambert, 2005). However, despite the high correlation between low birth weight and mortality (CMACE, 2010, Macfarlane and Mugford, 2000), some low birth weight infants are entirely healthy (Macfarlane and Mugford, 2000).

The maternal characteristics which are predictive of low birth weight are similar to those described overleaf for preterm birth, with differences according to ethnicity, and a higher incidence for mothers of low socio-economic position, with poor nutrition, maternal stress, smoking, and emotional stress (Ashdown-Lambert, 2005, Macfarlane and Mugford, 2000).

High birth weight, or macrosomic, infants are at a higher risk of problems such as shoulder dystocia and brachial plexus injury (Boulvain et al., 2009). The increased risks have led some to suggest early intervention through induction or caesarean section for suspected macrosomia (Boulvain et al., 2009, Chauhan et al., 2005). However, there is insufficient evidence of the benefit of early intervention, particularly as accurate diagnosis of macrosomia is difficult (Boulvain et al., 2009, Chauhan et al., 2005, National Institute for Health and Clinical Excellence, 2008b).

Twelve studies adjusted for birth weight in relation to mode of birth; three English (Alves and Sheikh, 2005, Paranjothy et al., 2005, Patel et al., 2005), one Italian (Cesaroni et al., 2008), four American (Braveman et al., 1995, Gareen et al., 2003, Heffner et al., 2003, Main et al., 2000), one Brazilian (Gomes et al., 1999), two Australian (Read et al., 1994, Roberts et al., 2002) and one French (Guihard and Blondel, 2001) (Table A2.29).

International Classification of Diseases (ICD-10) define low birth weight (LBW) as less than 2500g, very low birth weight (VLBW) as less than 1500g and extremely low birth weight as less than 1000g. A birth weight higher than 4000g has previously been used as a cut-off for high birth weight infants (Thomas and Paranjothy, 2001). All studies, except for one, included normal birth weight infants in their reference group and compared the normal weight infants to low birth weight infants, high birth weight infants, or both. The exception was the English study by Patel and colleagues, which analysed birth weight in their analysis as a continuous variable (Patel et al., 2005).

Most studies (6/7) which included LBW infants found increased caesarean section rates among mothers who had a LBW infant (Braveman et al., 1995, Cesaroni et al., 2008, Guihard and Blondel, 2001, Heffner et al., 2003, Paranjothy et al., 2005, Patel et al., 2005). The exception was the Australian study by Roberts and colleagues. They used a higher birth weight category as their reference (3000-3499g) and looked at all operative births as the outcome (caesarean sections and instrumental vaginal births), and found that mothers who had LBW infants did not have significantly different modes of birth (Roberts et al., 2002).

All studies assessed higher birth weight infants, and all found increased rates of intervention for high birth weight infants. Most studies assessed overall caesarean section rates (Braveman et al., 1995, Cesaroni et al., 2008, Gareen et al., 2003, Gomes et al., 1999, Guihard and Blondel, 2001, Heffner et al., 2003). The three English studies assessed elective caesarean sections separately, with mixed results. Alves and Sheikh, in their large sample, found that mothers who gave birth to heavier weight babies were more likely to have an elective caesarean section (Alves and Sheikh, 2005), whereas Paranjothy and colleagues and Patel and colleagues found no significant

association between birth weight and elective caesarean sections (Paranjothy et al., 2005, Patel et al., 2005). For the studies which assessed emergency caesarean section, all found that mothers with high birth weight infants were more likely to have an emergency caesarean section (Main et al., 2000, Paranjothy et al., 2005, Patel et al., 2005, Read et al., 1994). One Australian study assessed instrumental births and also found an increased risk for mothers with high birth weight infants (Read et al., 1994).

The majority of studies adjusted their results for many other maternal characteristics, indicating that both low and high birth weight have a significant and independent effect on mode of birth, especially emergency caesarean sections. In support of this, Patel and colleagues statistically modelled the relationship between birth weight (as a continuous variable) and mode of birth and found a non-linear J-shaped relationship, with the extremes of birth weight increasing the odds of emergency caesarean section (Patel et al., 2005).

In the NSCSA, mothers with a high birth weight baby (>4000g) who had an emergency caesarean section, were more likely to fail to progress in labour (Thomas and Paranjothy, 2001). This may suggest that women carrying heavier, and therefore larger, infants have more problems giving birth vaginally. LBW infants are at greater risk of other neonatal problems (Thomas and Paranjothy, 2001), which could explain the association with increased operative birth.

2.3.3 Sex

Eight studies assessed fetal sex in relation to mode of birth. Studies were from England (Agarwal et al., 2009), Scotland (Hall and Carr-Hill, 1982), The Netherlands (Bekedam et al., 2002), Italy (Cesaroni et al., 2008), the USA (Lieberman et al., 1997), Ireland (Eogan et al., 2003), Australia (Read et al., 1994) and Malaysia (Viegas et al., 2008) (Table A2.30). All studies found that mothers with a male fetus were more likely to have an operative birth than mothers with a female fetus.

One explanation of the difference in mode of birth between mothers with male and female fetuses could be fetal size. Male fetuses have been found to be larger than females, with larger head circumferences and longer bodies (Copper et al., 1993). However only three studies presented results adjusted for markers of fetal size such as birth weight (Bekedam et al., 2002, Lieberman et al., 1997, Read et al., 1994), and head circumference (Lieberman et al., 1997). Lieberrnan and colleagues (1997) investigated the indications for caesarean section and found that mothers with a male fetus were twice as likely to have a caesarean section for fetal distress than mothers with a female fetus, but that there was no significant difference for caesarean sections for failure to

progress. The authors suggest developmental and hormonal differences between male and female fetuses could explain the results (Lieberman et al., 1997).

2.4 Conclusion

Although this literature review of the maternal and infant risk factors for mode of birth covers an extensive range of mother and infant characteristics, the volume of literature across these characteristics was enormously varied. For factors such as advancing maternal age and obesity, both of which have gained much public attention regarding pregnancy outcomes, there was extensive literature available; either as studies had adjusted for these factors amongst others in relation to mode of birth, or, especially in the case of obesity, much research had been carried out directly assessing the factor in relation to mode of birth. Conversely, many sections of the literature review contain few studies regarding mode of birth and there are few UK-based studies assessing maternal or infant characteristics, in relation to mode of birth. Of the over 60 studies selected for this review, only 14 were from the UK (10 English and 4 Scottish).

Some studies identified in the search also did not use multivariate techniques to control for confounding factors. For example, the large 1994/1995 audit of 23 consultant-led maternity units in Scotland presented results only as unadjusted rates of emergency and elective caesarean sections within groups (McIlwaine et al., 1998, Wilkinson et al., 1998), making the findings difficult to interpret.

The majority of studies did not distinguish between elective and emergency caesarean sections, or include instrumental vaginal births separately. This causes problems in the interpretation of the results, as the reasons for elective procedures such as planned caesarean section, and those which are unplanned or emergency such as instrumental vaginal births and emergency caesarean sections can be very different.

2.5 Research questions

It is clear from the literature that there is a need for more multifactorial UK-based studies assessing which maternal and infant risk factors are significantly and independently associated with mode of birth. In addition, several specific gaps in the literature are apparent, which warrant further exploration:

2.5.1 Age

A large amount of literature examining the effect of maternal age on mode of birth was identified during the review. The literature told a clear story; that operative births increase with increasing maternal age. However, the following areas warrant further exploration:

i. What is the relationship between maternal age and complications in pregnancy and labour progress?

2.5.2 Socio-economic status

The few UK studies which have explored the relationship between socio-economic status and mode of birth have mostly assessed area-level deprivation, finding an association between affluence and elective caesarean sections, but not emergency caesarean sections. A further study examined maternal social class. Both may be poor measures of socio-economic status. Three specific research questions arose:

i. Is the effect of socio-economic status on mode of birth explained or modified by maternal age?
ii. Is smoking in pregnancy a risk factor for mode of birth, or is it simply a marker of maternal social disadvantage?
iii. Does *paternal* age have an effect on mode of birth in the UK, after adjustment for maternal age and socio-economic factors?

2.5.3 Ethnicity

i. Is the effect of maternal age on mode of birth modified by ethnicity, in accordance with the 'weathering hypothesis'?
ii. Is the effect of maternal height on mode of birth modified by ethnicity?
iii. Is the link between ethnicity and mode of birth explained by women's health during pregnancy or complications in labour?

2.5.4 Fetal sex

All eight studies found that mothers who were carrying a male fetus were more likely to have an operative birth than mothers with a female fetus, and research suggests that mothers carrying male infants may be more likely to be diagnosed with fetal distress during labour. Male fetuses have been found to be larger on average than female fetuses, but only three non-UK studies presented results adjusted for markers of fetal size such as birth weight.

i. Is fetal sex related to mode of birth in the UK? If so, is this effect independent of birth weight and gestational age? Are mothers carrying male fetuses more likely to have suffered problems during pregnancy or labour?

CHAPTER 3: The Millennium Cohort Study: Methods

3.1 Introduction

This chapter is presented in five main sections. Firstly, the design and sampling of the Millennium Cohort Study, from which the data for this thesis derive, is described. Secondly, details are given of how the analytical sample was chosen. The measures selected to address the research objectives are then explained, including details of coding, followed by an overview of the statistical methods used throughout the thesis. Lastly, a description of the analytic sample is provided.

3.2 The sample

The data for this study came from the Millennium Cohort Study (MCS) which is a large-scale study of the new century's babies and the families who are bringing them up, for the four countries of the United Kingdom. It is the fourth of Britain's birth cohort studies (large samples of individuals, born over a limited period of time in 1946, 1958 and 1970 who are also being followed through the course of their lives). The first sweep of the MCS was carried out from September 2000 to August 2001 in England and Wales, forming an academic cohort. To prevent overlaps with the infant feeding survey, data collection in Scotland and Northern Ireland began in November 2000, and was extended to January 2002 due to a shortfall in numbers (Dex and Joshi, 2004). The first sweep contains information on 18,818 babies in 18,552 families, collected from the parents when the babies were around 9 months old (75% 9 months, 19% 10 months, 3% both 8 and 11 months) (Dex and Joshi, 2004).

The sample design allowed for over-representation of areas with high proportions of ethnic minorities in England, deprived areas with high child poverty, and the three smaller countries of the UK (Plewis et al., 2004). 'Minority ethnic' wards were those in which at least 30% of the total population were in the categories 'Black' or 'Asian'. 'Disadvantaged' wards were those not classified as ethnic, but which were included in the poorest 25% of all wards based on the Child Poverty Index (CPI). 'Non-disadvantaged' wards were those which were not classed as ethnic or disadvantaged. (It should be noted that the majority of 'minority ethnic' wards would also have fulfilled the criteria for a 'disadvantaged' ward.)

The population of eligible live births was selected from a weighted random sample of 398 UK electoral wards. All children with eligible birth dates were taken from the Child Benefit Register, if they were living in one of the electoral wards when they were 9 months old (Dex and Joshi, 2004).

Children who had died or emigrated from the UK before 9 months were excluded (Joshi et al., 2002). A minority (2.5%) of 'sensitive cases' were not released for inclusion, for example due to a child death in the family in the last five years, or if the child had been taken into care (Joshi et al., 2002). Around 3% of children would not be on the Child Benefit records, so local Health Visitors were asked to forward the names and addresses of the families not on the records (Hansen et al., 2010). Births not eligible for Child Benefit include those to people such as diplomats, some foreign students, and asylum seekers. In addition, Child Benefit records may not be up-to-date if families have recently moved, which is common among families with new children (Joshi et al., 2002).

The completed overall response rate was 72 per cent. Compared to the 'non-disadvantaged' wards, response rates were lower for families living in disadvantaged wards and lowest for families from ethnic wards. Responses were also lower for families from Northern Ireland compared to the other countries (Dex et al., 2005). Detailed information regarding the sampling strategy and response rates can be found in the technical report (Plewis et al., 2007).

Data were collected through face-to-face Computer Assisted Personal Interviews (CAPI) and Computer Aided Self-Completion Interviews (CASI). The objective was to interview the cohort member's mother and her partner, if co-resident (Shaw and Calderwood, 2004). The main interviewee in the vast majority of cases was the natural mother, and 89% of resident partners were interviewed. The personal interviews collected information about the following areas: pregnancy, labour and delivery; baby's health and development; childcare; Grandparents and friends; parent's health; employment and education; housing and local area; and interests and time with baby. The main elements of the self-completed questions were relationship with partner; previous relationships; domestic tasks; previous pregnancies; mental health; and attitudes to relationships, parenting and work (Dex and Joshi, 2004).

Interview transcripts were in English. Therefore, for respondents who could not speak English, interviews were conducted through use of a translator. Translators could be a family member (but not children) or, if no translator was available, a translator from the National Centre for Social Research was provided (Shaw and Calderwood, 2004). Interviews carried out in verbal translation included Bengali, Gujarati, Kurdish, Punjabi, Somali, Turkish, Urdu, Arabic, Hindi and Tamil, and a small number in Welsh (Dex et al., 2005). Main interviews were entirely non-English in 226 cases (1%) and a further 547 (3%) contained a mixture of English and non-English.

Follow-up interviews have been carried out at ages 3, 5 and 7 and a fifth sweep will take place in 2012, when the children are around 11 years old. Full details of the survey are contained within the documentation supplied with the data with the Economic and Social Data Service (Economic and

Social Data Service, 2010) and at the Centre for Longitudinal Studies at the Institute for Education, University of London (www.cls.ioe.ac.uk).

In 2007, centrally-collected hospital level data were made available that could be linked to the MCS data (Dezateux et al., 2006, Johnson, 2007). However, hospital data were not utilised for this study due to data quality and availability issues which are described in Appendix 2.

3.3 Selection of the analytic sample

Information from the first sweep included 18,552 families. Natural mothers were the main respondents for the interviews; however some interviews were conducted where the natural mother was not the main respondent. These families were excluded from this analysis as only data from natural mothers who gave birth to the cohort child were relevant. This reduced the sample to 18,495 by excluding 28 natural fathers, 2 sets of adoptive parents, 2 sets of foster parents, 5 sets of maternal grandparents and 20 other cases where the natural mother was not interviewed.

Families with one cohort child, twins and triplets were interviewed for the MCS. As mothers who gave birth to more than one child would be more likely to have a longer and more complicated labour and birth, the families with more than one cohort child were excluded; this included 246 families with twins and 10 families with triplets, reducing the final dataset figure to 18,239 mother-infant pairs.

3.4 Measures

3.4.1 Outcome variable: Mode of birth

Information was collected from mothers concerning the type of birth they had experienced with the following question:

"What type of delivery did you have? Was it...

- *a normal delivery,*
- *assisted with forceps,*
- *assisted vacuum extraction,*
- *assisted breech,*
- *a planned caesarean,*
- *an emergency caesarean,*
- *or, another type of delivery?"*

Mode of birth initially included 10 categories. This was re-coded to include 4 categories (unassisted vaginal, instrumental vaginal, planned caesarean section and emergency caesarean section); by grouping all instrumentally assisted births together (vacuum extraction, forceps, assisted breech and other assisted births), grouping water births with unassisted vaginal births and making two further small categories of 'other answer' and 'another type of delivery' missing.

Just fewer than 300 women (less than 2%) reported more than one response for mode of birth. Combinations of first and subsequent responses were examined. For over half, the first and subsequent responses were coded the same; e.g. first response = vacuum extraction, second response = forceps, both of which were coded 'instrumental'. For the remainder of women the more invasive mode of birth response was coded as the primary mode of birth, e.g. emergency caesarean section was taken over instrumental birth (see Appendix 3 for further details).

3.4.2 Independent variables

3.4.2.1 Socio-demographic factors

Maternal age was measured in years. Both age at cohort member birth and age at first birth were categorised as mothers 19 or younger, 20-24, 25-29, 30-34, 35-39 and 40 or older, similar to the categories used in a similar UK study (Paranjothy et al., 2005). Parity was coded as primiparous or multiparous. In the MCS, mothers were not directly asked whether the cohort child was their first, or at what age they had first given birth. Fiona Mensah, formerly a researcher in the Department of Social Policy at the University of York, has developed an algorithm to estimate parity and age at first birth using available questions about previous children: including the number of siblings in the household, number of other children not living in the household and whether the mother had ever had a stillborn birth (Mensah, F, personal communication by email. 15 July 2008).

3.4.2.2 Ethnicity, language and migration status

The six category version of ethnicity based on the census classification was used (White, Indian, Pakistani and Bangladeshi, Black, Mixed and other), but women of 'other' ethnic group were excluded due to the heterogeneous nature of the group (see Chapter 6). The first language spoken at home was coded as English speaking or non-English speaking. Migration status was derived from questions included in the second wave of the MCS (at age 3). Mothers were asked if they were born in the UK, and if not, what year they came to live in the UK. Migration status was coded as lived in the UK since birth, born abroad but lived in the UK for more than five years, or born abroad and lived in the UK for less than five years.

3.4.2.3 Socio-economic factors

In the MCS, information regarding socio-economic status (SES) was collected at around 9 months after birth and referred to current SES. Socio-economic factors at 9 months could be used as a proxy measure of pregnancy SES if it could safely be assumed that changes in socio-economic position would be unlikely between pregnancy and 9 months postpartum. However, the period around pregnancy and birth is a period of socio-economic change for many families. Mothers may leave employment, or take up employment or discontinue education, a different residential environment may be needed and social benefit entitlement may change. Significant levels of mobility around pregnancy and birth occurred for MCS families, particularly among the youngest mothers and mothers from the most disadvantaged backgrounds (Tunstall et al., 2010). Using proxy measures of pregnancy SES from 9 months after birth could bias estimates of associations with mode of birth, especially when examining SES factors which are most likely to change, such as area and family income based measures. After consultation with Helena Tunstall (a Researcher in the Department of Health Sciences at the University of York with a special interest in geographical inequalities in health), maternal education and household social class were chosen as measures of SES at 9 months that were likely to most closely reflect the socio-economic position prior to birth (Tunstall, H, personal communication by email. 8 February 2010).

Mother's educational attainment was classified in 7 groups based on the National Vocational Qualification Scale (NVQ), ranging from no qualifications to postgraduate degree level qualifications (NVQ level 5) with a separate category for mothers with overseas qualifications. Mothers with degree level (NVQ level 4) and postgraduate level education (NVQ level 5) were combined. Social class was measured according to occupation using the National Statistics Socio-economic Classification (NS-SEC). For the purposes of this study, social class was based on the person in the household with the highest occupational level, using maternal occupation and partner occupation, if available. The version of the NS-SEC with seven categories ranging from routine occupation, to higher managerial and professional occupation was used, and individuals who were unclassified were also retained for the purpose of the analysis.

3.4.2.4 Maternal height

Self-reported height was measured in centimetres. A categorical variable was created including five categories of height: shorter than 154cm (approximately 5ft 1), 154-159cm, 160-165cm, 166-171cm and taller than 171cm (approximately 5ft 7). These categories are the same as those used in a previous UK study examining height in relation to mode of birth (Mahmood et al., 1988). According to the most recent health survey for England (The NHS Information Centre, 2008), the mean height for a woman in England is 161.6cm.

3.4.2.5 Interpersonal factors

To determine interpersonal factors prior to birth, information regarding whether the mother left home before the age 17, whether her parents were ever permanently separated and how the mother felt when she discovered the pregnancy were included. Whether the mother left home before the age of 17 was coded as yes or no, with mothers who left home to go to boarding school being classed as never having left home. Whether the mother's own parents were ever separated was coded as yes or no, with those whose parents were never together being coded as separated. How the mother felt about the pregnancy was recorded as "very happy"; "happy"; "not bothered either way"; "unhappy" or "very unhappy". This was re-coded to create a variable including all mothers who were happy or very happy, vs. all other mothers.

3.4.2.6 Pregnancy factors

To measure factors related to the mother's pregnancy, information regarding whether the mother had received fertility treatment, whether the pregnancy was planned, and whether antenatal care was received were used.

Fertility treatment was coded as yes or no, with 'not applicable' mothers included with the mothers who responded 'no'. Whether the pregnancy was planned was coded as "planned to get pregnant" vs. "pregnancy was a surprise". Antenatal care was initially two variables; whether the woman received any antenatal care and if so, did she attend any antenatal classes. This was re-coded to create one variable with the categories "received care and attended classes", "received care but did not attend classes", and "did not receive care or attend classes".

3.4.2.7 Health factors

To determine women's health during pregnancy, pre-pregnancy BMI, smoking during pregnancy and complications or illness during pregnancy were measured.

Body mass index (BMI) was calculated using self-reported height and weight before pregnancy. BMI was classified according to the guidelines used by the World Health Organization (WHO): a BMI score less than 18.4 = underweight, between 18.5 and 24.9 = ideal, between 25 and 29.9 = overweight, between 30 and 34.9 = obese and greater than 35 = severely obese (World Health Organization, 2006).

Mothers were asked how many cigarettes they smoked per day prior to pregnancy, whether they had changed the number of cigarettes smoked during pregnancy, and the number of cigarettes they

smoked per day after the change. In line with a previous study of mothers' smoking behaviour in the MCS (Pickett et al., 2009), mothers were classified as (a) never having smoked, (b) quit smoking during pregnancy (c) light smokers during pregnancy (less than 10 cigarettes per day) and (d) heavy smokers during pregnancy (10 or more cigarettes per day).

Women were asked if they had experienced any problems or illnesses during pregnancy for which they had received medical attention. Problems during pregnancy initially included over 20 different categories. This was re-coded on the advice of Helen Baston, Consultant Midwife and co-supervisor of the study, to include mothers who had no complications, mothers who had complications that could be possible risk factors or indications for caesarean section (e.g. bleeding in later pregnancy, pre-eclampsia, diabetes, symphysis pubis dysfunction, fetal distress, placenta praevia) and other complications (e.g. vomiting, urinary infection, allergies, backache, early rupture of membranes) (Baston, HA, personal communication. 26 February 2008). Mothers could report multiple responses so these were combined to create dummy variables, e.g. caesarean section risk factor – yes or no (see Appendix 3).

3.4.2.8 Labour and birth factors

To identify characteristics of labour and birth, measures regarding complications during labour, whether the labour was induced and whether the mother had a companion with her during the labour and birth were included. Whether the labour was induced (or attempted to be induced) was coded as yes or no. Companionship was coded as those who were accompanied or unaccompanied. Complications during labour initially included over 20 categories. These were reduced to include no complications, malpresentation, fetal distress (e.g. heart rate sign, meconium, cord around the neck) and other complications (e.g. very long labour, raised blood pressure, haemorrhage) (Baston, HA, personal communication. 26 February 2008). As with problems during pregnancy women could report multiple responses, so these were combined (see Appendix 3).

3.4.2.9 Infant factors

To determine infant characteristics, birth weight, gestational age and infant sex were included. Birth weight was measured in kilos. A categorical version of the variable was created by grouping together all infants with a very low birth weight (<1.50kg), low birth weight (1.50-2.49kg), normal weight (2.50-3.99kg) and high birth weight (>4.00kg). Gestational age was initially measured in days. To create a categorical variable gestation was re-coded into weeks and then grouped according to completed weeks; <33, 33-36.9 (preterm), 37-41.9 (normal) and >42 (post-term).

3.5 Statistical methods

The disproportionately stratified sampling strategy used in the MCS meant that some children, for example those born in disadvantaged or minority ethnic families, had a greater chance of being selected for the study. All analyses were therefore conducted using survey weights. Throughout the thesis reported counts are unweighted, but percentages, means, and regression coefficients are weighted, and statistical tests take account of survey weights. These weights allow inference to the UK population.

Descriptive statistics were used to describe the characteristics of women who had different modes of birth, and their infants. Multinomial logistic regression models were used to estimate relative risk ratios for mode of birth in relation to socio-demographic, socio-economic, interpersonal, pregnancy, labour and birth and infant characteristics. Multinomial logistic regression models are appropriate when the outcome is categorical, with more than two categories. As such the baseline category in all models was unassisted vaginal birth, and the risks of instrumental vaginal birth, emergency caesarean section and planned caesarean section were those compared to the risk of unassisted vaginal birth. Analyses were mainly stratified by parity and a significance level of <0.05 was used throughout.

To identify the important characteristics which predict mode of birth in Chapter 10 (or attendance at antenatal care and antenatal classes in Chapter 9), a three-step process of multivariate model building was used. Firstly, the unadjusted relationship between covariates and mode of birth were explored. Secondly, characteristics found to be significantly related to mode of birth in the unadjusted analyses were modelled together with similar characteristics, e.g. education and social class, in ‘domain’ models. Thirdly, characteristics found to be significantly related to mode of birth from each domain model were added into a final model. Covariates were only dropped from further models if they were non-significantly related to each part of the model, i.e. to instrumental birth, emergency caesarean section and planned caesarean section. At the outset of Chapter 9 and Chapter 10 figures are presented to describe the models for primiparous and multiparous mothers. All figures presenting relative risk ratios and confidence intervals from the multivariate models are on the logarithmic scale.

Throughout the thesis ‘complete-case’ analyses were performed, with data presented only for women with valid responses to each of the questions of interest after coding. Multivariate regression models therefore included only women with data for each of the variables included in the respective regression models. However, as shown in Table 3.1, most variables had very low levels of missing data, at 2% or less. Partner age, migration status and BMI had the highest levels of missing data at 17.7%, 20.2% and 6.3%, respectively. Partner age at birth was only available for

women with partners and was not in fact included in final multivariate models. Migration status was the only variable included from wave 2 of the MCS, as the information was not collected in wave 1. Detailed information has been published about the women who were not followed-up at wave 2 (Plewis, 2007), who were more likely to be younger, of an ethnic minority group (particularly Black or 'Other'), from poorer backgrounds and living in rented accommodation compared to women who were successfully followed-up. However, women with missing data on migration were compared to those in the remaining sample and had very similar rates of operative births. Women with missing data on BMI were also explored. They were similar to women with BMI in terms of operative birth rates, however, ethnic minority women, particularly Pakistani/Bangladeshi and Black women were more likely to have missing BMI (21% and 18% respectively compared to 4% for White women). As we know these women are more likely to be overweight than other ethnic groups, any increased risk of operative birth with BMI could be somewhat underestimated.

Although the sample size of the MCS is large, stratification by mode of birth, parity and other characteristics produced some small cell numbers which may have reduced the power of some analyses. Unweighted frequencies were considered when interpreting the results of models.

Due to the number of tests conducted, the issues of multiple testing were also considered in the interpretation of the results. With a p-value of 0.05 we expect that 1 in 20 of the tests conducted may have produced a significant result by chance. Although no formal method was used to deal with the issues of multiple testing, the data were interpreted with this issue in mind, taking into account not only the significance of the results, but also the patterns observed, consistency, and size of effects.

Throughout the results chapters, figures are embedded in the text and tables can be found in Volume 2, for ease of reference. Tables labelled with an 'A' are included in Volume 2.

3.6 Characteristics of the analytic sample

Table 3.1 shows the characteristics of mothers and their infants for the whole analytic sample. The mothers were mainly White (90%), with more than 90% born in the UK and the majority of those born outside of the UK having lived in the UK for more than five years. Just over 2% of mothers lived in non-English speaking households. More than 12% of mothers had no educational qualifications, and around 22% were from the lowest social class households (routine and semi-routine).

Around 13% of mothers had left home before the age of 17 and over 30% came from a family where their own parents had separated. Just over 15% of mothers were unhappy or 'not bothered' when they discovered they were pregnant. Most mothers had planned the cohort pregnancy, but for over 40% the pregnancy had been a surprise. Around 3% of mothers had received fertility treatment for the cohort pregnancy.

Approximately 30% of mothers reported a pre-pregnancy weight classed as overweight or obese for their height, and over 21% smoked throughout pregnancy. Mothers were asked if they had had a problem or illness during pregnancy for which they had sought medical attention. Over 13% of mothers reported a complication in pregnancy that could be a risk factor for caesarean section, and approximately 32% had another type of problem or illness during their pregnancy. Over 97% of mothers received antenatal care, but only 37% also attended antenatal classes.

Approximately 68% of mothers had an unassisted vaginal birth, 10% had an instrumental birth and 21% had a caesarean section (including 12% emergency and 9% planned). Around 30% of mothers had their labour induced and over 32% of women reported having complications during labour. More than 4% of women reported being unaccompanied during their labour and birth.

Six per cent of infants were low birth weight and over 13% were high. Over 7% had been born preterm and around 4.5% were born post-term. Just under half (48.6%) were female.

Table 3.1: Characteristics of natural mothers in the MCS who gave birth to one child

Characteristics of mothers and their infants		**Unweighted sample size n = 18,239**	**Weighted percentages**	**Unweighted frequency (%) missing data**
Socio-demographic factors				
Age at cohort member birth (years)		n=18,231		8 (0.04)
	19 or younger	1,580	7.4	
	20-24	3,516	16.2	
	25-29	5,045	27.6	
	30-34	5,250	31.5	
	35-39	2,458	15.2	
	40 and older	382	2.2	
		Min=13	Mean = 28.9	
		Max=48	CI = 28.6-29.1	
Age at first birth (years)		n=17,981		258 (1.4)
	19 or younger	3,822	18.0	
	20-24	5,185	25.3	
	25-29	4,928	29.7	
	30-34	3,112	20.9	
	35-39	847	5.7	
	40 and older	87	0.5	
		Min=12	Mean = 25.6	
		Max=48	CI = 25.4-25.9	
Age of partner at cohort member birth		n=15,019		3,220 (17.7)
	19 or younger	250	1.4	
	20-29	5,059	30.4	
	30-39	8,194	57.9	
	40 and older	1,516	10.3	
Parity		n=17,996		235 (1.3)
	Primiparous	7,432	42.3	
	Multiparous	10,564	57.7	
Ethnicity, language and migration status				
Ethnicity		n=17,861		378 (2.0)
	White	15,285	90.5	
	Mixed	188	1.0	
	Indian	472	1.9	
	Pakistani and Bangladeshi	1,254	4.0	
	Black or Black British	665	2.7	

First language		n=18,239		0
	English spoken at home	17,528	97.7	
	Other languages	710	2.3	
How long lived in the UK*		n=14,544		3,695 (20.2)
	Since birth	12,657	90.2	
	More than 5 years	1,307	7.1	
	Less than 5 years	580	2.7	
Socio-economic factors				
Educational level		n=18,208		31 (0.2)
	NVQ level 4 and 5	5,279	33.5	
	NVQ level 3	2,576	14.2	
	NVQ level 2	5,280	29.6	
	NVQ level 1	1,542	8.2	
	None	2,976	12.1	
	Overseas qualification	555	2.4	
Highest social class in household		n=18,239		0
	Higher managerial and professional	2,598	18.6	
	Lower managerial and professional	4,394	27.2	
	Intermediate	2,372	13.0	
	Small employers and self-employed	1,170	6.5	
	Lower supervisory and technical	1,670	8.5	
	Semi-routine	3,056	13.8	
	Routine	1,802	8.0	
	Unclassified	1,177	4.5	
Maternal height				
Height (cm)		n=17,963		276 (1.5)
	<154	1,264	5.7	
	154-159	3,444	17.7	
	160-165	7,015	39.2	
	166-171	3,980	23.5	
	>172	2,260	14.1	
Interpersonal factors				
Left home before 17		n=18,214		25 (0.1)
	No	15,709	86.8	
	Yes	2,505	13.2	
Parents ever separated		n=18,236		3 (0.02)
	No	12,784	69.3	
	Yes	5,452	30.7	

Feelings about pregnancy		n=18,175		64 (0.35)
	Unhappy or not bothered	3,184	15.7	
	Happy	14,991	84.3	
Pregnancy factors				
Fertility treatment		n=18,233		6 (0.03)
	Yes	420	2.7	
	No	17,813	97.3	
Planned pregnancy		n=18,208		31 (0.17)
	Planned to get pregnant	9,812	58.1	
	Pregnancy was a surprise	8,396	41.9	
Antenatal care		n=18,228		11 (0.06)
	Received care, attended classes	6,134	36.9	
	Received care, did not attend classes	11,399	60.3	
	Did not receive care, did not attend classes	694	2.9	
Health factors				
Pre-pregnancy BMI		n=17,093		1,146 (6.3)
	Underweight (<18.5)	1,031	5.4	
	Ideal (18.5-25)	11,139	66.3	
	Overweight (25-30)	3,417	19.6	
	Obese (30-35)	1,074	6.3	
	Severely obese (>35)	432	2.5	
Smoking in pregnancy		n=18,232		7 (0.04)
	Never smoked	11,698	65.7	
	Quit during pregnancy	2,319	13.3	
	Light (<10 cigarettes per day)	2,333	12.0	
	Heavy (≥10 cigarettes per day)	1,882	9.1	
Problem or illness in pregnancy		n=18,226		13 (0.07)
	No problem Yes	11,386	60.7	
	No	6,840	39.3	
	CS risk factor Yes	2,385	13.8	
	No	15,841	86.2	
	Other complication Yes	5,520	31.7	
	No	12,706	68.3	

Characteristics of labour and birth					
Mode of birth			n=18,208		31 (0.2)
	Unassisted vaginal		12,505	68.1	
	Instrumental vaginal		1,776	10.4	
	Planned caesarean section		1,668	9.1	
	Emergency caesarean section		2,255	12.4	
Labour induced or attempted induction			n=18,217		22 (0.1)
	Yes		5,646	29.8	
	No		12,571	70.2	
Complications during labour and birth			n=17,835		404 (2.22)
	No complications	Yes	12,417	67.8	
		No	5,418	32.3	
	Malpresentation	Yes	1,088	6.7	
		No	16,747	93.3	
	Fetal distress	Yes	3,049	18.3	
		No	14,786	81.7	
	Other	Yes	2,273	13.4	
		No	15,562	86.6	
Companion during labour and birth			18,235		4 (0.02)
	Yes		17,265	95.7	
	No		970	4.3	
Infant factors					
Birth weight (kg)			n=18,218		21 (0.1)
	VLBW (<1.50)		142	0.7	
	LBW (1.50-2.49)		1,048	5.3	
	Normal (2.50-3.99)		14,812	81.2	
	High BW (>4.00)		2,216	12.8	
Gestational age (weeks)			n=18,061		178 (0.9)
	<33 (very premature)		247	1.3	
	33-36.9 (preterm)		1,043	5.8	
	37-41.9 (term)		15,994	88.5	
	>42 (post-term)		777	4.5	
Sex			n=18,239		0
	Male		9,381	51.4	
	Female		8,858	48.6	

*Migration status was taken from wave 2 of the MCS

CHAPTER 4: The Millennium Cohort study: Bivariate analyses

4.1 Introduction

The literature review of maternal and infant risk factors for operative birth (see Chapter 2), identified only two UK-based studies (both English), which had large samples and included statistical adjustment to establish which factors were significantly and independently related to caesarean section (Paranjothy et al., 2005, Patel et al., 2005). The Millennium Cohort Study provided a large UK-based data set in which to extend the analysis of the maternal and infant characteristics of mothers who have caesarean sections, as well as an opportunity to explore the predictors of instrumental births.

This chapter includes analyses of the maternal and infant risk factors for mode of birth within the MCS, described in Chapter 3. Bivariate (unadjusted) analyses are presented for mothers' socio-demographic, socio-economic, interpersonal, pregnancy, health and labour characteristics, as well as infant characteristics, in relation to mode of birth.

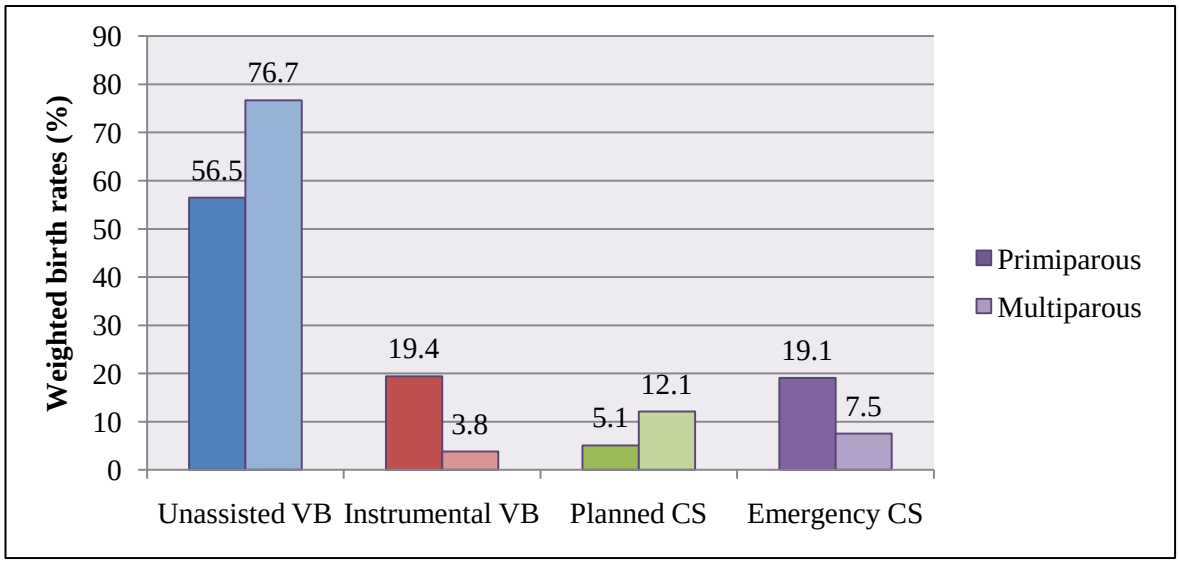
Exploring the unadjusted relationship between maternal and fetal characteristics and mode of birth provides a platform for further analyses. Due to the interrelationship between many of these characteristics, further analyses in Chapters 5 through 7 and Chapters 9 and 10 will establish the *independent* effects of any factors found to be significantly related to mode of birth in this chapter.

Table A4.2 presents the unadjusted characteristics of mothers and infants by their mode of birth, stratified by parity. Unweighted frequencies and weighted percentages are presented, with p-values from chi squared tests. Any description of results refers to significant associations, and factors which were not significantly related are highlighted in the text. Characteristics with an apparent gradient effect on mode of birth were tested for significance using trend tests, the results of which are presented in Table A4.3.

4.2 Results: Unadjusted maternal and fetal risk factors for mode of birth

Unplanned operative birth rates were high for primiparous mothers in the MCS, with almost 40% having an instrumental birth or an emergency caesarean section. Multiparous mothers had higher rates of *planned* caesarean sections and unassisted vaginal births, compared to women for whom the cohort birth was their first (see Figure 4.1).

Figure 4.1: Mode of birth by parity

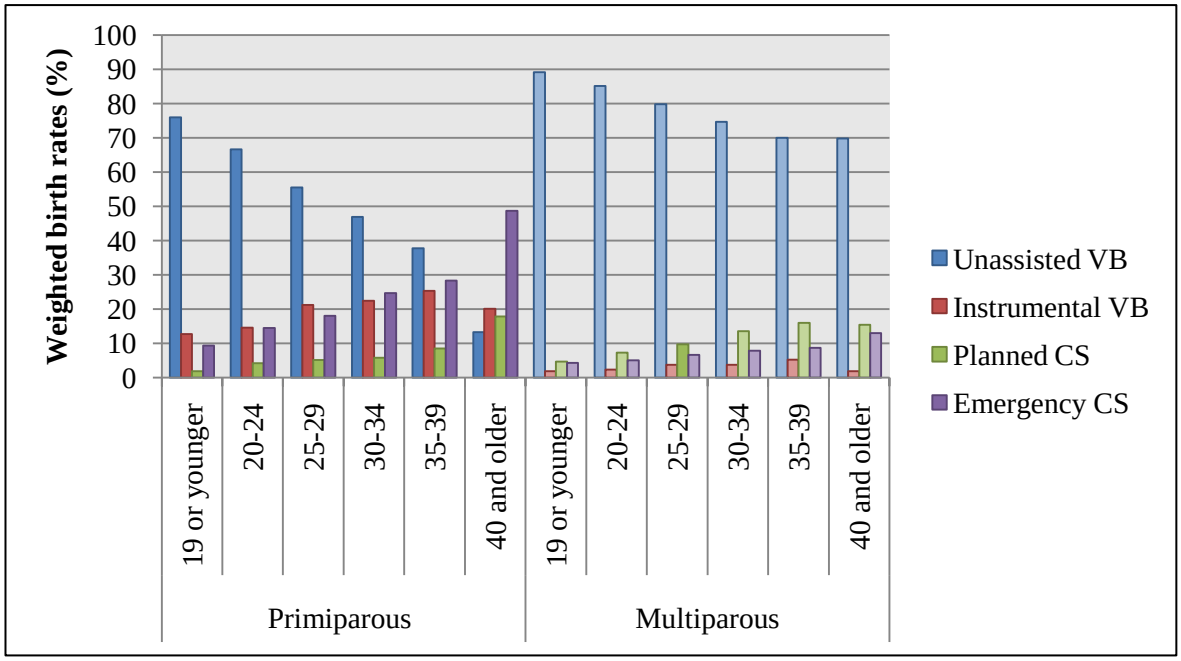


4.2.1 Socio-demographic factors

4.2.1.1 Maternal age at MCS birth

For both primiparous and multiparous mothers, there was a very clear gradient of increasing likelihood of operative birth with increasing age (see Figure 4.2). Tests for trend confirmed significant upward trends of operative births with increasing age, the strongest of which was for planned caesarean section (see Table A4.2). Younger mothers were much more likely to have an unassisted vaginal birth and much less likely to have an operative birth, especially a planned caesarean section. Over three-quarters of first-time teenage mothers had an unassisted vaginal birth compared to only 13% of mothers aged 40 and older. Although rates of operative births increased with maternal age for mothers having a subsequent birth, a large proportion of older multiparous mothers had an unassisted vaginal birth. In fact, rates of unassisted vaginal births among older multiparous mothers were comparable to the rates for first-time mothers in their early twenties.

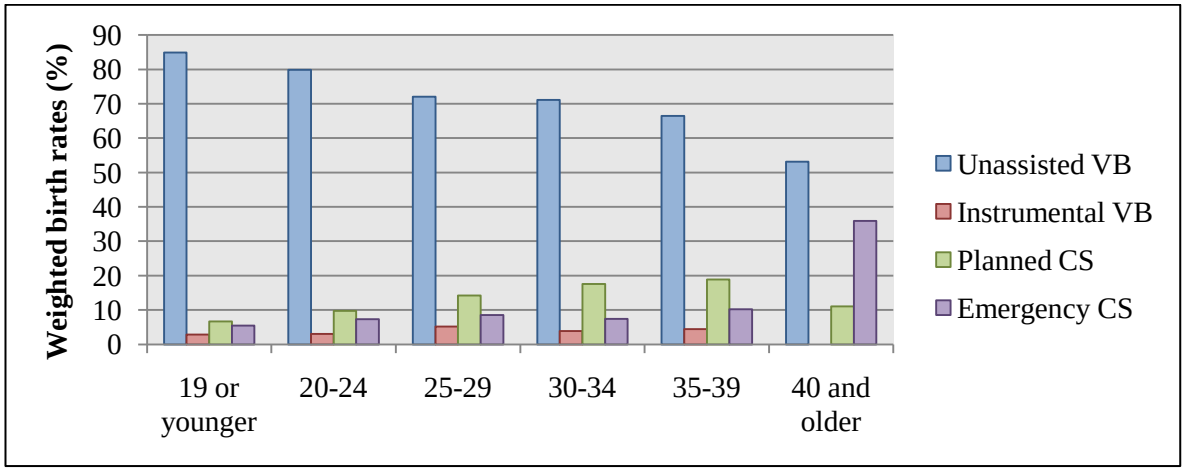
Figure 4.2: Mode of birth by maternal age and parity



4.2.1.2 Maternal age at first birth

Age at first birth was also examined for multiparous women in the MCS. Mothers who were younger at their first birth were less likely to have an operative birth in the subsequent MCS birth (see Figure 4.3). As with age at cohort member birth the trend of increasing operative births with increasing age at first birth was significant, and strongest for planned caesarean section.

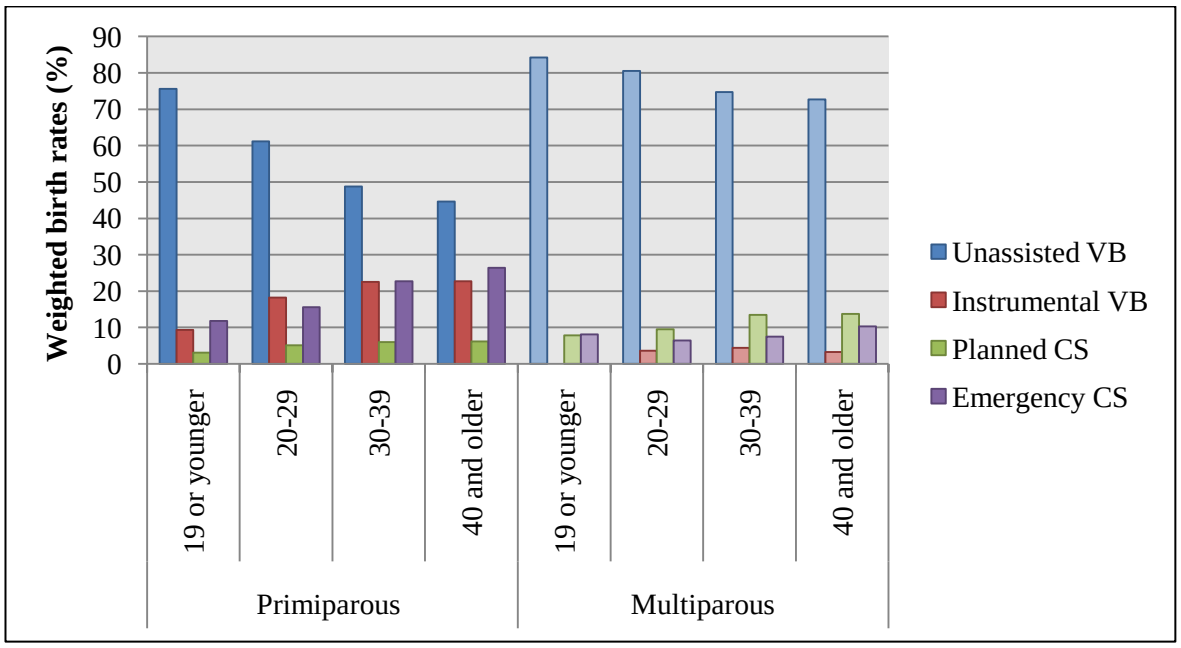
Figure 4.3: Mode of birth for multiparous women according to age at first birth



4.2.1.3 Paternal age

Unassisted vaginal births were more likely for infants with young fathers, with increasing operative births with increasing paternal age for both primiparous and multiparous women (see Figure 4.4). Tests for trend revealed the gradient was significant for all operative births for primiparous mothers, and for planned and emergency caesarean sections for multiparous mothers.

Figure 4.4: Mode of birth by paternal age and parity

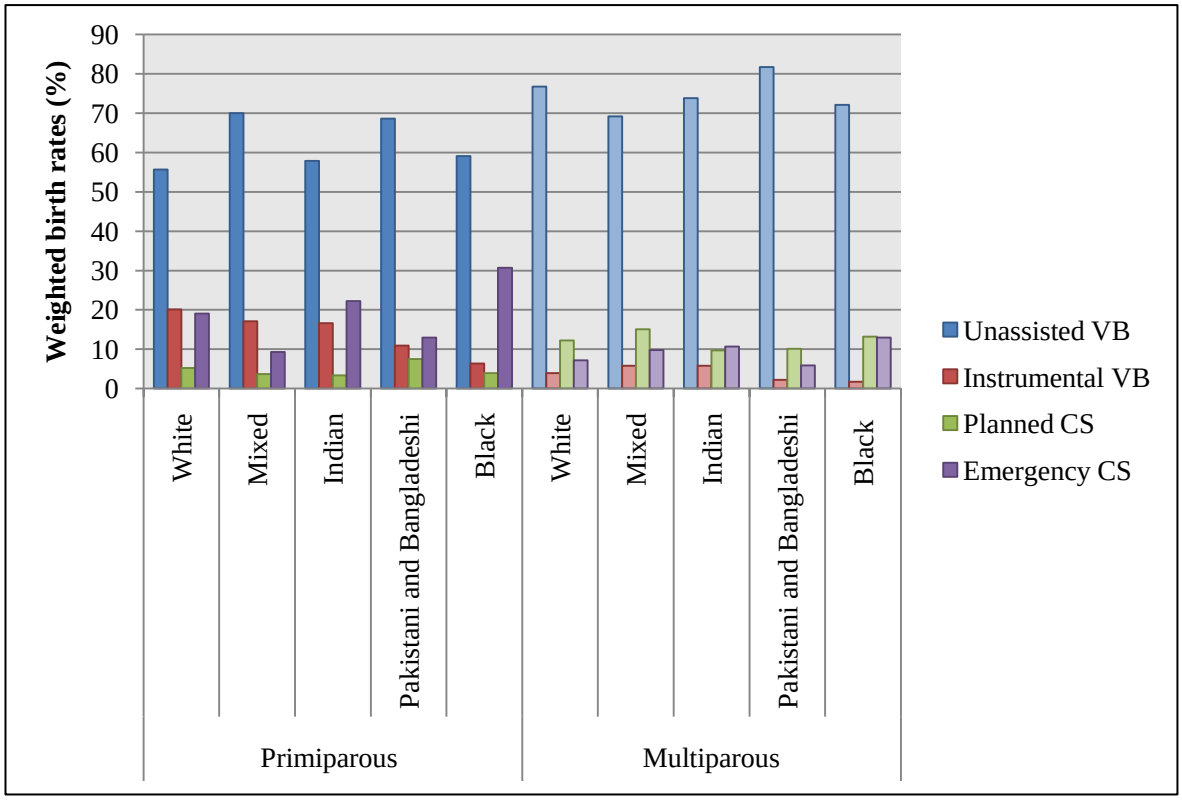


4.2.2 Ethnicity, language and migration status

4.2.2.1 Ethnicity

First-time White mothers had the lowest rate of unassisted vaginal births and the highest rate of instrumental vaginal births of all ethnicities (see Figure 4.5). White mothers seemed to fare better in successive births though, with one of the highest unassisted vaginal birth rates among multiparous mothers. Primiparous and multiparous Black mothers had the highest rate of emergency caesarean section, with over 30 % of first-time Black mothers having an emergency caesarean section. Black mothers were, however, unlikely to have an instrumental vaginal birth, with the lowest rates among both first-time and multiparous mothers. Primiparous mothers of Pakistani or Bangladeshi ethnicity and White mothers had the highest rates of planned caesarean sections, whereas for multiparous mothers those of Mixed ethnicity had the highest rate.

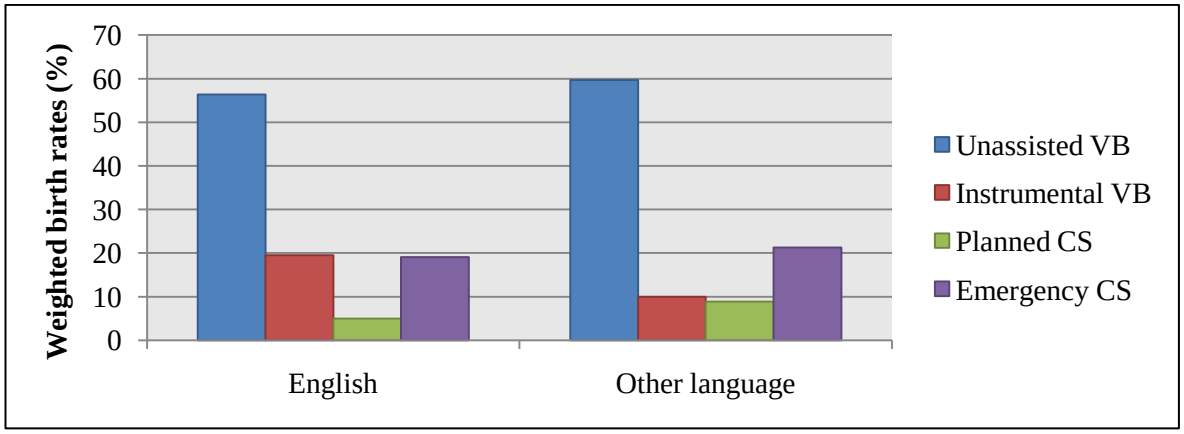
Figure 4.5: Mode of birth by ethnicity and parity



4.2.2.2 First language spoken at home

First-time mothers living in native English-speaking households were much more likely to have an instrumental birth compared to mothers living in households where English was not the first language, but they were less likely to have a planned caesarean section (see Figure 4.6). Language spoken at home was not predictive of mode of birth for multiparous mothers.

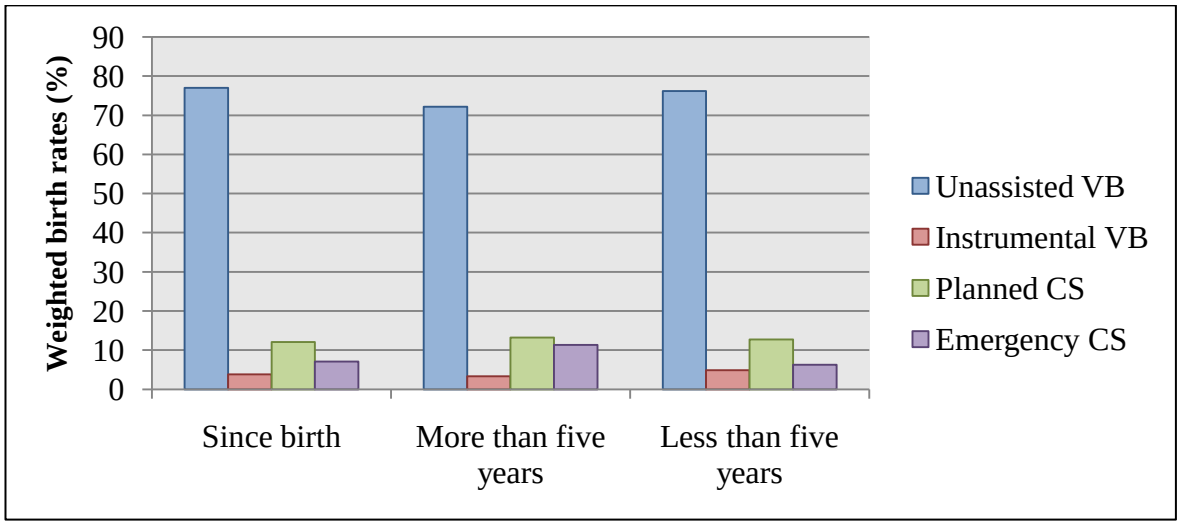
Figure 4.6: Mode of birth by language spoken at home for primiparous women



4.2.2.3 Migration status

Multiparous mothers who had lived in the UK for more than five years were more likely to have an emergency caesarean section compared to mothers who had lived in the UK since birth or for less than five years (see Figure 4.7). Migration status was not significantly related to mode of birth for first-time mothers.

Figure 4.7: Mode of birth by length of time women had resided in the UK, for multiparous women



4.2.3 Socio-economic background

4.2.3.1 Educational level and social class

Operative births were more common with increasing socio-economic status (see Figures 4.8 and 4.9). Among primiparous mothers, there was a gradient of decreased operative births with decreasing educational attainment, which was significant in a test for trend (overseas qualifications were excluded). For multiparous women, there was a significant negative trend for instrumental births and planned caesarean sections which decreased with decreasing educational attainment, although the trend for emergency caesarean section was non-significant.

Similarly, primiparous and multiparous women of higher social class tended to have higher rates of operative births, compared to mothers of lower social class. Downward trends of similar magnitudes to those for educational attainment were found for social class. For primiparous mothers, all operative births significantly decreased with lower social class. Among multiparous mothers, instrumental births and planned caesarean sections decreased with decreasing social class, but the trend for emergency caesarean sections was non-significant.

Figure 4.8: Mode of birth by educational level and parity

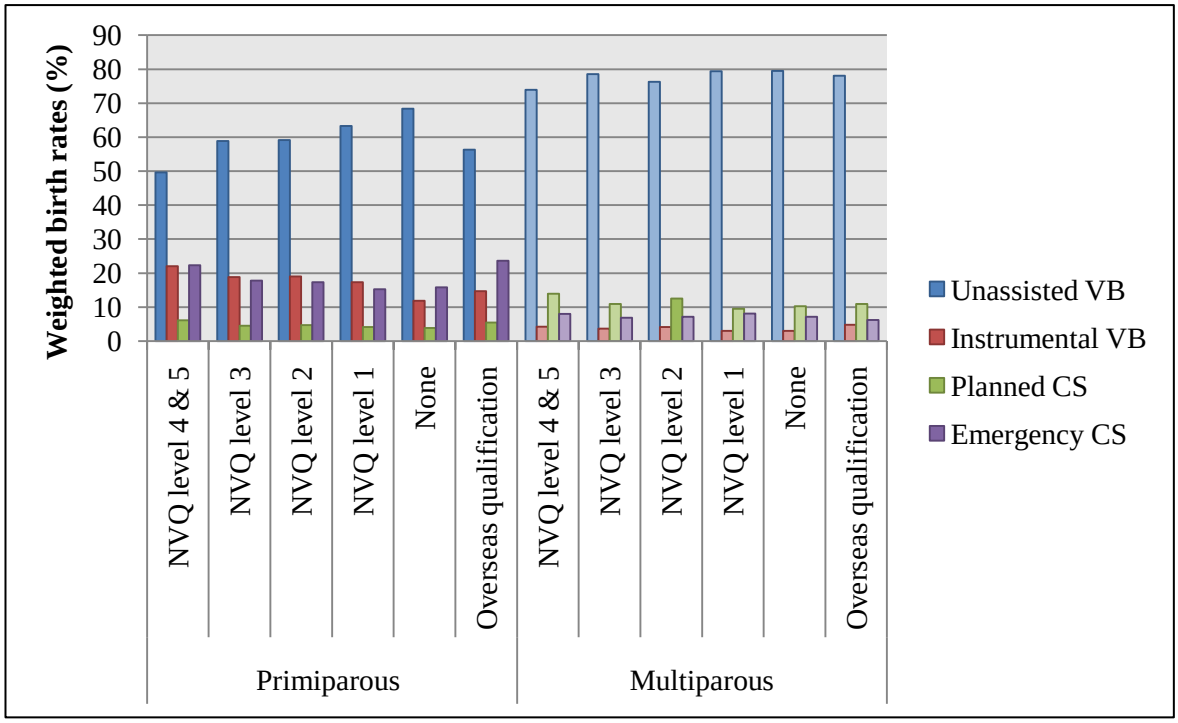
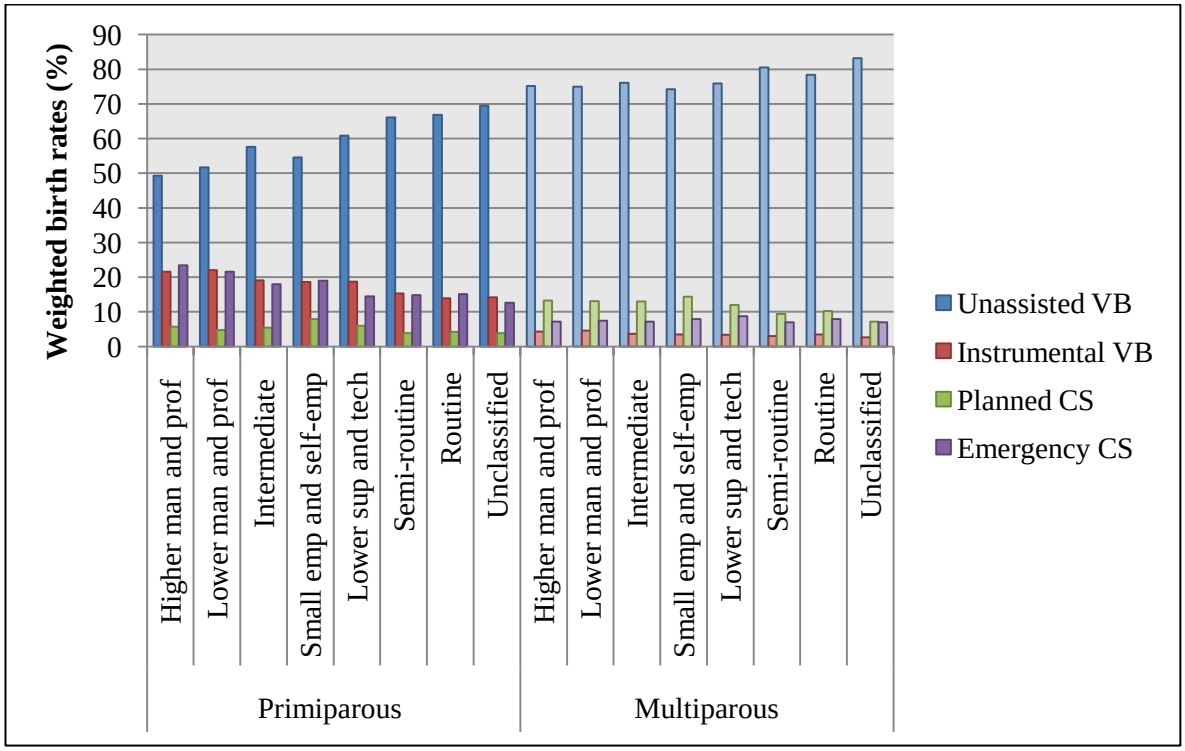


Figure 4.9: Mode of birth by social class and parity

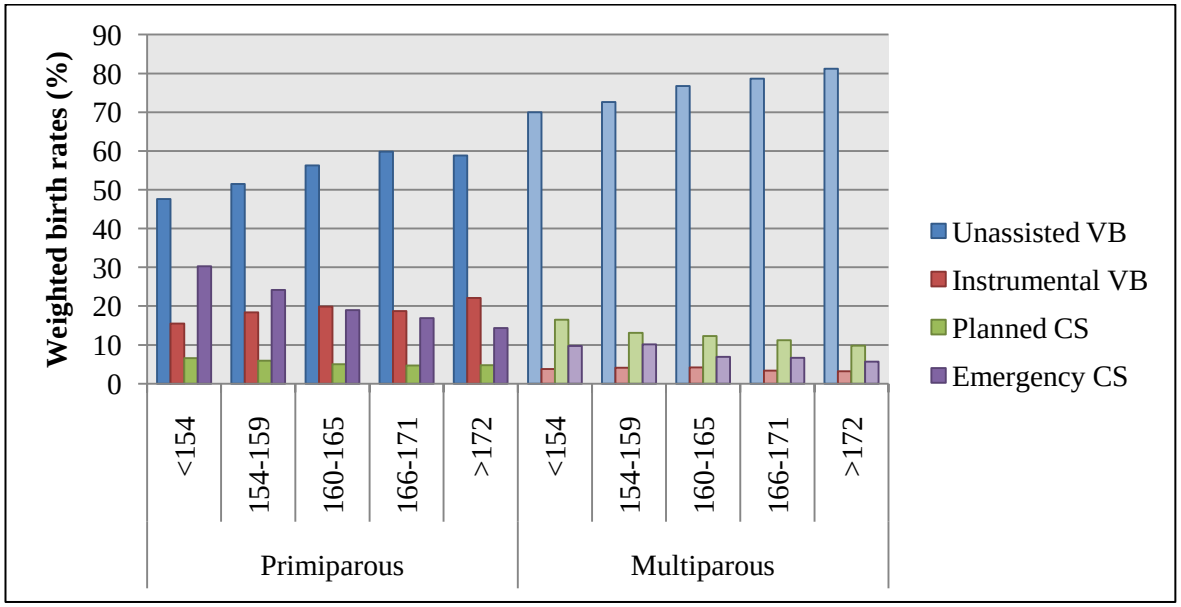


4.2.4 Maternal height

For both primiparous and multiparous mothers, rates of operative births increased with decreasing height (see Figure 4.10). For first-time mothers, emergency caesarean sections were most strongly related to height; mothers in the shortest group had a rate of 30%, more than twice that of mothers in the tallest group, and the test for trend was highly significant. Planned caesarean sections also increased with decreasing height; the trend was weaker than for emergency caesarean section, but still significant. For instrumental births the effect of height was less clear; although there appeared to be a slight increase in rates with increasing height, the test for trend was non-significant.

For multiparous mothers, the effect of height on operative birth rates was similar to that for first-time mothers. The increased risk of planned caesarean section for shorter mothers was stronger than for first-time mothers, probably reflecting previous caesarean sections. For instrumental births, rates did not vary greatly by height, with rates between 2.8% for mothers in the tallest groups and 4.1% for mothers of average height. However, unlike for primiparous mothers, there was a significant positive trend.

Figure 4.10: Mode of birth by maternal height and parity



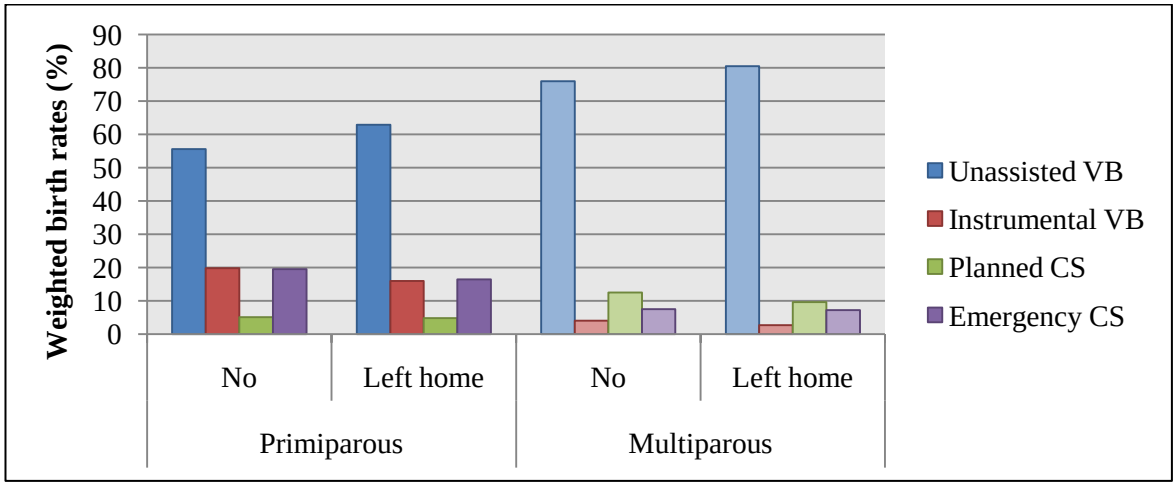
4.2.5 Interpersonal factors

Whether the mother had left home before the age of 17, if her parents had ever separated and how she felt when she discovered she was pregnant, were analysed as psychosocial factors. Overall, mothers *without* interpersonal problems had higher rates of operative birth.

4.2.5.1 Left home before the age of 17

Primiparous and multiparous mothers who left home before the age of 17 were generally less likely to have any type of operative birth compared to mothers who had left home after 17 (see Figure 4.11).

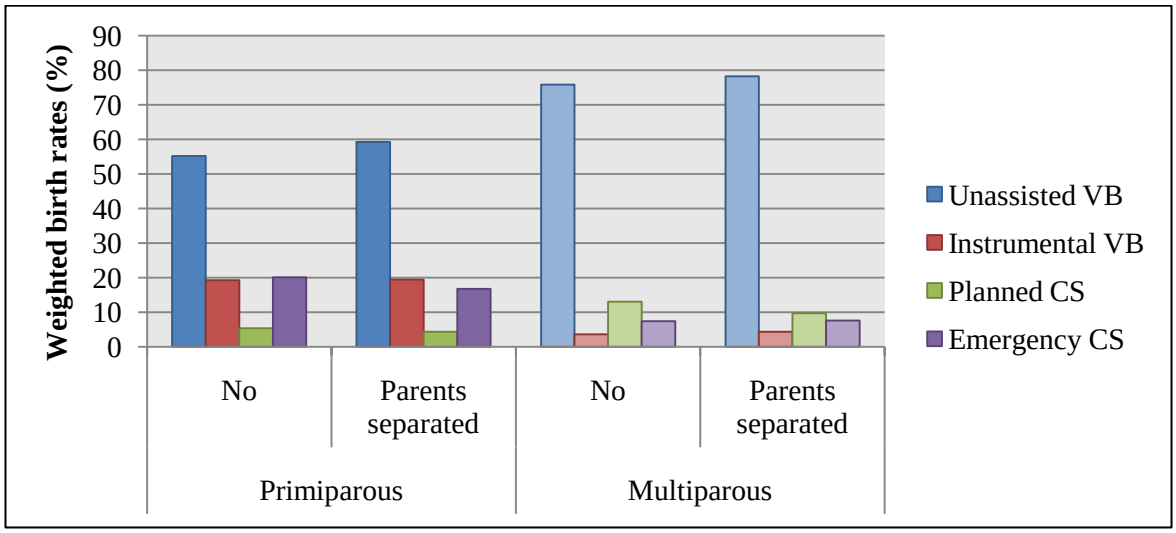
Figure 4.11: Mode of birth by whether mothers left home before the age of 17 and parity



4.2.5.2 Parents ever separated

Overall, mothers whose parents had ever separated were less likely to have a caesarean section but slightly more likely to have an instrumental vaginal birth than mothers whose parents had never separated (see Figure 4.12).

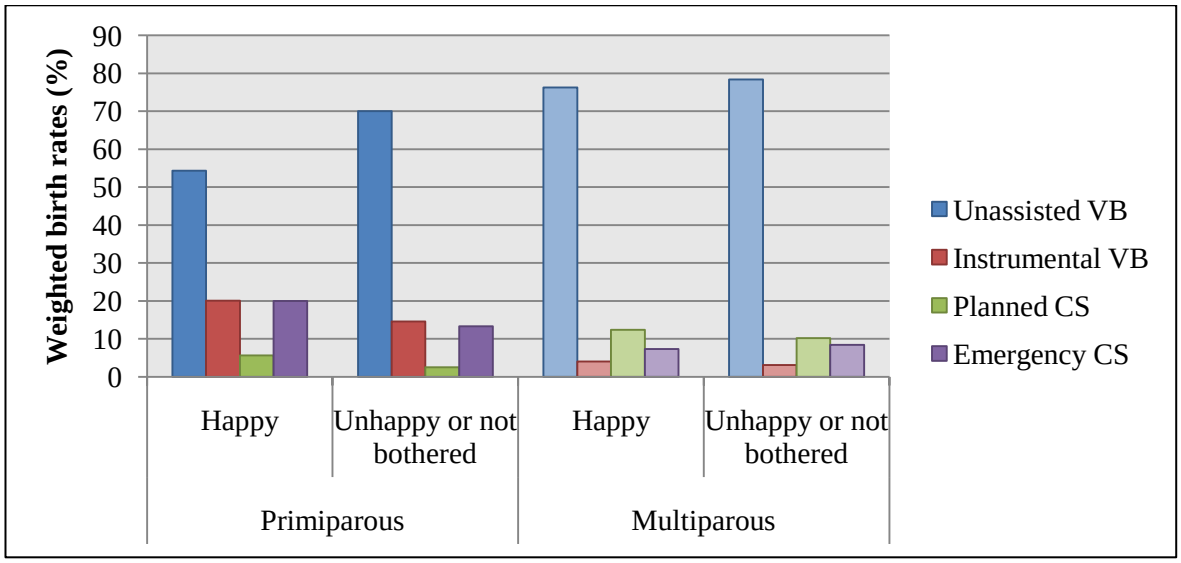
Figure 4.12: Mode of birth by whether the mother's parents had ever separated and parity



4.2.5.3 Feelings about pregnancy

Mothers who were unhappy or not bothered when they discovered they were pregnant were much less likely to have an operative birth compared to mothers who were happy, and this effect was stronger for primiparous mothers (see Figure 4.13).

Figure 4.13: Mode of birth by feelings about pregnancy and parity

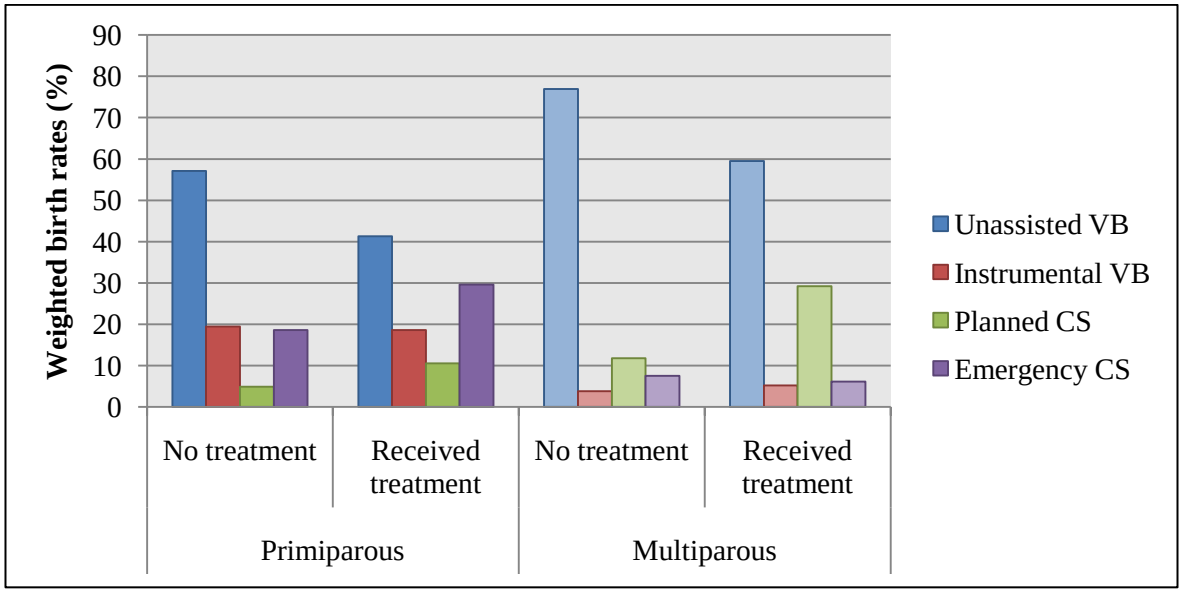


4.2.6 Pregnancy factors

4.2.6.1 Fertility treatment

Primiparous and multiparous mothers who had received fertility treatment were more than twice as likely to have a planned caesarean section as mothers who had not (see Figure 4.14). For primiparous mothers there was also a substantially higher rate of emergency caesarean section for mothers who had fertility treatment, but instrumental birth rates were almost equivalent. Multiparous mothers who had fertility treatment were more likely to have an instrumental birth but slightly less likely to have an emergency caesarean section.

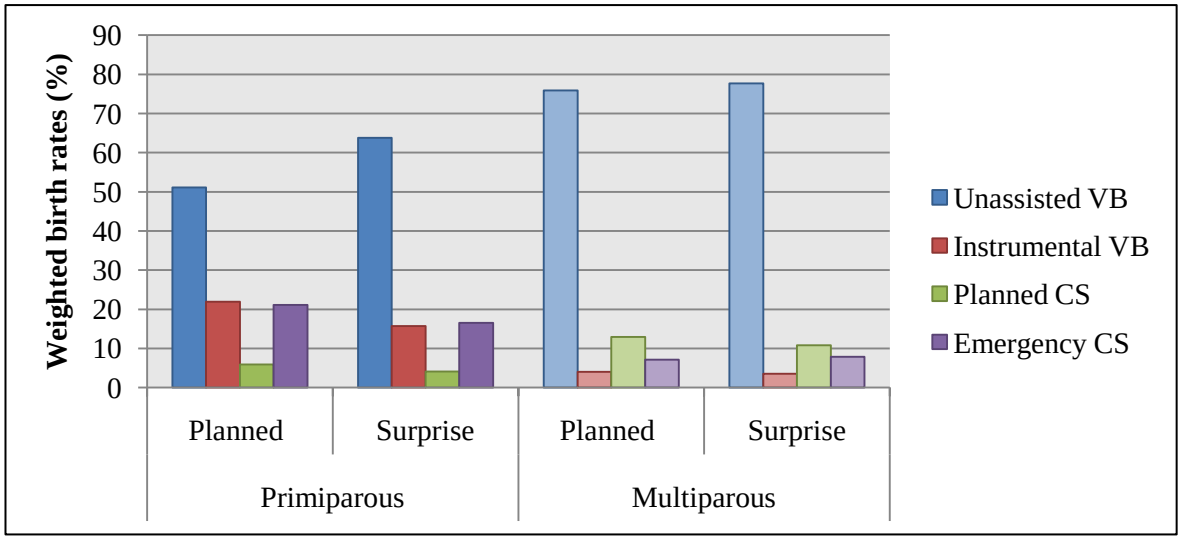
Figure 4.14: Mode of birth by fertility treatment and parity



4.2.6.2 Planned pregnancy

Compared to mothers who had planned their pregnancy, mothers for whom the pregnancy was a surprise were less likely to have an operative birth, although the effect was less evident for multiparous women (see Figure 4.15).

Figure 4.15: Mode of birth by planned pregnancy and parity



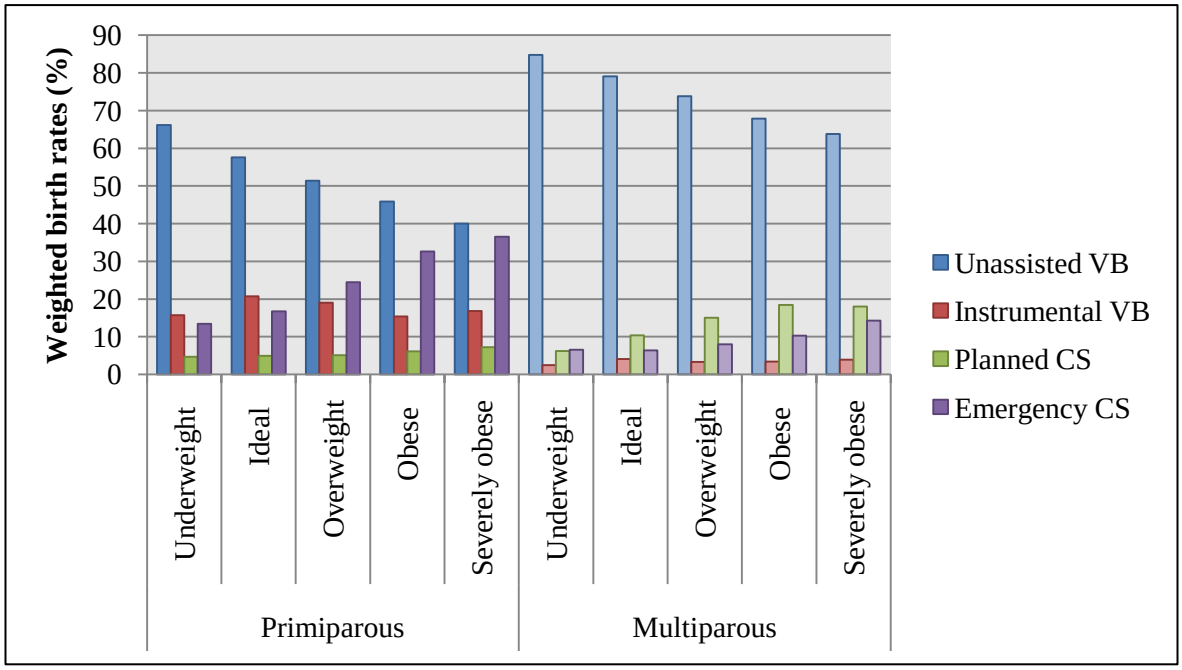
4.2.7 Health factors

4.2.7.1 Pre-pregnancy BMI

For primiparous and multiparous mothers, there was a significant trend of increased caesarean section rates with increasing BMI (see Figure 4.16). For first-time mothers, the rates of both planned and emergency caesarean sections increased with BMI category, although the effect was strongest for emergency caesarean sections. Obese primiparous mothers had almost twice the emergency caesarean section rate of mothers of normal BMI, with a rate of over 32%. Severely obese women had the highest emergency caesarean section rate however, at 36.5%, and only 40% of first-time severely obese women had an unassisted vaginal birth.

For multiparous mothers, both planned and emergency caesarean sections notably increased with increasing BMI, although the trend was somewhat stronger for planned caesarean sections.

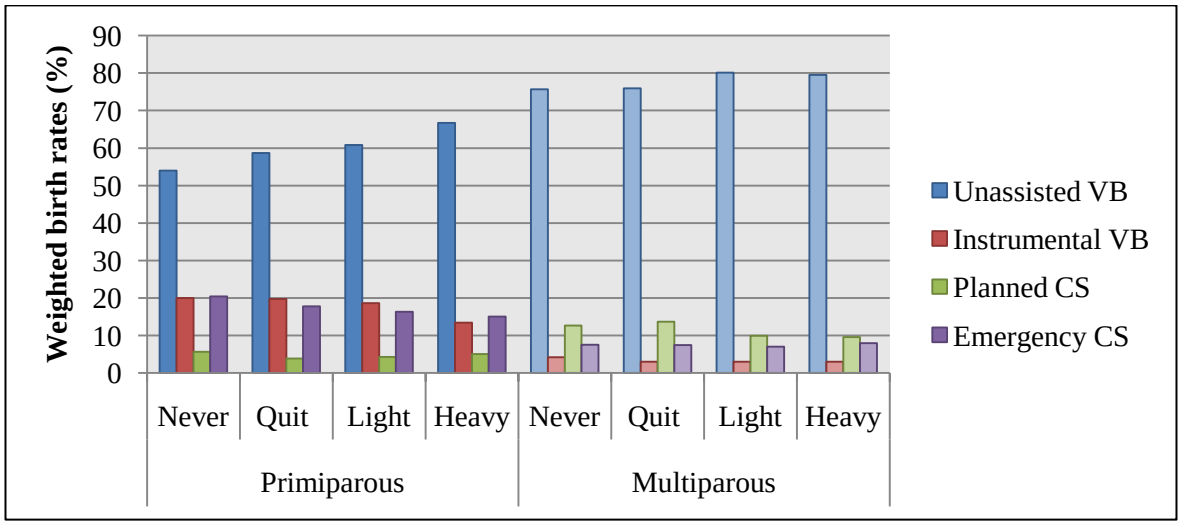
Figure 4.16: Mode of birth by BMI and parity



4.2.7.2 Smoking during pregnancy

For first-time mothers, rates of instrumental births, planned and emergency caesarean sections significantly decreased with increased smoking during pregnancy (see Figure 4.17). Multiparous mothers who smoked during pregnancy had lower rates of instrumental births and planned caesarean sections than mothers who had never smoked; however, a significant downward trend was only apparent for planned caesarean sections.

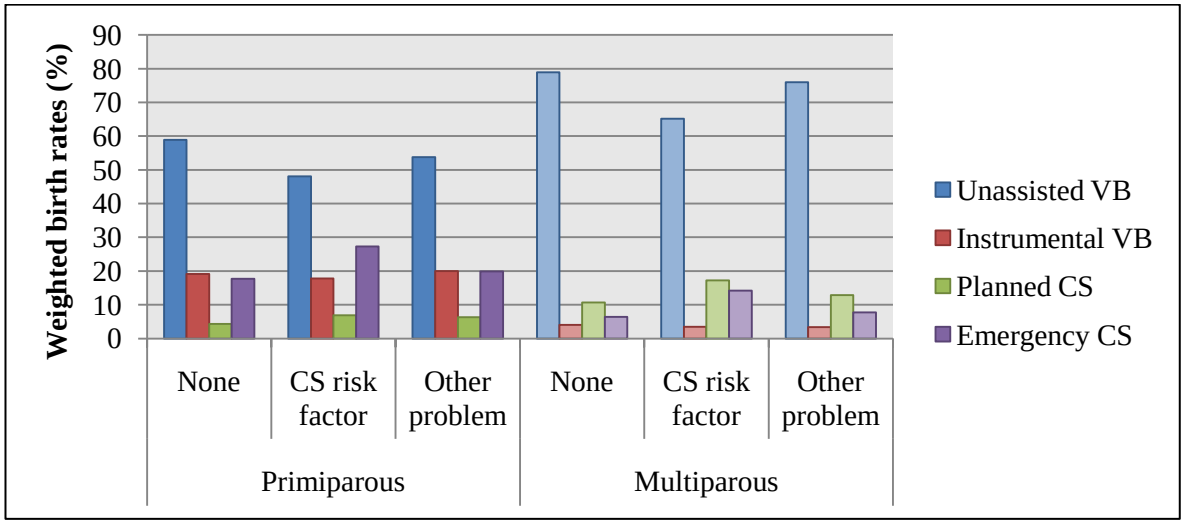
Figure 4.17: Mode of birth by smoking during pregnancy and parity



4.2.7.3 Complications during pregnancy

Mothers who had a complication or illness during pregnancy were much more likely to have a planned or emergency caesarean section and this was more likely for those who had a complication associated with an increased risk of caesarean section (see Figure 4.18). Complications during pregnancy appeared to have less impact on rates of instrumental births however, the rates of which were similar for women who experienced no complications to those that experienced complications.

Figure 4.18: Mode of birth by complications during pregnancy and parity

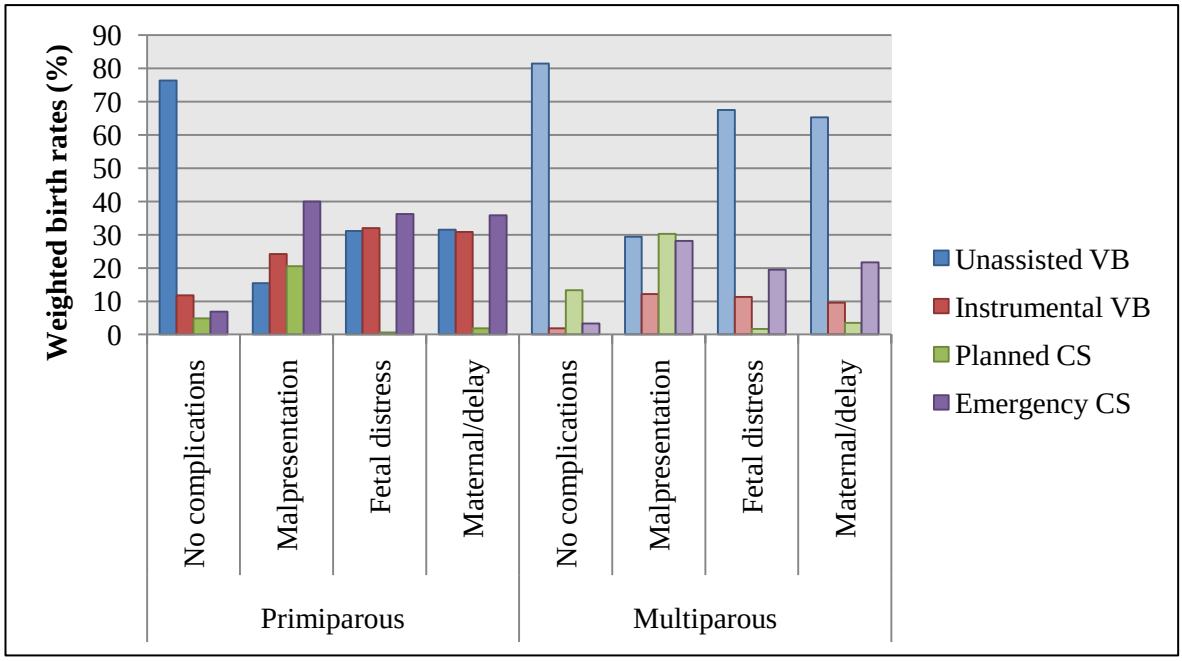


4.2.8 Labour factors

4.2.8.1 Complications during labour and birth

Mothers who had complications during labour were substantially more likely to have an unplanned operative birth (see Figure 4.19). Only around 31% of primiparous women who reported fetal distress or maternal or delay complications had an unassisted vaginal birth. Unplanned operative births were more frequent for these women. Multiparous women who experienced complications during labour also had higher rates of unplanned operative births than women who experienced no complications, but had much higher rates of unassisted vaginal births than primiparous women. For example, only around 31% of primiparous women who experienced fetal distress during labour had an unassisted vaginal birth whereas over 67% of multiparous women with this type of complication had an unassisted vaginal birth. Less than 16% of primiparous women and 30% of multiparous women with a malpresented fetus had an unassisted vaginal birth.

Figure 4.19: Mode of birth by complications during labour and birth and parity

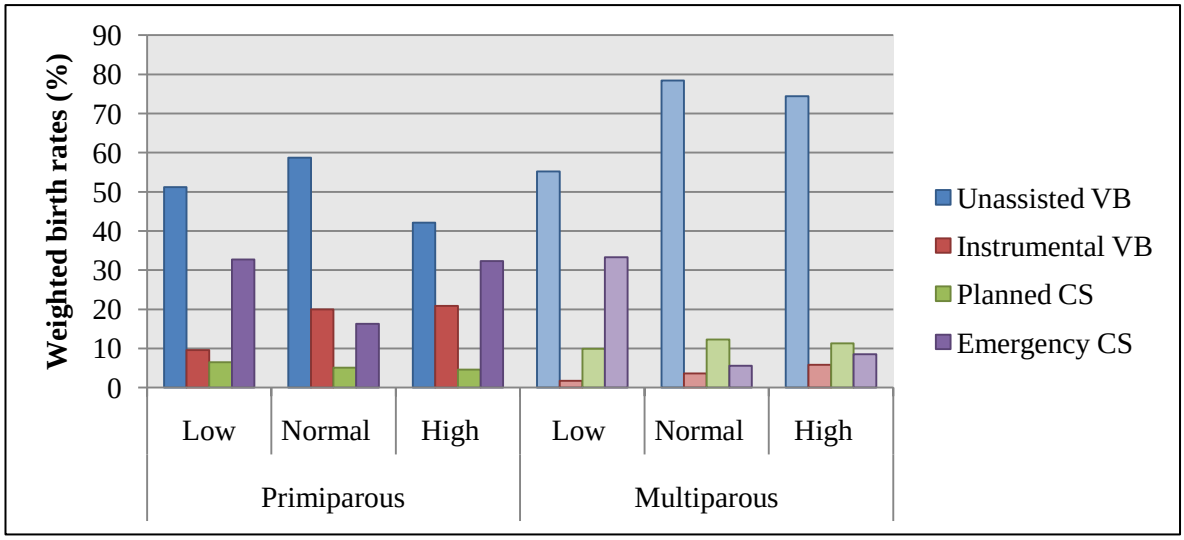


4.2.9 Infant factors

4.2.9.1 Birth weight

Mothers who gave birth to normal weight infants had the highest rate of unassisted vaginal births (see Figure 4.20). Planned caesarean section rates differed little by birth weight, but emergency caesarean sections were higher for both low and high birth weight infants. Over 32% of both low and high birth weight infants born to first-time mothers were born by emergency caesarean section, around double the rate for normal weight infants. However, for multiparous women the difference between rates for normal weight infants (5.6%) and high weight infants (8.5%) was comparatively small. Consequently there was a significant downward trend for emergency caesarean section with increasing birth weight among multiparous women which was not observed for primiparous women. Instrumental births were more likely with increasing birth weight and were lowest for very low birth weight infants (upward trend significant for both primiparous and multiparous women).

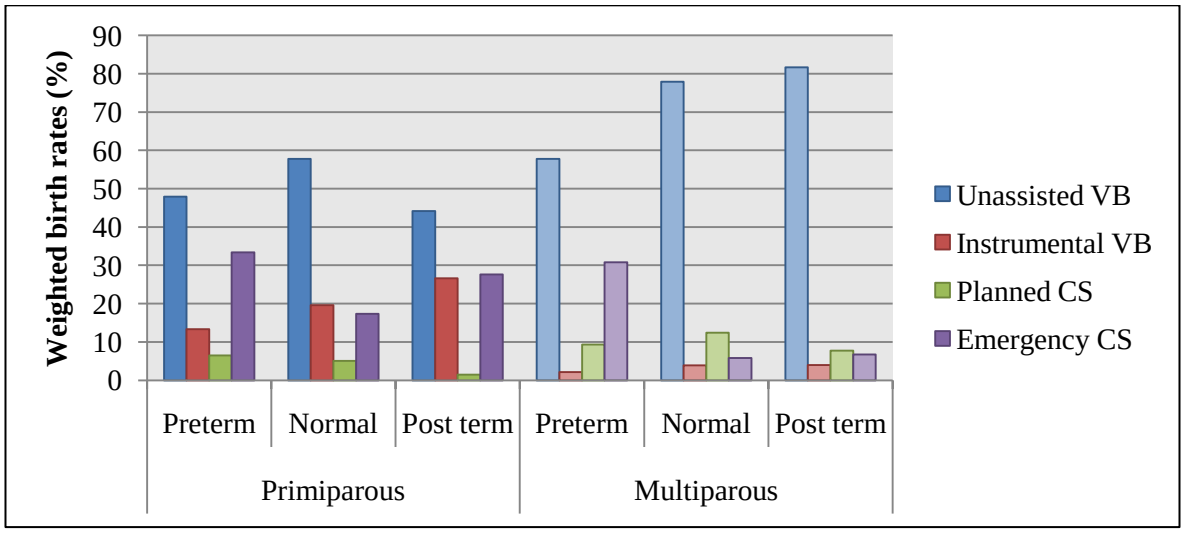
Figure 4.20: Mode of birth by infant birth weight and parity



4.2.9.2 Gestational age

Mothers who gave birth at term had the highest rates of unassisted vaginal births (see Figure 4.21). Mothers who gave birth both preterm and post-term were more likely to have an emergency caesarean section. For multiparous women, due to the low rate of emergency caesarean section among high birth weight infants, there was a significant downward trend for emergency caesarean section with increasing birth weight. Rates of instrumental births increased with increasing gestation, especially among primiparous women where rates doubled from 13% to 27% when comparing preterm and post-term infants. The trend of increasing instrumental births with increasing birth weight was significant for primiparous women.

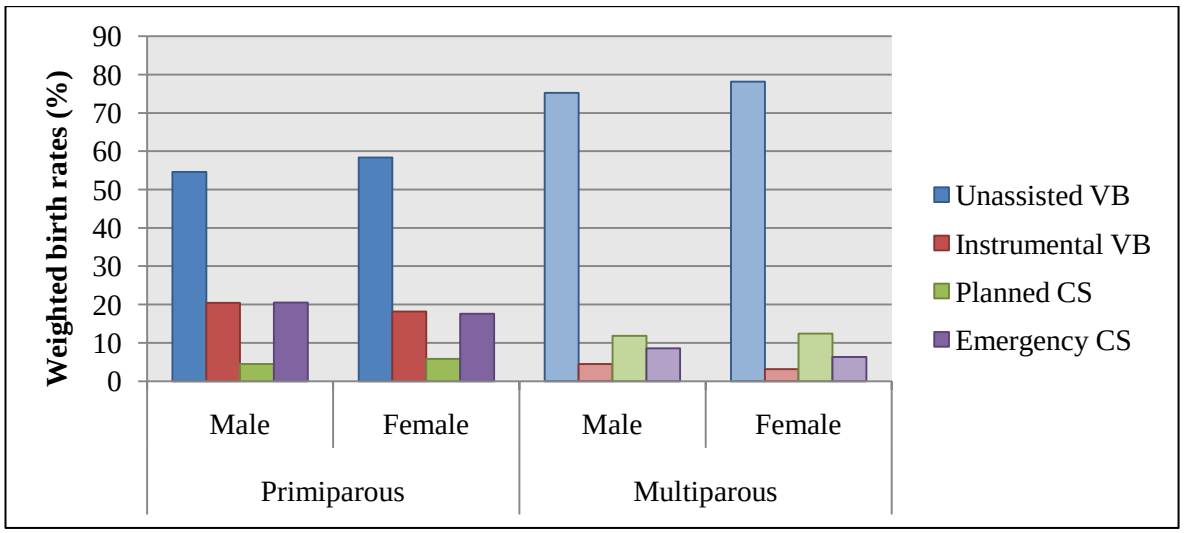
Figure 4.21: Mode of birth by gestational age and parity



4.2.9.3 Fetal sex

Both primiparous and multiparous mothers carrying a male fetus had higher rates of unplanned operative births than mothers carrying a female fetus (see Figure 4.22).

Figure 4.22: Mode of birth by fetal sex and parity



4.3 Discussion

Among *primiparous* mothers, all socio-demographic, socio-economic, interpersonal, pregnancy, labour and infant factors analysed were significantly related to mode of birth. Only migration status was unrelated. For *multiparous* women the majority of factors analysed were also significantly associated with mode of birth, with only language spoken at home not a significant predictor.

4.4 The need to control for confounding

Figure 4.23 is a simplified diagram of the characteristics explored in the unadjusted analyses. The dashed lines show how the characteristics of mothers and their infants are interrelated. All possible relationships could not be shown due to the number of possible associations. However, what the diagram does begin to highlight is the complexity of potential explanations for differences in mode of birth. The diagram also illustrates that characteristics cannot be considered independently of one another. Unadjusted analyses shown in this chapter reveal interesting patterns, but alone they cannot give a true picture of the relationship between each characteristic and mode of birth.

Figure 4.23: Conceptual model of maternal and infant factors affecting mode of birth in the MCS

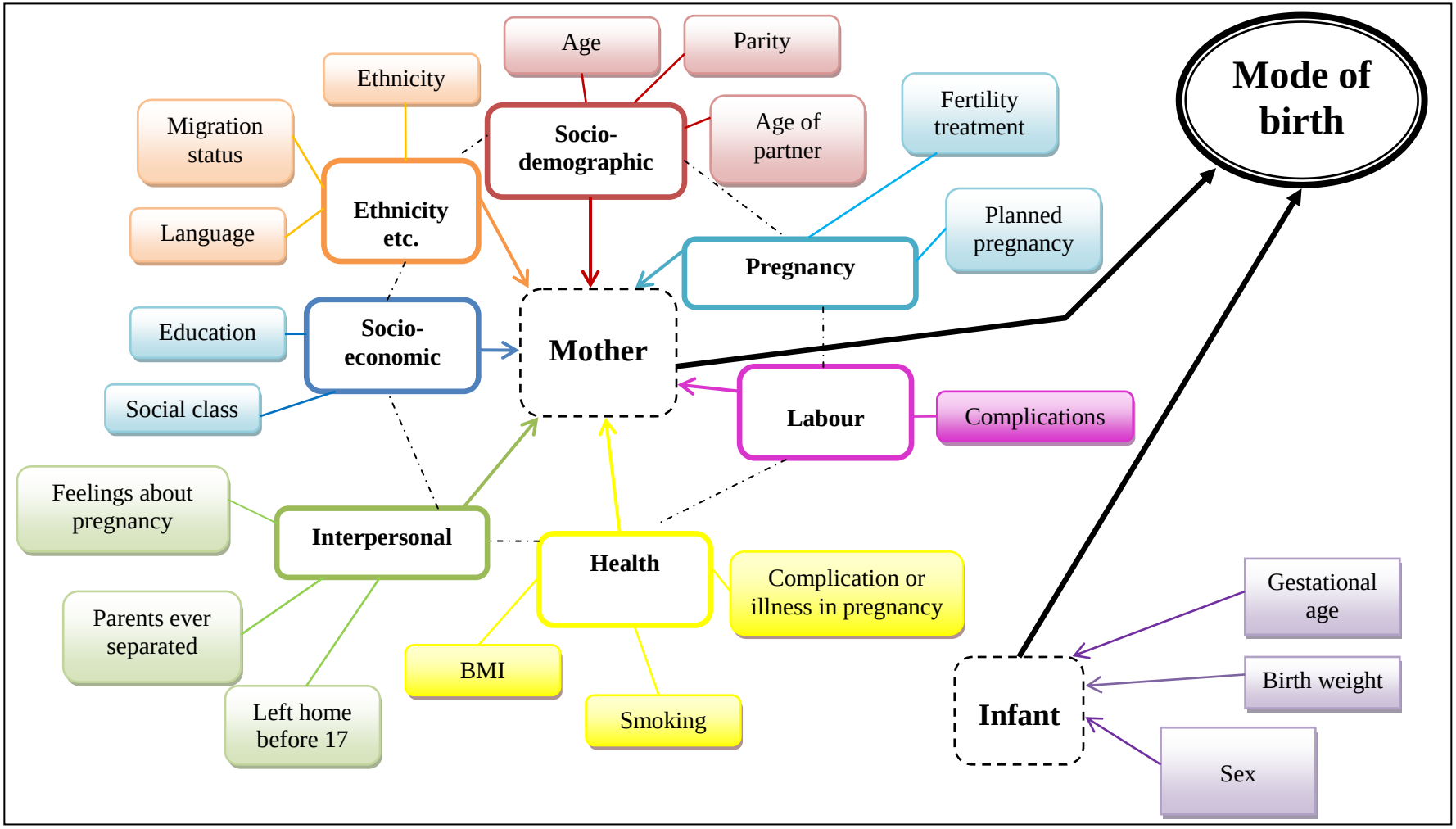
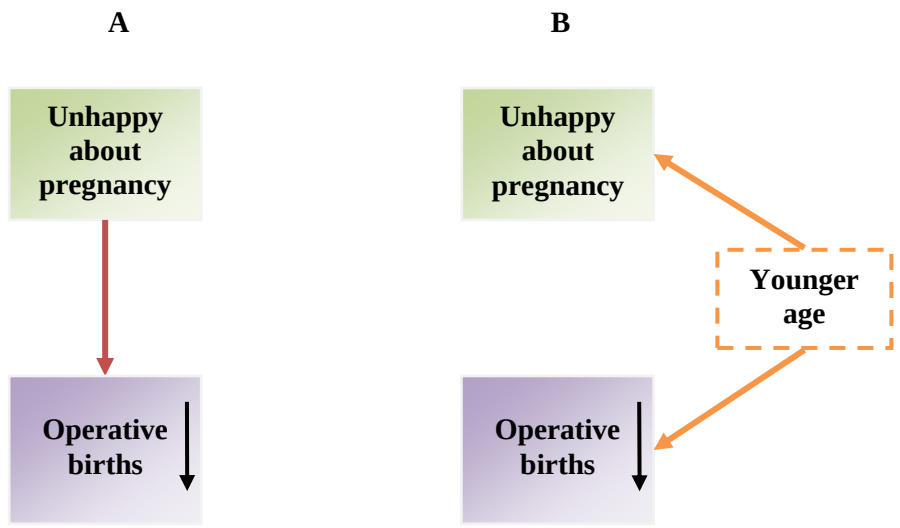


Figure 4.24 gives an example, using feelings about pregnancy, of the need for statistical adjustment in further analyses. Being unhappy about the pregnancy appeared in unadjusted analyses to be protective for having an operative birth. It is possible that the way women felt about their pregnancy could influence their birth experience in a causal pathway as shown in diagram A, for example, if they were less prepared for labour. However, women who are happy about pregnancy and those that are unhappy are likely to be different in many ways. Comparing the mean age of first-time mothers according to feelings about pregnancy reveals that mothers who were unhappy when they discovered they were pregnant had a mean age of 22 years whereas mothers who were happy had a mean age of 27 years. The relationship between feelings about pregnancy and mode of birth could therefore be confounded by other maternal factors, such as age (see diagram B of Figure 4.24).

Figure 4.24: Potential confounding



Additional analyses in Chapters 5, 6, 7, 9 and 10 will investigate further the relationships between the characteristics explored in this chapter and mode of birth using multivariable techniques to address the research questions outlined in Chapters 2 and 8. Stratification and multivariable adjustment of analyses will be used to address the issues of confounding and effect modification.

4.5 Summary

- In this chapter bivariate analyses are presented showing the unadjusted relationships between maternal and fetal characteristics and mode of birth in the MCS.
- All maternal, labour and fetal characteristics examined were found to be significantly related to mode of birth.
- Although some interesting relationships were revealed, these relationships could be confounded by other factors.
- In-depth analyses in subsequent chapters will statistically control for potential confounding factors to identify the independent effects of maternal and fetal characteristics on mode of birth.

CHAPTER 5: The Millennium Cohort Study: The inter-relationships between age, socio-economic status and mode of birth

5.1 Background

5.1.1 Maternal age

As discussed in Chapter 2, there has been increasing interest in the effect of older maternal age on a number of health outcomes, including mode of birth. The evidence from many observational studies indicates that the risk of a mother having an operative birth increases with maternal age. Figure 4.2 of Chapter 4 displayed the weighted rates of modes of birth according to maternal age in the MCS. In agreement with the previous literature there was a strong gradient of increasing risk of operative births with increasing age for both primiparous and multiparous women.

5.1.2 Socio-economic status

In countries with mixed publicly and privately-funded health care systems, such as Brazil, or the USA where health care is mainly controlled by the private sector with health insurance, the type of care a woman receives, and subsequently the type of birth a woman has, can be greatly influenced by her socio-economic position.

In the UK, a woman's socio-economic status might be hypothesised to have less impact on mode of birth due to the publicly-funded health care system, with very few women giving birth outside the NHS. Although, there has been much media attention over women being 'too posh to push', this seems to be mainly driven by the high profile births of celebrities who pay privately for health care (Asthana, 2005, Martin, 2001, McConnell, 2007).

Few UK studies have examined the relationship between socio-economic status and mode of birth. Six studies assessed area-level deprivation. Three found an association between affluence and increased risk of caesarean section; the first assessed elective caesarean sections only (Alves and Sheikh, 2005), and two further studies from England and Scotland found an increased risk of elective caesarean sections for mothers from more affluent areas, but no effect for emergency caesarean sections (Barley et al., 2004, Fairley et al., 2011). A fourth study found that mothers

from deprived areas in England were more likely to have a caesarean section due to 'unforeseen circumstances', although the results were unadjusted (Redshaw et al., 2007), whereas a Scottish audit reported no difference in unadjusted caesarean section rates by deprivation quintile (Wilkinson et al., 1998). The largest and most recent study found no independent association between area-level deprivation and mode of birth, although the outcome measure was the overall caesarean section rate (Bragg et al., 2010). One English study examined social class and home ownership, and found neither was independently related to mode of birth (Patel et al., 2005). A much larger Scottish study did find an association between higher social class and an increased risk of elective caesarean section, after adjustment for other covariates, including deprivation (Fairley et al., 2011).

Although study samples were mainly large (four included over 300,000 women each), the measures of socio-economic status used in previous UK studies may not have accurately represented womens' social position. Area-level deprivation estimates can only be proxies for individual socio-economic status as areas are not homogeneous in terms of social-mix, and mobility of individuals to and from areas mean that their social make-up will change (Graham, 2007). A recently published Scottish study using both individual and area-level measures of socio-economic status demonstrated that the measures were capturing different elements of socio-economic position, and in some cases predicted caesarean section differently (Fairley et al., 2011). Fairley and colleagues used social class of the father, or of the mother if no information for the father was available. The only other study to use social class, by Patel and colleagues (2005), used maternal social class as a measure of socio-economic status. Social class based on the occupation of the pregnant woman may also be an inaccurate measure of socio-economic position, especially for women with male partners, who generally earn more money (Graham, 2007).

5.2 Research questions

Although it is apparent that there is a body of evidence for the decreasing likelihood of unassisted vaginal birth with increasing maternal age, the reasons for the association between maternal age and mode of birth are largely unknown. To increase understanding, the following question was explored in the MCS:

i. What is the relationship between maternal age and complications in pregnancy and labour progress?

Women of higher socio-economic status are more likely to postpone childbearing, whereas women of low socio-economic status tend to have their children younger. Relating to the confounding effect of age, three more specific questions arose from a review of the literature:

ii. Is the effect of socio-economic status on mode of birth explained or modified by maternal age?

iii. Is smoking in pregnancy a risk factor for mode of birth, or is it simply a marker of maternal social disadvantage?

iv. Does *paternal* age have an effect on mode of birth in the UK, after adjustment for maternal age and socio-economic factors?

i) What is the relationship between age and pregnancy outcomes and the progress of labour?

5.2.1 Background

The reason for the detrimental effect of age on mode of birth has been debated and is not fully understood. Part of the debate concerns whether there is a biological explanation for the relationship between older age and increased operative births, or whether the association is related to the preferences of women, or their health professionals.

Advanced maternal age is related to several unfavourable health outcomes. Fertility decreases significantly after the mid-thirties, and a much higher rate of miscarriages among these women contributes to the lower fertility rates (Heffner, 2004). In addition, fetal chromosomal abnormalities are also higher for older women and decreased quality of the ova are believed to be the cause of these problems (Heffner, 2004). The incidence of pregnancy complications including gestational diabetes (Cleary-Goldman et al., 2005, Kirz et al., 1985, Martel et al., 1987), hypertension (Kirz et al., 1985) and placenta praevia (Cleary-Goldman et al., 2005) have also been found to be higher for older mothers.

Older women may also fare worse during labour. The uterine muscles, like any other muscles in the body, may become less effective with age. Main and colleagues (2000) assessed three outcomes as indicators of uterine function; duration of the first stage of labour, duration of the second stage of labour and need for augmentation of labour. All three outcomes increased with maternal age, in a sample of over 8,000 primiparous American women. Older mothers are also more likely to ‘fail to progress’, (Ecker et al., 2001, Main et al., 2000), or to have reports of fetal distress in labour (Ecker et al., 2001, Main et al., 2000, Martel et al., 1987). In addition, Gareen and colleagues (2003) in a

well-adjusted study observed that dystocia accounted for some of the excess risk of caesarean section for older mothers.

A large and more recent study provides further evidence for a biological effect of maternal age on the labour process. Smith and colleagues used Scottish maternity data from 1980-2005, including over 580,000 primiparous women (Smith et al., 2008a). Length of labour was found to increase significantly with maternal age in a linear relationship. In a separate part of the study, uterine muscle biopsies were obtained from 62 primiparous and multiparous women during elective caesarean sections. Tests performed on the tissue biopsies revealed a significant negative relationship between maternal age and contractile activity (ability of the uterus tissue to contract).

Malpresentation has also been found to increase with increasing age. Ecker and colleagues (2001) suggested uterine anomalies may explain the increasing malpresentation with age in their sample of over 3,000 American women. A more recently published American study utilised data on over 8 million singleton pregnancies in women aged 30 and over, again finding an increased likelihood of malpresentation with increasing age (Luke and Brown, 2007).

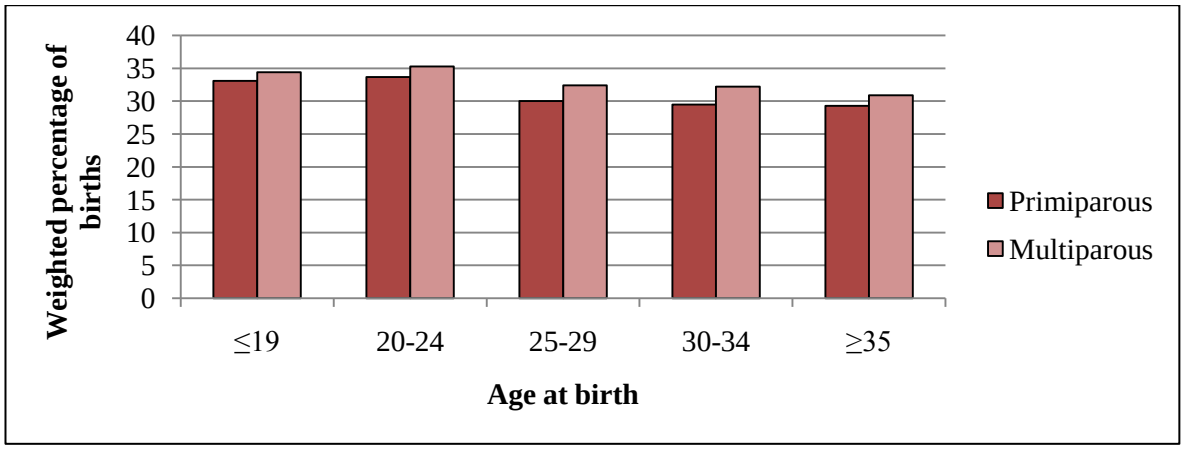
5.2.2 Results

Tables A5.1 and A5.2 present the frequencies and weighted percentages of pregnancy and labour outcomes according to maternal age groups. The results of tests for trend are also presented. For length of labour, which was a continuous variable, weighted mean length of labour is presented along with the results of a regression predicting length of labour.

5.2.2.1 Problems during pregnancy

Women in the MCS were asked: "*Did you have any illnesses or other problems during your pregnancy that required medical attention or treatment?"* If the woman responded that she had a problem, then she was asked about the nature of the illness or problem. For the purposes of these analyses problems were coded as those that could complicate birth (e.g. bleeding in later pregnancy, preeclampsia, diabetes, symphysis pubis dysfunction, fetal distress, placenta praevia) and the remainder of complications were coded as 'other' (e.g. vomiting, urinary infection, allergies, backache, early rupture of membranes). For both primiparous and multiparous women there was no evidence of an increase in problems which could complicate birth with increasing maternal age (see Tables A5.1 and A5.2). There was also no evidence of an increase in 'other' problems with maternal age; in fact, there was a slight negative association (see Figure 5.1).

Figure 5.1: Rates of 'other' pregnancy problems by maternal age at birth*



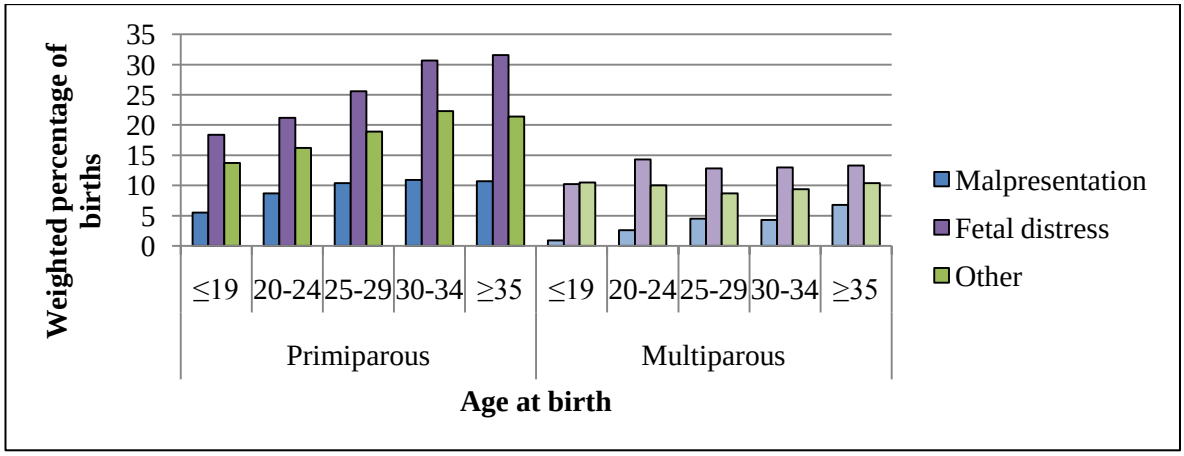
*Test for trend coefficient= -0.06, p<0.05 for primiparous women and -0.05, p<0.05 for multiparous women

5.2.2.2 Complications during labour

Figure 5.2 shows the rates of labour complications for women according to maternal age. Among *primiparous* women there was evidence of increasing malpresentation, fetal distress and other complications during labour (test for trend coefficients 0.16, p<0.001 for malpresentation, 0.20 p<0.001 for fetal distress and 0.16 p<0.001 for other complications). For *multiparous* women there was no significant trend for fetal distress or other complications with increasing age. However, there was a significant positive trend of increasing malpresentation with increasing maternal age, which was similar in magnitude to the gradient for first-time mothers (test for trend coefficient = 0.29, p<0.001).

The addition of malpresentation, fetal distress and other complications to multinomial logistic regression models for the effect of age on mode of birth made little difference to the relative risk ratios (see Tables A5.3 and A5.4).

Figure 5.2: Rates of labour complications by maternal age and parity



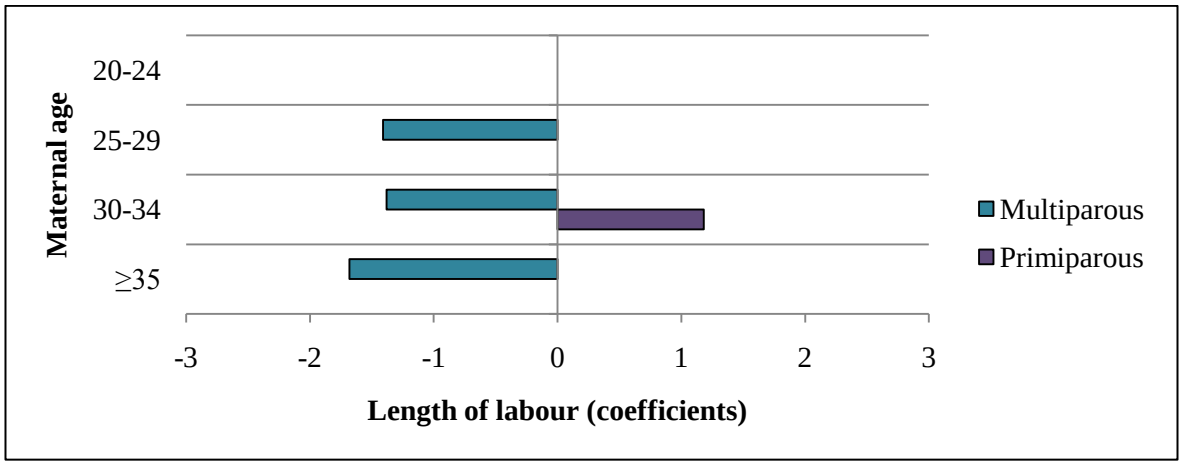
5.2.2.3 Induction of labour

There was no evidence of an increase in induction of labour with age for either primiparous or multiparous women.

5.2.2.4 Length of labour

For *primiparous* women, length of labour increased with increasing age (see Table A5.1). In an unadjusted regression model predicting length of labour, mothers aged 30-34 had a length of labour over an hour longer than mothers aged 19 or younger (coefficient =1.18, $p<0.05$). However, *multiparous* women in their late twenties had shorter labours than mothers aged 19 or younger, and length of labour decreased with age thereafter (see Table A5.2 and Figure 5.3).

Figure 5.3: Length of labour by maternal age and parity: coefficients from an unadjusted regression analysis*



*Only significant ($p<0.05$) coefficients displayed, comparator group = ≤19

5.2.3 Discussion

Previous observational studies have shown an increase in problems during pregnancy such as gestational diabetes, hypertension or placental praevia with increasing maternal age (Cleary-Goldman et al., 2005, Kirz et al., 1985, Martel et al., 1987). Findings for the MCS did not support these observations. Problems which could complicate birth (including placental problems and diabetes, amongst others) were not found to increase with increasing age. Furthermore, for primiparous mothers there was a slight negative trend for decreasing 'other' pregnancy complications with advancing maternal age. These types of problems (including problems such as vomiting and back ache) were not measured in previous studies.

Overall MCS data suggested increased complications during labour, which could be markers for poorer uterine activity for older mothers. Previous studies have shown increased diagnoses of fetal distress and failure to progress for women with older maternal age (Ecker et al., 2001, Main et al., 2000, Martel et al., 1987). The MCS does not include details of the indication for caesarean section or instrumental birth, however, primiparous women were more likely to report fetal distress and other complications with increasing age. In addition, malpresentation was more frequently reported among older primiparous and multiparous mothers, in support of previous American data (Ecker et al., 2001, Luke and Brown, 2007). There was no association between maternal age and fetal distress or other complications for multiparous mothers.

Length of labour has also been previously reported as a marker for uterine activity (Main et al., 2000), and has been found to increase with maternal age (Main et al., 2000, Smith et al., 2008a). For *primiparous* women in the MCS this finding was supported as mothers in their early thirties had a significantly longer labour than mothers aged 19 or younger (although there was not a trend with increasing age as in previous studies). For *multiparous* women however, the effect of age on length of labour was different; from age 25 length of labour *decreased* with advancing age. Previous studies did not stratify labour outcomes by parity. Among the multiparous women older maternal age could be a marker for higher parity, which could be confounding the results with length of labour.

Although previous studies have identified higher rates of induction for older mothers, this was not apparent in the MCS.

Overall, MCS data showed no association between age and problems during pregnancy. However, there was evidence of an increase in malpresentation, fetal distress and other complications in labour for first-time women with increasing age, and women over 30 had significantly longer labours compared to mothers under twenty. For multiparous women malpresentation increased with maternal age. However, when adjusted for, these labour factors did not explain the variation in mode of birth by maternal age.

5.3 Socio-economic status in the Millennium Cohort Study

The Millennium Cohort Study includes much detail about the socio-economic status of the individuals involved. Unlike the ALSPAC cohort study, on which Patel and colleagues based their findings (Patel et al., 2005, Golding et al., 2001), the MCS was conducted throughout the UK, with over-sampling for women from deprived areas. ALSPAC was conducted in Avon, a comparatively

affluent and less ethnically diverse county than Britain at the time of cohort initiation (University of Bristol, 2008). In addition, the study by Fairley and colleagues (2011) may only be generalisable to Scotland.

As discussed in Chapter 3 (Methods), many measures of socio-economic status collected in the MCS were not used in this study as they were collected nine months after the birth. With the issues of temporality in mind, two measures of socio-economic status were chosen which might be most stable over the pre- and post-partum periods: educational level and 'social class' based on the highest status occupation in the household. Thus, for women with partners (where there was information on their partners occupation), the 'highest social class' was chosen.

Instrumental births have not been examined in earlier research on the effects of socio-economic status on mode of birth. Due to the availability of information on instrumental births in the MCS, this outcome will also be assessed in this chapter, as well as in Chapter 10.

ii) Is the effect of socio-economic status on mode of birth explained or modified by maternal age?

5.3.1 Background

One consistent finding in the literature is that *unadjusted* rates of caesarean section are higher for mothers of higher socio-economic position, regardless of the measure used. Maternal age is likely to be a common confounding factor across these studies. Women of higher socio-economic status are more likely to delay childbearing, and maternal age has a strong effect on mode of birth. Although the majority of studies adjusted for maternal age, this was often amongst many other factors. One large Canadian study by Leeb and colleagues adjusted the effect of socio-economic status on mode of birth for maternal age only (Leeb et al., 2005). Although unadjusted analyses had indicated that women in the least affluent areas had *lower* rates of caesarean section, when adjusted for age this finding was reversed, indicating that women in the least affluent areas had the *highest* rates of caesarean section. The effect of adjusting for age will therefore be explored in the MCS in this chapter.

5.3.2 Methods

Tables A5.5 and A5.6 present the results of multinomial logistic regression models for the effect of socio-economic status on mode of birth for primiparous and multiparous women, respectively. An unadjusted model and a model adjusted for maternal age are presented.

5.3.3 Results

Figures 5.4 and 5.5 show mothers' mean age according to education and 'social class'. As expected, there was a strong association between both educational level and social class (measured by highest status occupation in the household) and maternal age. The gradient was most noticeable for mothers having their first child. For example, for social class there was a difference of almost 10 years between mothers living in households where the highest occupation was unclassified or routine, and those where the highest occupation was higher managerial and professional.

Figure 5.4: Weighted mean maternal age by education and parity

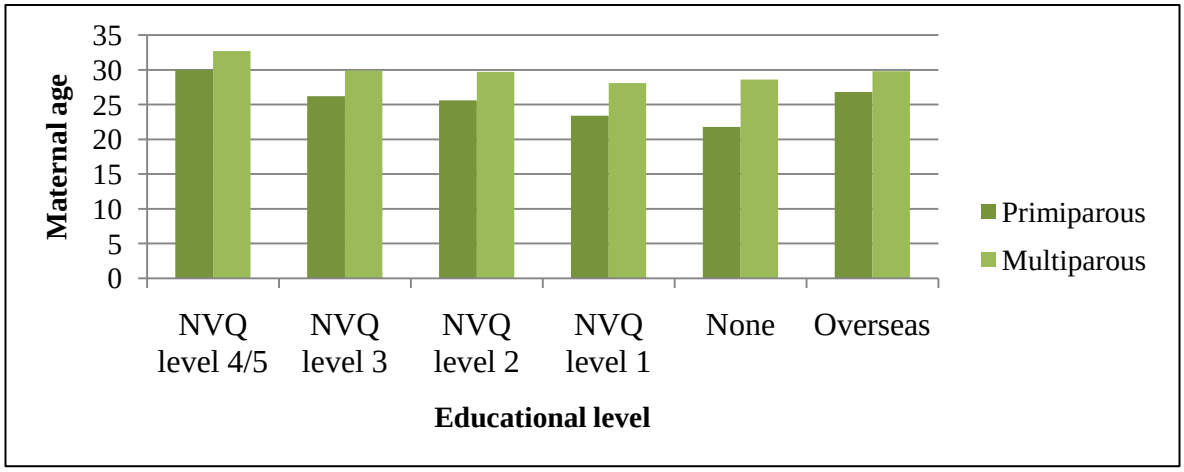
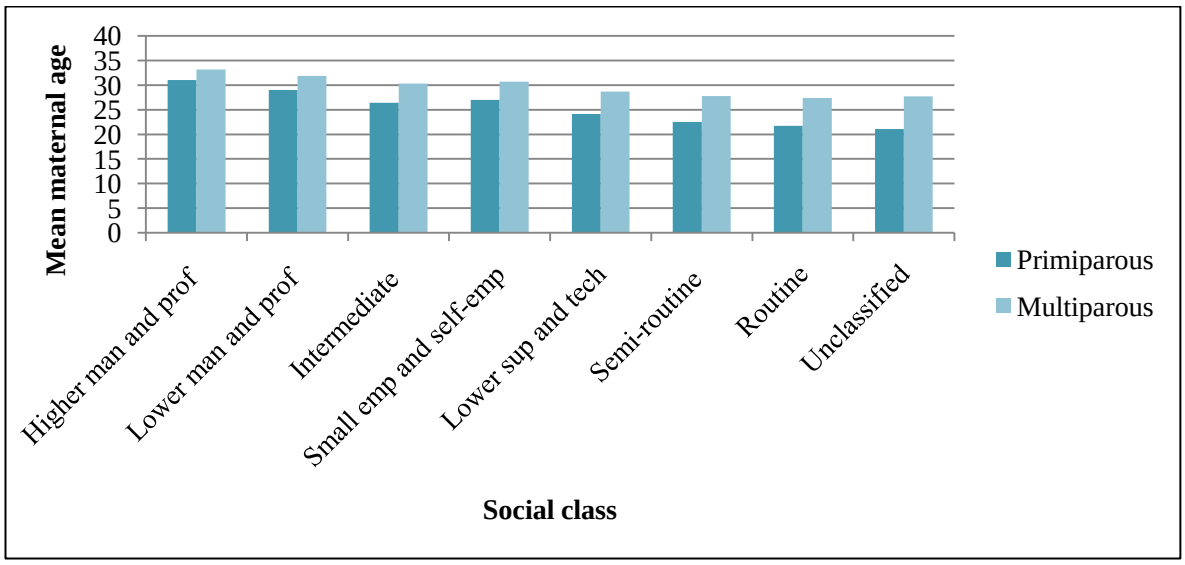
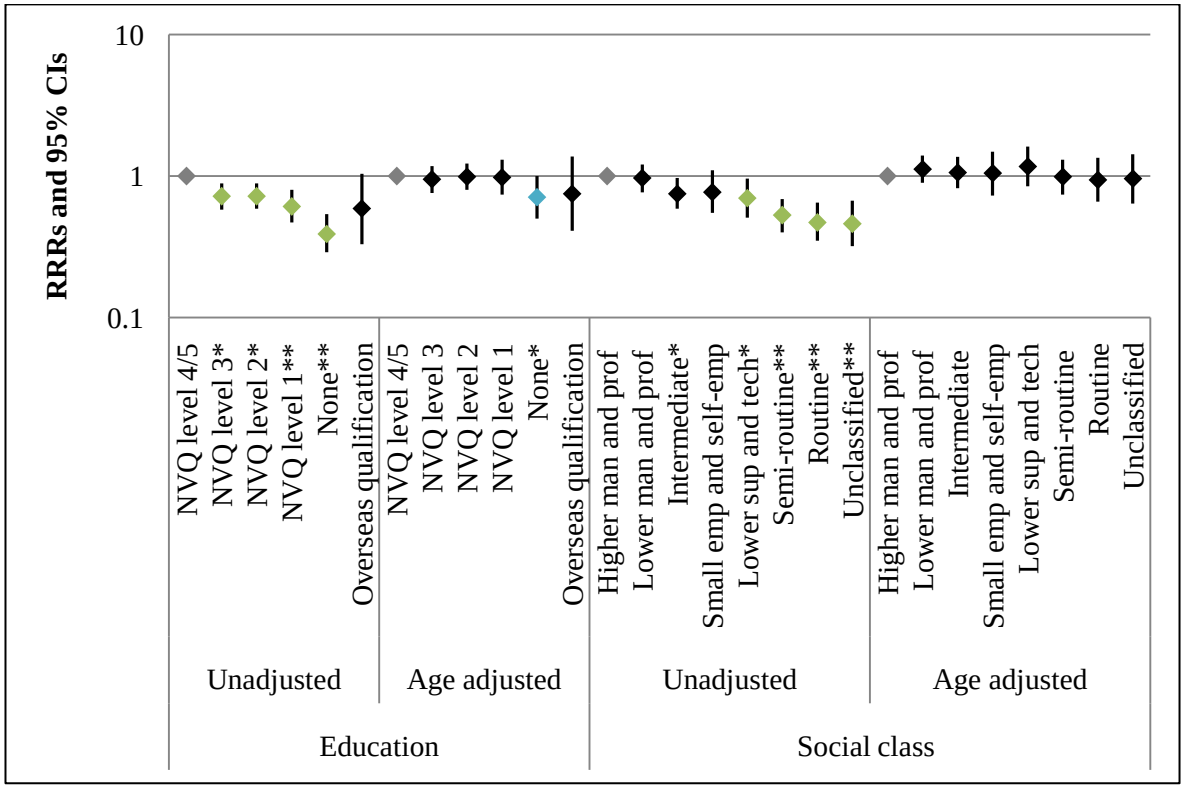


Figure 5.5: Weighted mean maternal age by social class and parity



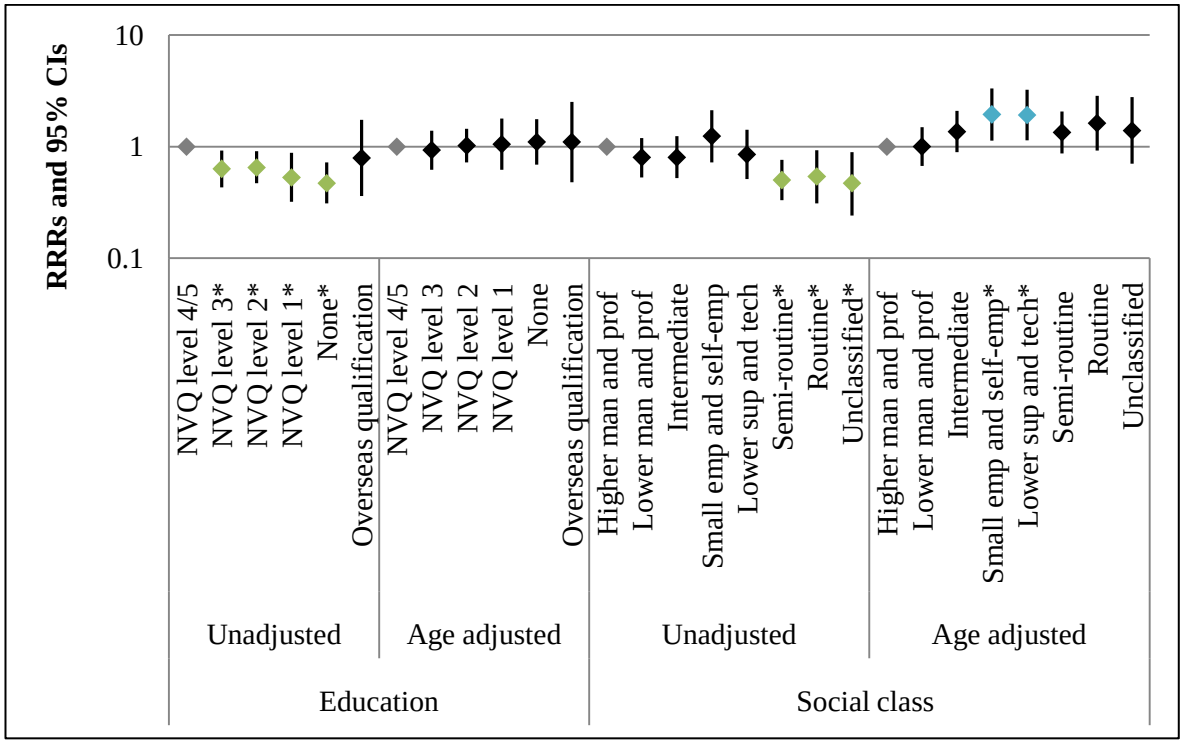
Tables A5.5 and A5.6 and Figures 5.6 through 5.11 display the relative risk ratios and confidence intervals for mode of birth, according to education and 'social class'. Among *primiparous* women, lower levels of education and social class were associated with a decreased risk of operative birth. However, adjustment for maternal age either made the majority of these findings non-significant, or reversed them. For example, women from lower social class households were at *higher* risk of having a planned caesarean section. For instrumental births, women with no education were at a decreased risk compared to women with degree level qualifications, although the risk was attenuated from the unadjusted result.

Figure 5.6: The effect of socio-economic status on the risk of instrumental birth for primiparous women



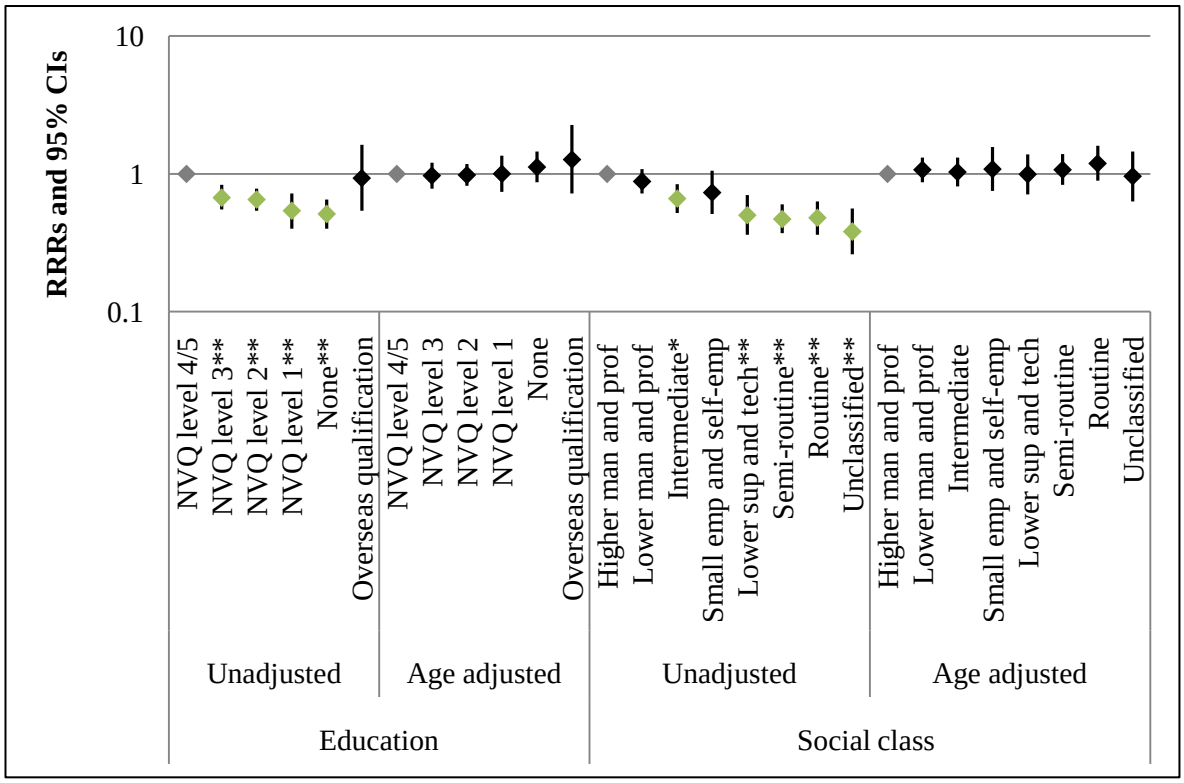
*p<0.05, **p<0.001

Figure 5.7: The effect of socio-economic status on the risk of planned caesarean section for primiparous women



*p<0.05

Figure 5.8: The effect of socio-economic status on the risk of emergency caesarean section for primiparous women

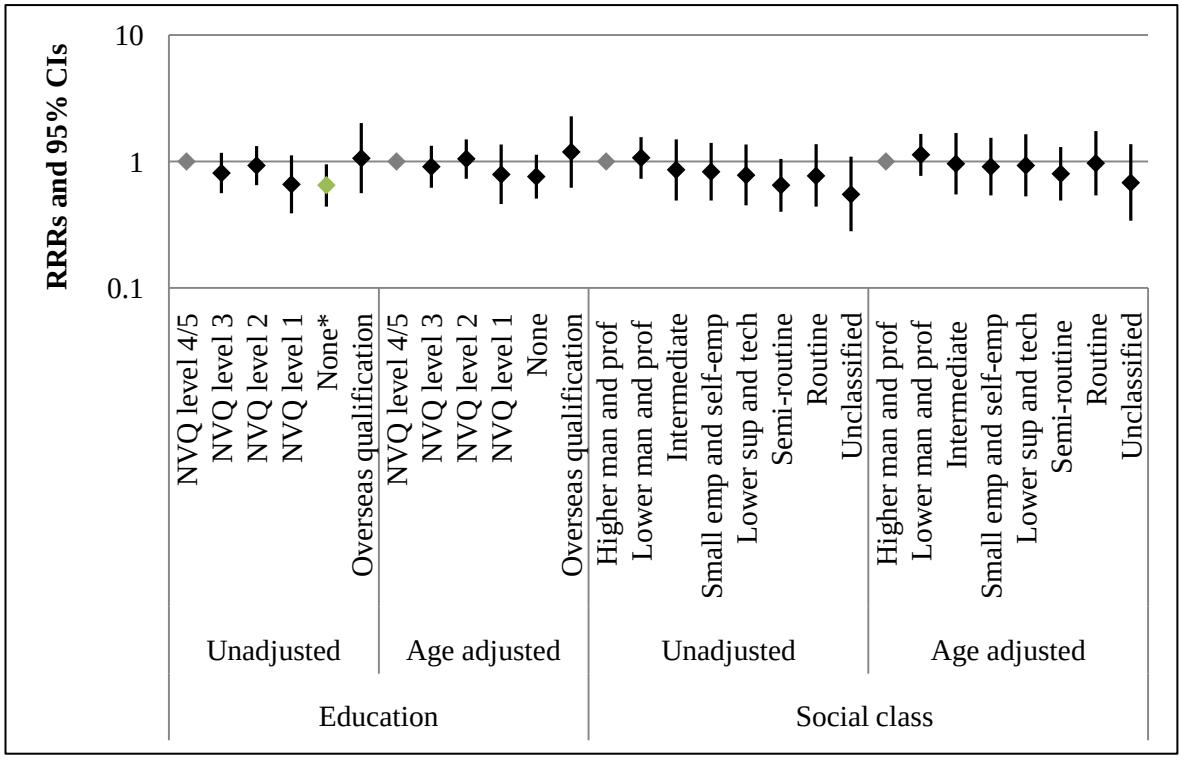


*p<0.05, **p<0.001

Among *multiparous* mothers the effect of socio-economic status on mode of birth was not as prominent in either the unadjusted analyses or the analyses adjusted for age (see Table A5.4). Nevertheless, planned caesarean sections were less likely for women of low social class and educational attainment (compared to women from high social class households and with high levels of education, see Figure 5.10). In addition, women with no qualifications were at a reduced risk of an instrumental birth compared to women with degree level qualifications. In the unadjusted model there was no effect of socio-economic status on emergency caesarean sections.

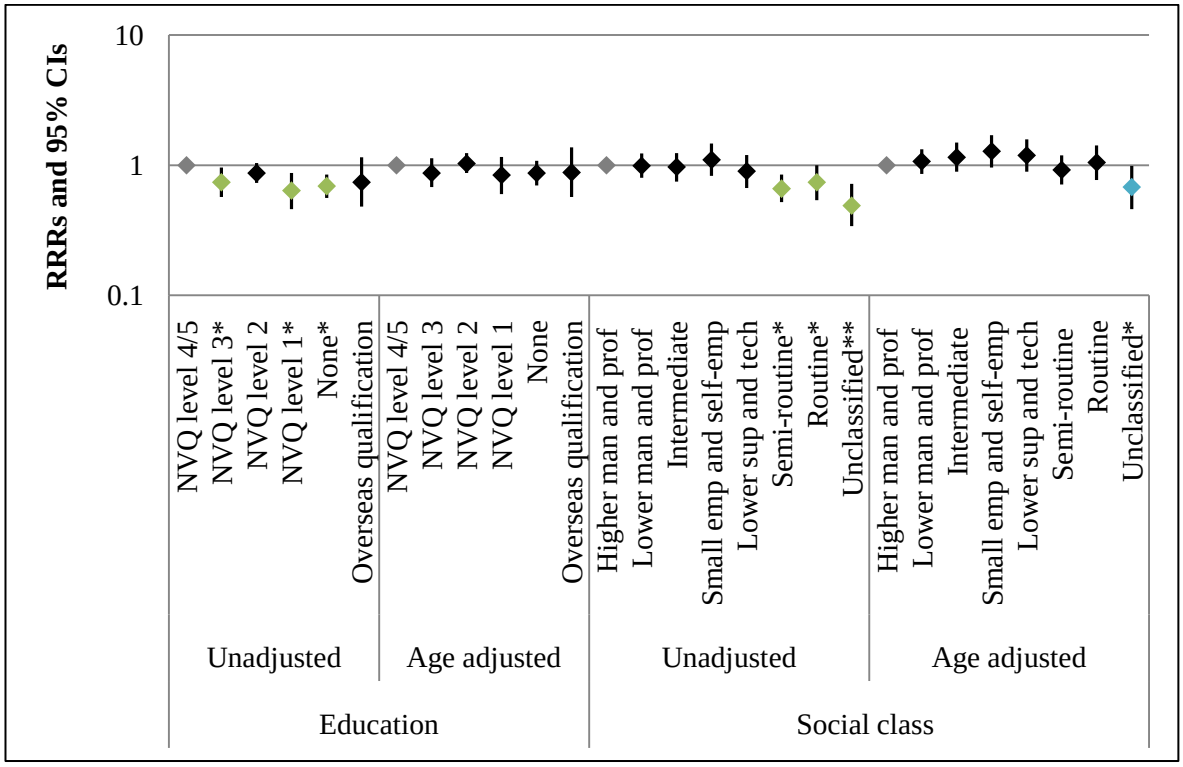
When adjusted for age, socio-economic status was no longer associated with the risk of instrumental birth. Unlike for primiparous women, lower social class remained significantly associated with *lower* risk of planned caesarean section. Although socio-economic status had not been a significant predictor of emergency caesarean section in the unadjusted model, when adjusted for age, mothers from lower social class backgrounds were at an *increased* risk compared to mothers from the highest social classes (see Figure 5.11).

Figure 5.9: The effect of socio-economic status on the risk of instrumental birth for multiparous women



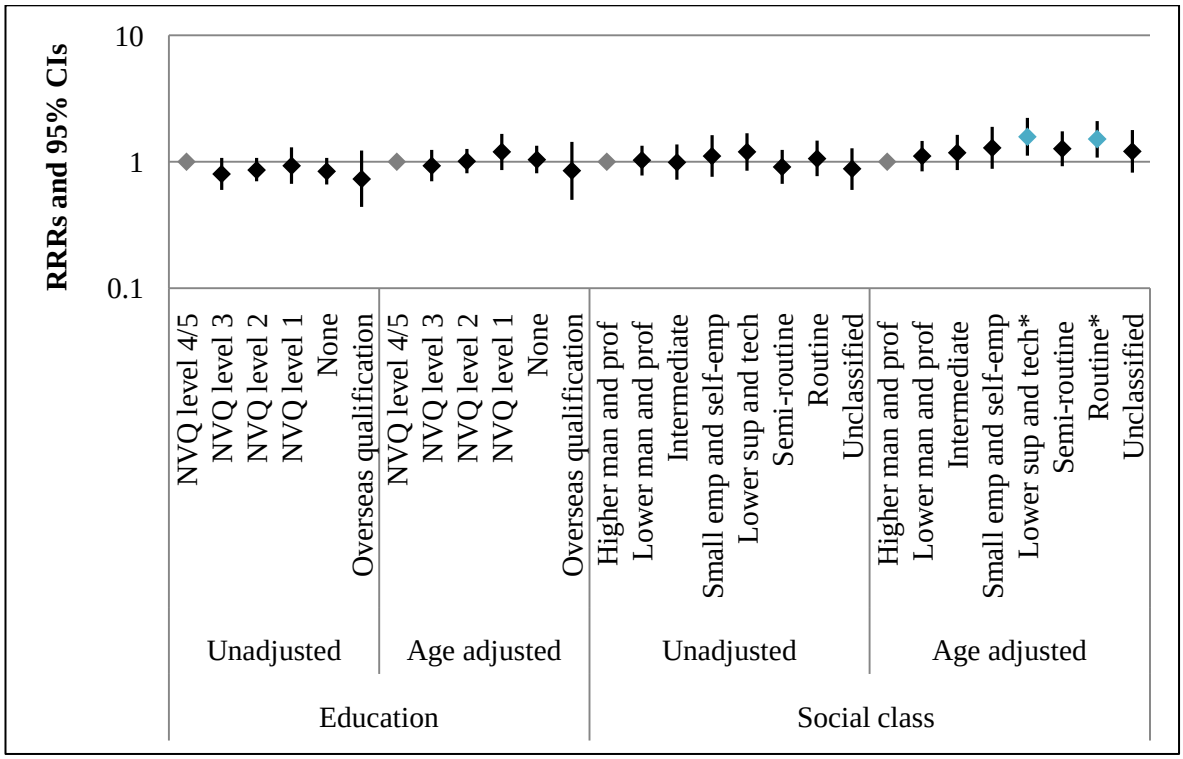
*p<0.05

Figure 5.10: The effect of socio-economic status on the risk of planned caesarean section for multiparous women



*p<0.05, **p<0.001

Figure 5.11: The effect of socio-economic status on the risk of emergency caesarean section for multiparous women



*p<0.05

5.3.4 Discussion

Few UK studies have examined the effect of socio-economic status on mode of birth. The few studies available seem to indicate that women from affluent areas are more likely to have a planned caesarean section, and that women from more deprived areas are more likely to have a caesarean section due to unforeseen circumstances (Alves and Sheikh, 2005, Barley et al., 2004, Redshaw et al., 2007).

Many of the studies included in the literature review had adjusted for maternal factors, including age. Substantial literature has suggested a strong relationship between advancing maternal age and increased risk of operative births. In a Canadian study, Leeb and colleagues (2005) adjusted for age only, and found that in crude analyses, caesarean section rates were *lowest* in the most deprived neighbourhoods; however, when maternal age was adjusted for, this finding reversed, with the most deprived neighbourhoods having the *highest* rates of caesarean section.

The findings from the MCS stress the importance of adjustment for maternal age when investigating the relationship between socio-economic status and mode of birth. Overall, adjustment for age had a similar impact to that shown in the study by Leeb and colleagues (2005). In the unadjusted models it appeared that lower socio-economic status was associated with a decreased risk of operative birth; however maternal age explained much of this variation, and adjustment for age in some cases, reversed the unadjusted findings, with women in lower socio-economic groups actually at an increased risk of operative birth.

iii) Is smoking in pregnancy a risk factor for mode of birth, or is it simply a marker of maternal social disadvantage?

5.3.5 Background

Three studies identified in the literature review examined the relationship between smoking in pregnancy and mode of birth; two Swedish and one English. The first large Swedish study using data from 1992-1993, including around 92,000 women, found no association between smoking and mode of birth after adjustment for age, education, mother's country of birth, BMI and type of hospital (Cnattingius et al., 1998). The second study was conducted by one of the authors of the earlier paper, Sven Cnattingius. Similar data were utilised but from 1992-1997 including over 400,000 women (Cnattingius and Lambe, 2002). A slight increased risk of caesarean section was found for women who smoked between 1 and 9 cigarettes per day after adjustment for very similar

covariates. The final study was conducted using the English ALSPAC cohort which included adjustment for social class and home ownership in addition to a range of other maternal factors (Patel et al., 2005). No association between smoking and mode of birth was identified.

In the UK, smoking is more prevalent among people from disadvantaged backgrounds. Graham and colleagues (2006) conducted a review of literature and an analysis of a British survey of women. Smoking status including uptake, persistence, consumption and cessation were influenced by disadvantage. Particularly, women who left school or began motherhood at an early age were more likely to smoke (Graham et al., 2006). More recently Graham and colleagues conducted analyses within the MCS regarding socio-economic status influences on smoking during pregnancy. Mothers from more disadvantaged backgrounds as measured by childhood social class, current social class, age of leaving education and household income were less likely to quit smoking during pregnancy than their more advantaged counterparts (Graham et al., 2010).

Analyses were conducted to investigate if smoking during pregnancy was independently related to mode of birth in the MCS, or whether it was reflective of socio-economic disadvantage and therefore eliminated by adjustment for socio-economic factors.

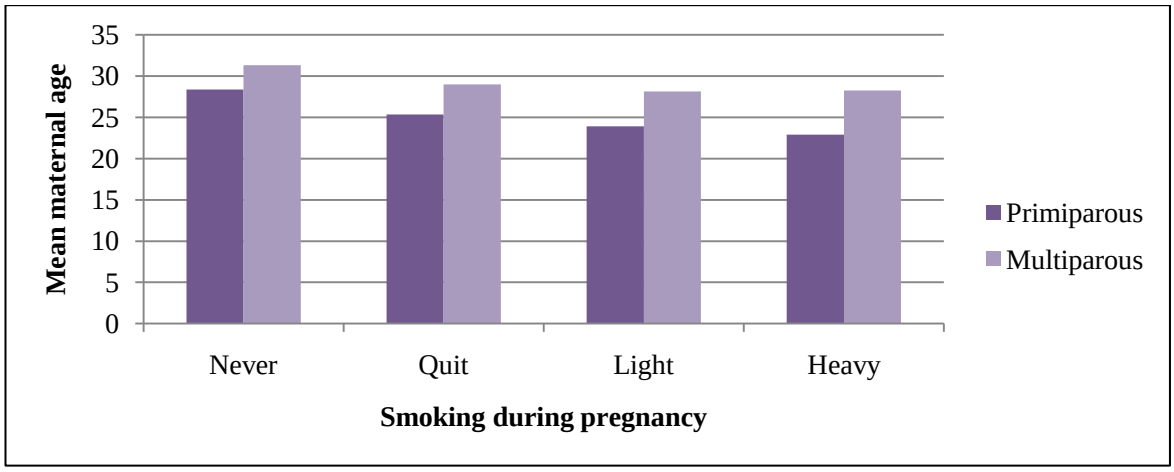
5.3.6 Results

Table A5.7 shows the results from three multinomial logistic models. Model A shows the unadjusted relative risk ratios for smoking in pregnancy on mode of birth, Model B includes adjustment for maternal age and socio-economic factors and Model C additionally adjusts for birth weight.

In Chapter 4, unadjusted rates of unassisted vaginal birth increased with increasing smoking in pregnancy.

Figure 5.12 displays the mean maternal age for women according to their smoking during pregnancy. Primiparous women who had never smoked were on average 28 years old and age decreased with increasing smoking with mothers who smoked heavily during pregnancy around five years younger on average. Multiparous women who smoked during pregnancy were also younger on average than women who had never smoked, although by a smaller magnitude (around 28 for women who smoked and 31 for women who had never smoked).

Figure 5.12: Weighted mean maternal age according to smoking status during pregnancy



Figures 5.13 and 5.14 show the strong relationship between socio-economic status and smoking during pregnancy, with rates of pregnancy smoking increasing with increasing disadvantage. Smoking was very common for women of low educational level or social class. In fact, around 40% of primiparous women with no educational qualifications or in the lowest social class smoked during pregnancy.

Figure 5.13: Educational level of women according to their smoking during pregnancy

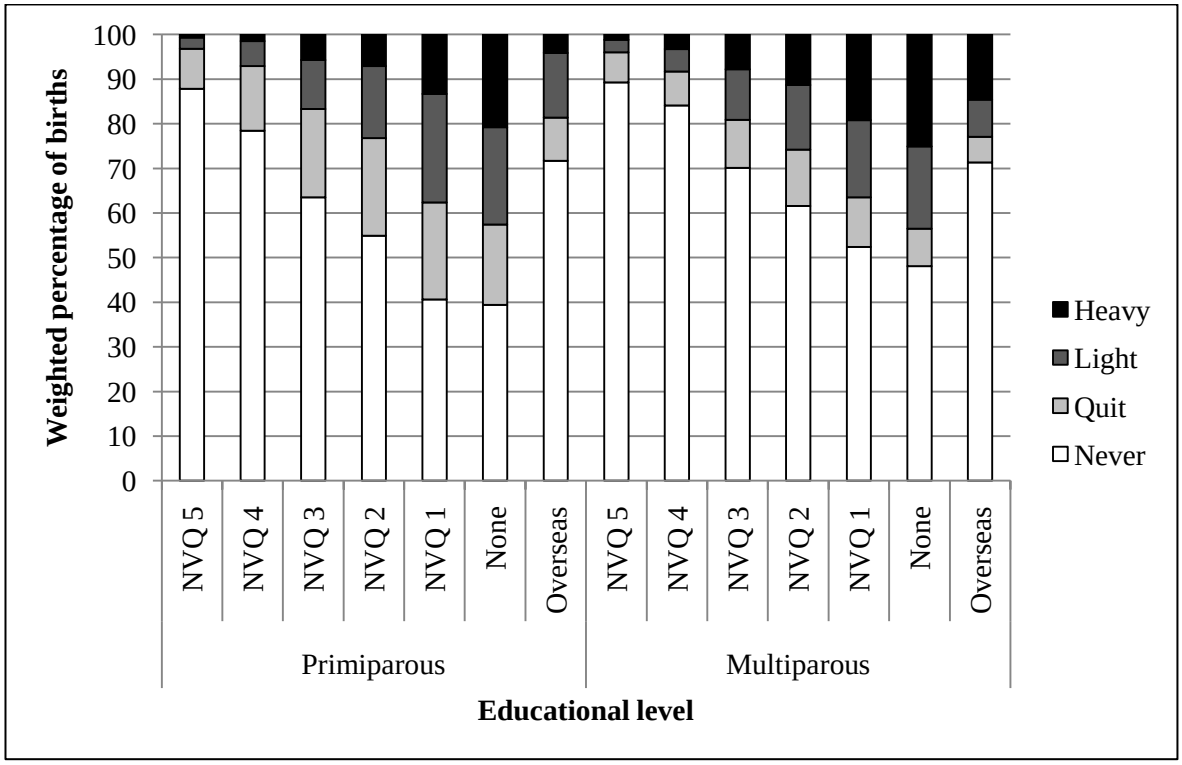
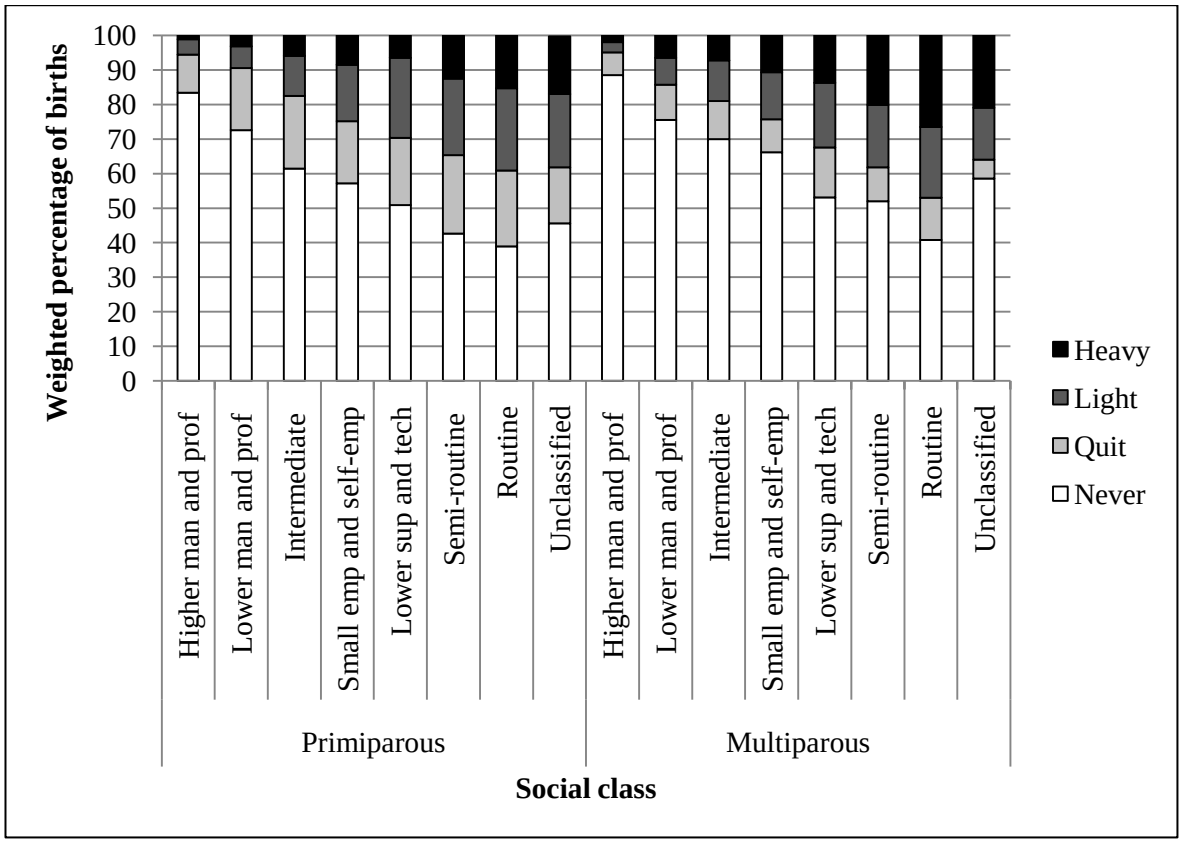
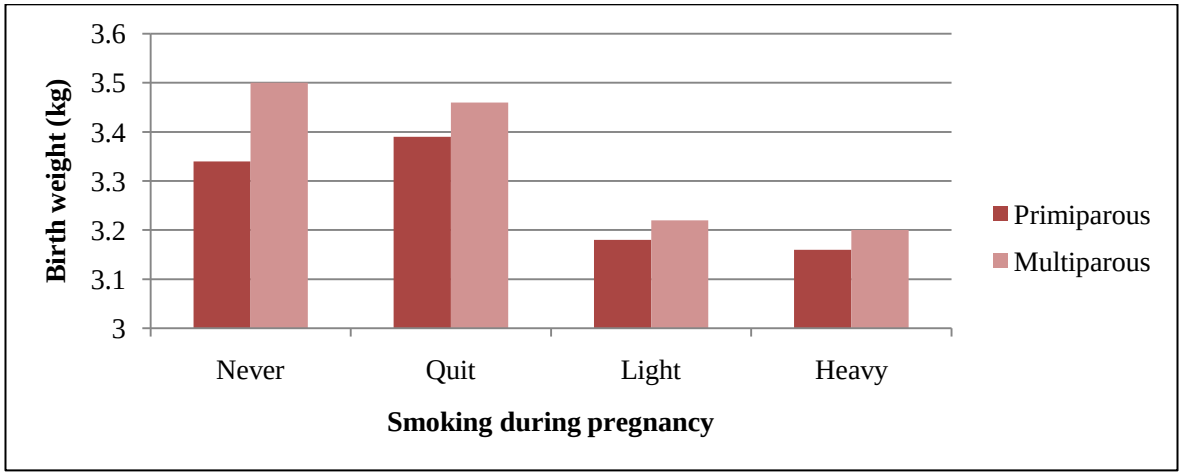


Figure 5.14: Social class of women according to their smoking during pregnancy



Women who smoked during pregnancy had infants who were lighter on average than mothers who had never smoked or had quit smoking due to pregnancy, with mothers who smoked heavily during pregnancy having the lightest infants (see Figure 5.15). An unadjusted regression revealed that the reduction in birth weight was statistically significant for both primiparous and multiparous women (data not shown).

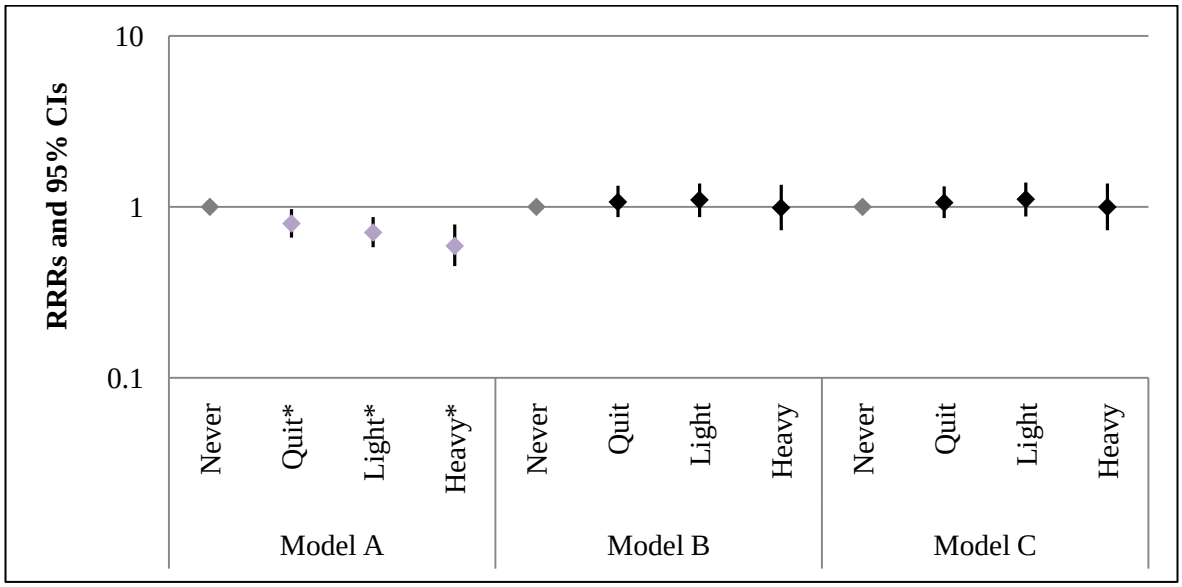
Figure 5.15: Weighted mean birth weight according to smoking status during pregnancy



Women who smoked during pregnancy in the MCS were on average younger, of lower socio-economic status and gave birth to lower birth weight infants than women who had never smoked. Age, socio-economic status and birth weight are therefore likely confounders of the relationship between smoking during pregnancy and mode of birth.

Among *primiparous* mothers, in unadjusted analyses, compared to mothers who had never smoked, mothers who smoked heavily during pregnancy were less likely to have an instrumental birth (RRR=0.54, p<0.001). Mothers who quit smoking for the pregnancy were less likely to have a planned caesarean section than mothers who had never smoked (RRR=0.63, p<0.05), and there was also a decreased risk of planned caesarean section for mothers who smoked lightly during pregnancy, but of borderline significance (RRR=0.69 p=0.06). Finally, compared to women who had never smoked, increased smoking during pregnancy decreased the likelihood of emergency caesarean section (see Figure 5.16). After adjustment for maternal age and socio-economic status smoking status during pregnancy was no longer significantly related to mode of birth. Additional adjustment for birth weight made little difference to the model.

Figure 5.16: The effect of smoking in pregnancy on the risk of emergency caesarean section for primiparous women



*p<0.05

Among *multiparous* mothers, light and heavy smokers were at a reduced risk of planned caesarean section compared to mothers who had never smoked in unadjusted analyses (RRR=0.74, p<0.05 for light and RRR=0.72, p<0.05 for heavy smoking). When the model was adjusted for age and socio-economic status however (Model B), smoking status was no longer related to mode of birth. Further adjustment for birth weight in Model C made no difference to the result.

5.3.7 Discussion

As discussed by Graham and colleagues (2010), women of low socio-economic status were less likely to quit smoking during pregnancy in the MCS. These analyses demonstrate the strong gradient of increasing pregnancy smoking with increasing disadvantage, as well as with decreasing maternal age.

Although smoking during pregnancy appeared to reduce the risk of operative birth in unadjusted analyses, adjustment for maternal age and socio-economic status eliminated the effect. This result suggests that, as hypothesised, smoking during pregnancy was a marker for social disadvantage. Additional adjustment for birth weight had little or no extra effect on risk, suggesting that birth weight did not further explain the relationship between smoking and mode of birth. Moreover, this may reflect an increased prevalence of low birth weight among the disadvantaged women, adjusted for by including socio-economic status in the model.

iv) Does *paternal* age have an effect on mode of birth in the UK, after adjustment for maternal age and socio-economic factors?

5.3.8 Background

Cultural and social changes over recent decades have led to an increase in parenting at older ages. Much research has detailed the impact of advanced maternal age on childbearing women, including the effect on mode of birth. However, more recently there has been increased interest in the effect of advanced paternal age, for example examining the effect of advanced paternal age on reproductive health (Pasqualotto et al., 2008) and infant outcomes (Saha et al., 2009). One study has also examined the link between paternal age and mode of birth. Tang and colleagues examined over 300,000 births that occurred in Taiwan between 1999 and 2001 (Tang et al., 2006). Older paternal age was significantly related to increased rates of caesarean section after adjustment for maternal age, maternal and paternal education and mother's marital status, amongst other infant and obstetric factors. The results were stratified by maternal age group. Among mothers aged 20-29 (the youngest age group), compared to those with partners aged 20-29, mothers with partners aged 30-34, 34-39 and over 40 were 1.12, 1.18 and 1.34 times more likely to have a caesarean section, respectively. For mothers in older age groups (30-34 and 35 and older) the risk of caesarean section was higher, as expected, but within each maternal age bracket the risk increased with paternal age (Tang et al., 2006).

As only one previous study has identified a link between paternal age and mode of birth, over and above the effects of maternal age and socio-economic background in a Taiwanese sample, the effect of paternal age on mode of birth were explored in the UK context using the MCS.

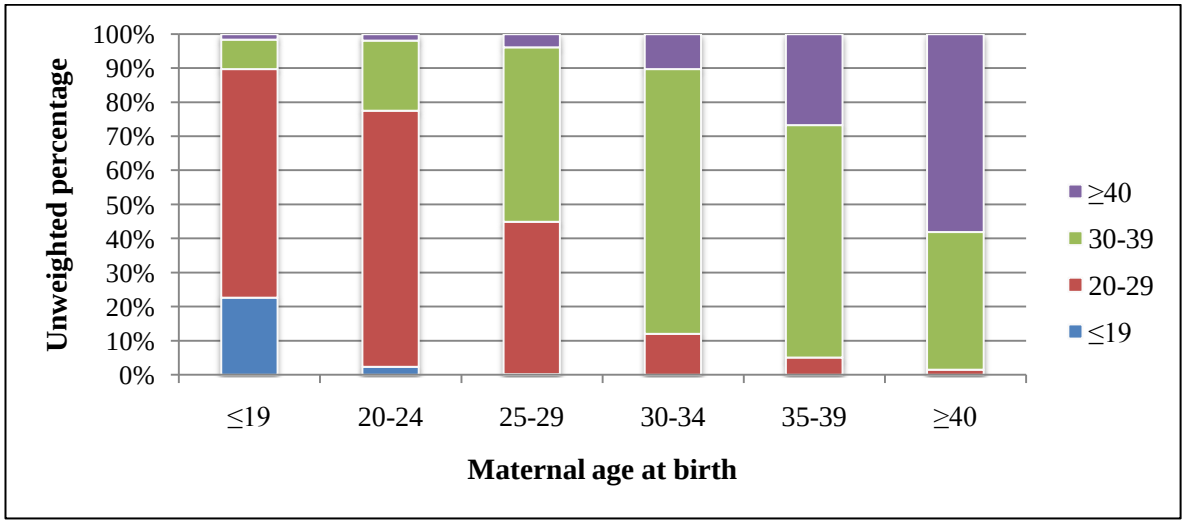
5.3.9 Results

Table A5.8 presents the results of multinomial logistic regression models for primiparous and multiparous women exploring the effect of paternal age on mode of birth, adjusted for maternal age.

As discussed in Chapter 4, operative births increased with partner's age at birth. As maternal age is significantly associated with mode of birth, and partner's age is likely to be significantly correlated with mother's age, paternal age was examined, stratified by maternal age.

Figure 5.17 shows the age of partners by the age of mothers (partners age is given in 10-year categories for ease of interpretation). As predicted, the majority of mothers were in a relationship with a partner of a similar age. As only around 6% of partners aged 19 or younger were in a relationship with a woman aged older than 24, this group was excluded for the purpose of the analysis. Equally mothers aged 19 or younger were excluded from the analysis as only 10% were in a relationship with a partner aged 30 or older, and mothers aged 40 and older were also excluded as there were few mothers in the category.

Figure 5.17: Paternal age by mother's age



When paternal age was adjusted for maternal age, the effect of paternal age on mode of birth for both primiparous and multiparous mothers disappeared (see Table A5.8).

5.3.10 Summary

A Taiwanese study reported that paternal age was independently associated with mode of birth, after adjustment for maternal age and socio-economic background, among other factors (Tang et al., 2006). However, in the MCS, paternal age is not independently related to mode of birth.

5.4 Summary

What is already known on this subject?

- Previous literature has shown an increased risk of operative births for mothers with increasing maternal age. Some evidence suggests that biological reasons may explain the association between maternal age and mode of birth.
- Few UK-based studies have examined the link between socio-economic status and mode of birth. No UK studies have included instrumental births.
- Few studies have observed the effect of smoking during pregnancy on mode of birth; one large Swedish study had found an increased of caesarean section for women who smoked.
- One study from Taiwan showed an increased risk of caesarean section with increased *paternal* age, independent of the effects of maternal age and socio-economic status.

What does this study add?

- In agreement with previous literature, the incidence of labour complications increased for mothers with increasing maternal age which may add further support to the biological theory. However, when adjusted for, these labour factors did not explain the relationship between maternal age and mode of birth.
- Socio-economic status was measured through educational level and household social class which may more accurately measure social position. After adjustment for maternal age, women of lower socio-economic status were generally at a higher risk of operative birth.
- Smoking during pregnancy was a marker for social disadvantage and as such was not independently related to mode of birth when maternal age and socio-economic status were controlled for.
- Paternal age was not independently related to mode of birth in this large UK sample, with any variation in mode of birth by paternal age explained by maternal age.

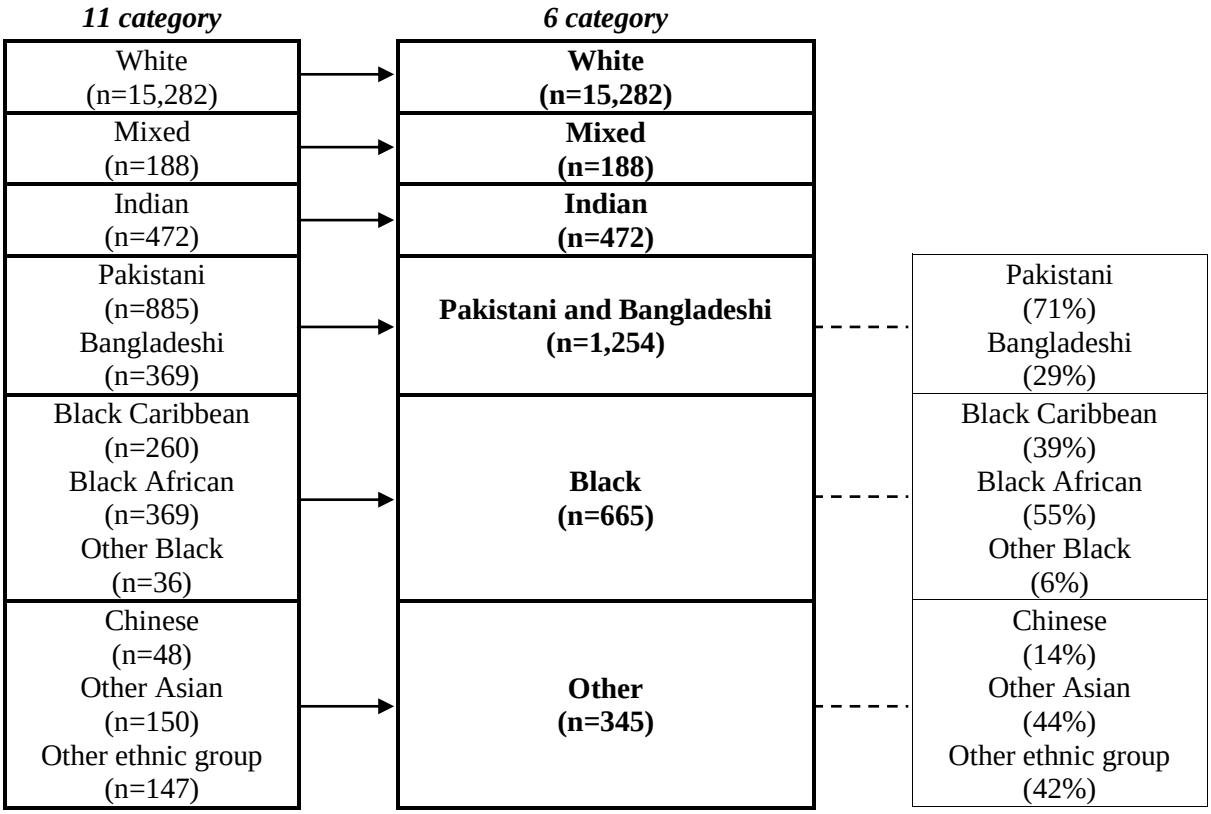
CHAPTER 6: The Millennium Cohort Study: Ethnicity and mode of birth

6.1 Background

Few studies have examined the effect of ethnicity on mode of birth, and this is particularly true in the UK, where only five studies were identified (Bragg et al., 2010, Ibison, 2005, Paranjothy et al., 2005, Patel et al., 2005, Richardson and Mmata, 2007). Overall from the current literature, non-White women, and particularly Black women, appear to be at an increased risk of emergency caesarean section. The results for elective caesarean section and instrumental births are less clear, but it seems that non-White women may be at a *reduced* risk of elective caesarean section and that the risk of instrumental birth was higher for women of some minority groups, and lower for others, compared to White women.

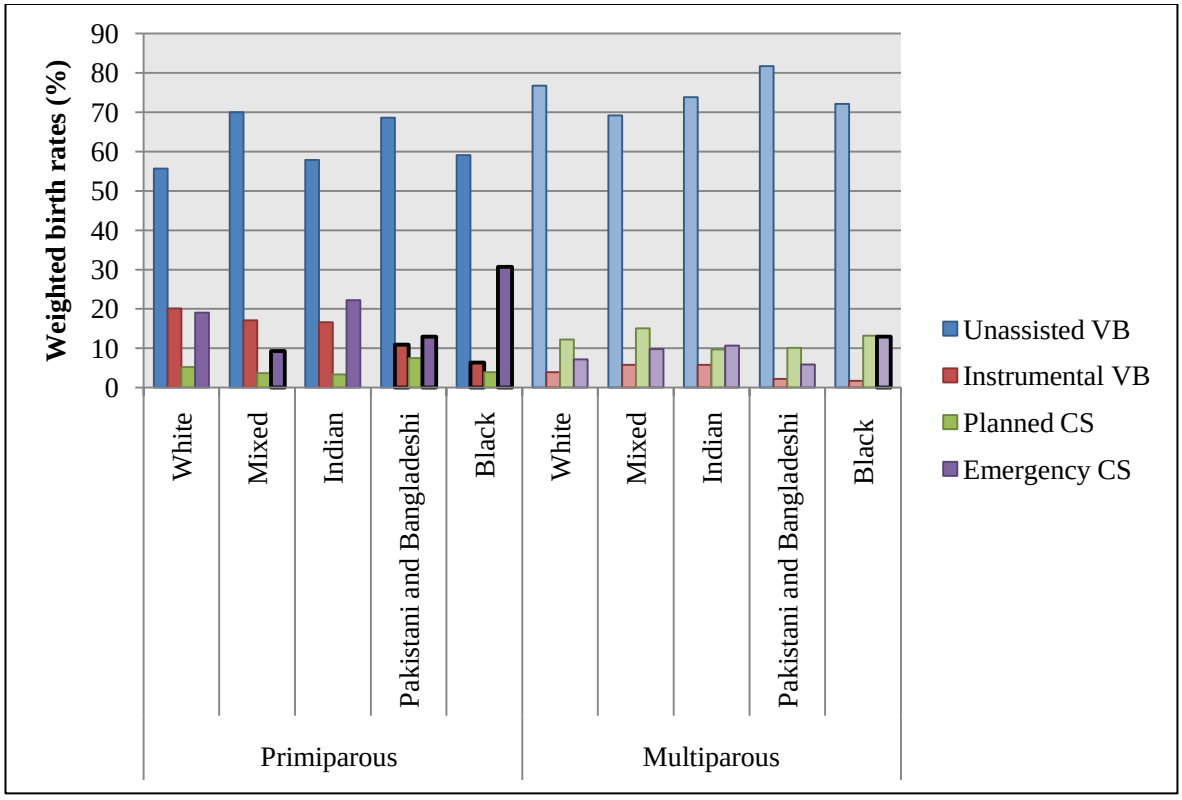
The six category census classification (White, Mixed, Indian, Pakistani and Bangladeshi, Black and Other ethnic group) was used for MCS analyses. A more detailed 11 category census classification is available in the MCS; however, the smaller groups would under-power some analyses. Figure 6.1 shows how the 11 groups are combined in order to create the six categories.

Figure 6.1: Categorisation of ethnicity in the MCS: 6 and 11 category census classification



As outlined in Chapter 3 (Methods), women of 'other' ethnic origin were excluded for the purposes of this study due to the heterogeneous nature of the group. Figure 6.2 shows the unadjusted rates of mode of birth for mothers of different ethnic backgrounds, stratified by parity. Bars highlighted in bold indicate a significant difference in mode of birth compared to White women (see Table A6.3). Among primiparous women, Black women were more likely to have an emergency caesarean section compared to White women, but women of Mixed ethnicity and Pakistani/Bangladeshi ethnicity were comparatively less likely. Primiparous women of Pakistani/Bangladeshi and Black ethnicity were significantly less likely to have an instrumental vaginal birth than White women. Black multiparous women were around twice as likely to have an emergency caesarean section compared to White women. Ethnicity was not related to planned caesarean section rates.

Figure 6.2: Mode of birth by ethnicity and parity



*Bars with a **bold** outline indicate a significantly different risk to the risk for White mothers in unadjusted multinomial logistic regression analyses (see Table A6.3)

The reason for the link between ethnicity and mode of birth is likely to be multifactorial. As discussed in Chapter 2, the health of the UK's ethnic minority groups is often poorer than for White women. Ethnic inequalities in health may be due to a combination of factors, including differences in; culture and lifestyle, socio-economic status, environment, genetic and generational factors, access to healthcare and the following of health advice (Bhopal, 2009).

This chapter will investigate the social position of women from minority ethnic groups in the MCS, and will then go on to address research questions which arose from a review of the literature:

i. Is the effect of maternal age on mode of birth modified by ethnicity, in accordance with the 'weathering hypothesis'?
ii. Is the effect of maternal height on mode of birth modified by ethnicity?
iii. Is the link between ethnicity and mode of birth explained by women's health during pregnancy or complications in labour?

6.2 Social position

6.2.1 Background

James Nazroo has explored the health of Britain's ethnic minority groups (Nazroo, 1997, Nazroo, 2003). On most health indicators, minority groups in the UK have poorer outcomes than the White majority. However, ethnic minority groups are not universally disadvantaged in terms of health or socio-economic position. In terms of health, Chinese, African Asians and Indians are most similar to Whites, whereas Caribbeans, Pakistanis and Bangladeshis experience much poorer health. When examining socio-economic position, a very similar pattern emerges, with Chinese and African Asians being most similar to Whites in terms of socio-economic status, closely followed by Indians. Caribbeans and Pakistanis however, are typically more deprived, and Bangladeshis are the most deprived ethnic group (Nazroo, 1997).

6.2.2 Results

Figure 6.3 shows the proportion of women in the MCS who came from households where the highest occupation was semi-routine or routine (the two lowest social class bands according to the NS-SEC). In accordance with Nazroo's findings, Indian women were similar to White women in terms of 'social class', with around 21% of low social class, and Pakistani and Bangladeshi women were the group with the highest proportion low social class, with almost 37% in the lowest social class bands.

Figure 6.3: Low social class by ethnic group

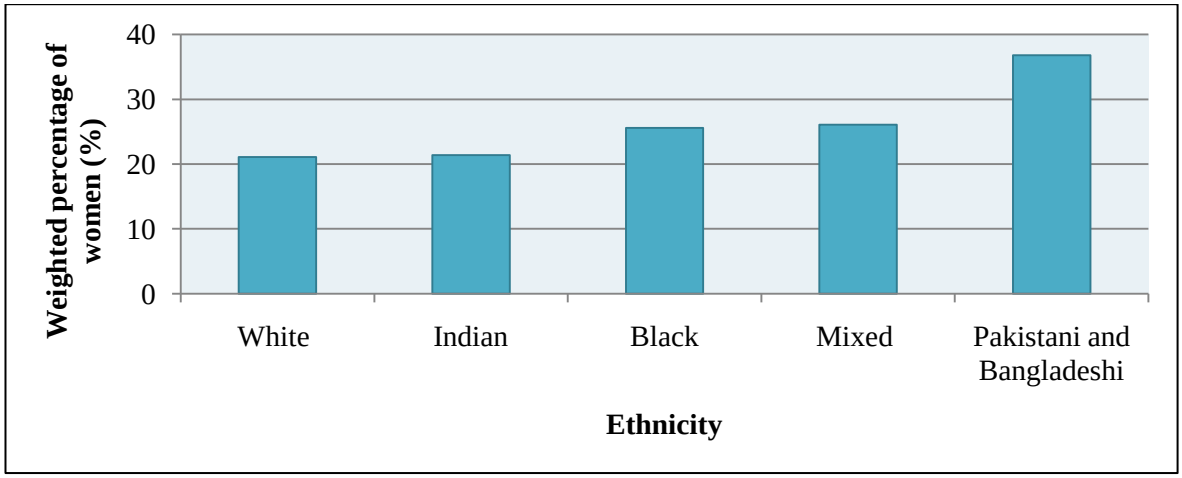


Figure 6.4 shows the educational level of women according to their ethnic group. For the purposes of the graph, mothers with a low level of education (NVQ level 1 - equivalent to GCSE grades D-G) and those who reported having no education were combined. Because the focus here is on markers of disadvantage NVQ level 2 (equivalent to GCSE grades A-C) through to level 5 (postgraduate degree level), were also combined.

Pakistani/Bangladeshi mothers had by far the highest rate of low or no education. In fact, the 47% of Pakistani/Bangladeshi women in this group comprised 40% with no education and 7% with NVQ level 1 equivalent education. White and Indian mothers had the smallest proportion of women with low levels of education women, with a similar rate of around 20%. For Indian mothers, around 10% had an overseas qualification.

Figure 6.4: Educational level by ethnic group

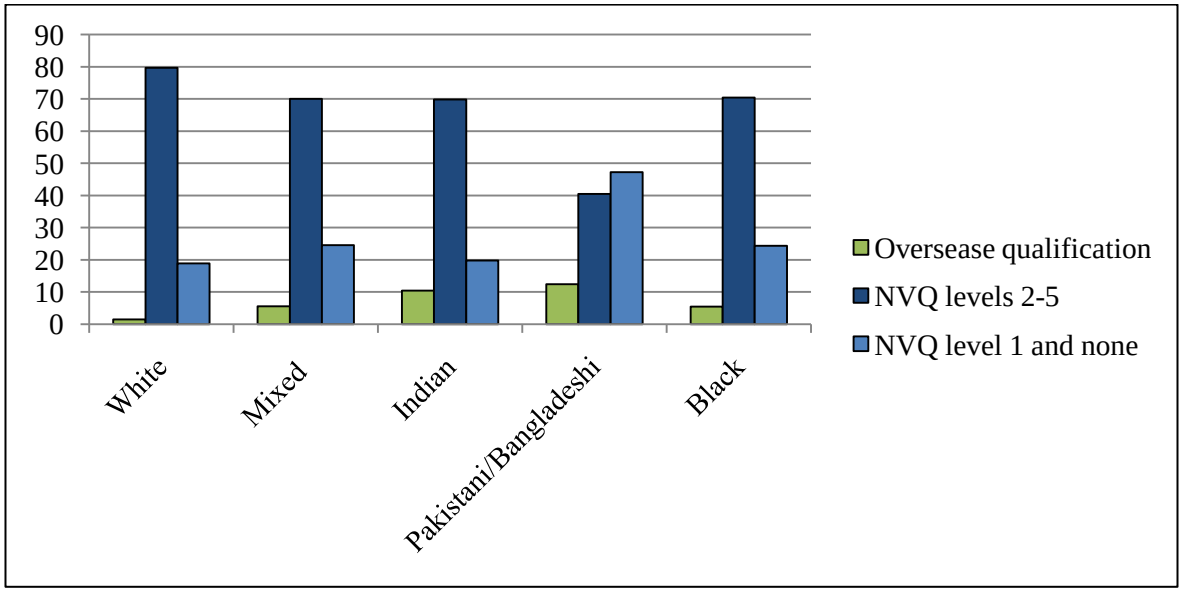
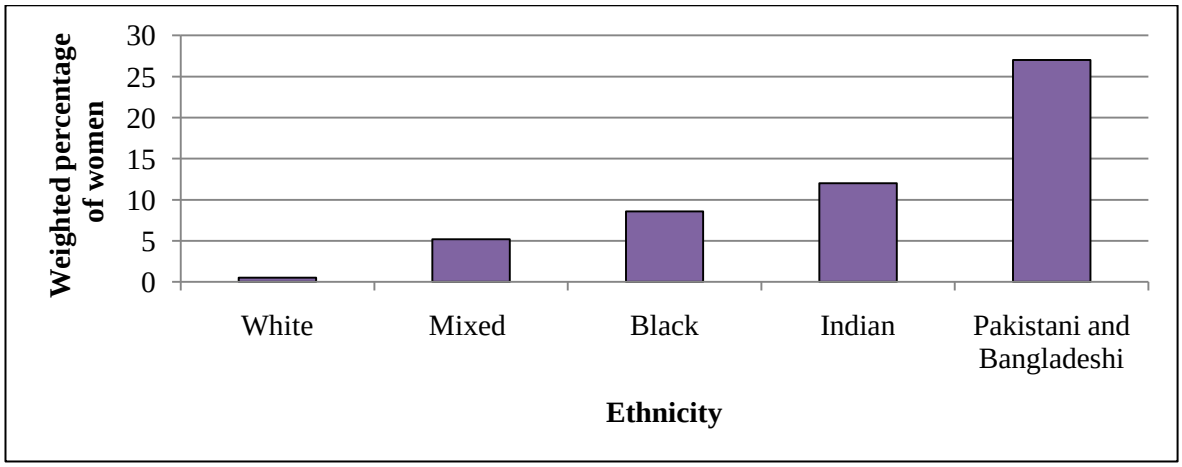


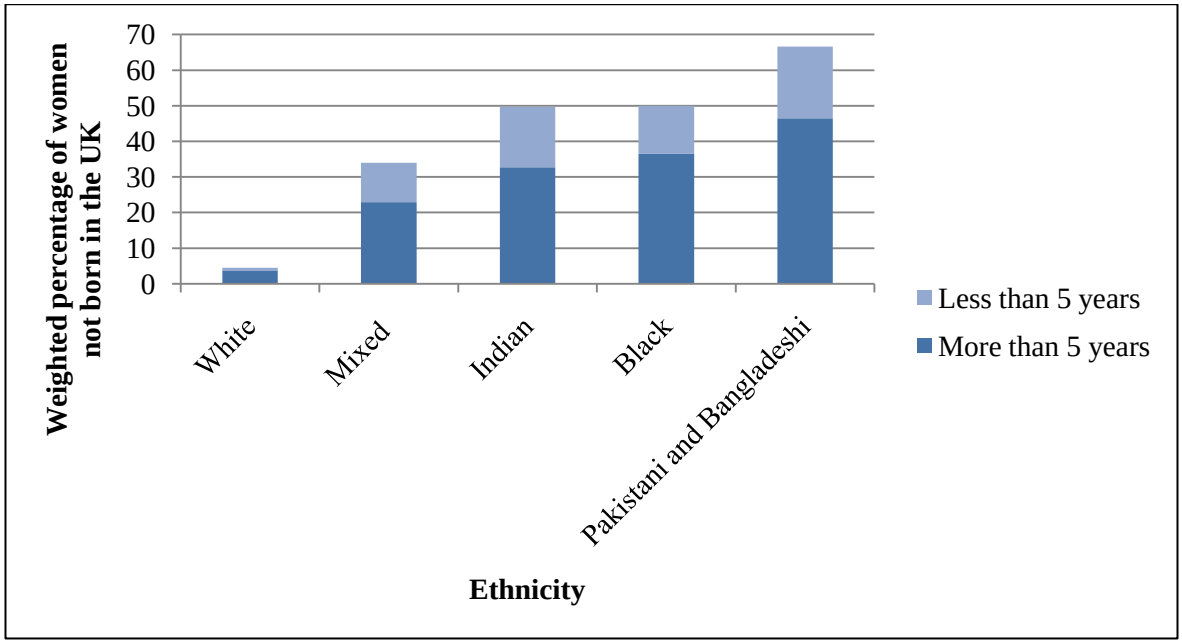
Figure 6.5 shows the proportion of women from non-English speaking households according to ethnic group. Around a quarter of Pakistani/Bangladeshi mothers were from non-English speaking households, compared to around 12% of Indian women, 9% of Black women and 5% of Mixed ethnicity women.

Figure 6.5: Mothers from non-English speaking households by ethnic group



Migration status was assessed through interview in Wave 2 of the MCS, when the child was around 3 years old. Due to attrition, information in Wave 2 is not available for all mothers who were interviewed at nine months (Wave 1). If women had been born outside the UK they were asked what year they became a UK resident. Migration was categorised as born in the UK, lived in the UK for more than five years, or for less than five years. A five year cut-off was chosen as a reflection of possible acculturation. Figure 6.6 shows the proportion of foreign-born women according to their ethnic background for the 14,518 women with data on migration from Wave 2 in this sample. Over 95% of White women were UK-born. Only a third of the Pakistani/Bangladeshi women had been born in the UK, and the same was true for around half of Black and Indian mothers.

Figure 6.6: Migration status by ethnic group



6.2.3 Discussion

As discussed by Nazroo (Nazroo, 1997, Nazroo, 2003), despite the poorer health of most ethnic minority groups in the UK, minority groups are not universally disadvantaged in terms of health and socio-economic status. In agreement with Nazroo's findings, Indian women in the MCS were similar in terms of social class and education to White women. The Pakistani/Bangladeshi women in the MCS were by far the most disadvantaged. Thirty-eight percent of Pakistani/Bangladeshi women were from a household in the lowest two social class bands, and 40% had no educational qualifications.

In addition to educational level and social class, language and migration status were investigated in the MCS as markers of social position. Migration causes a great deal of social disruption and stress, and the relative economic position of a person is likely to be different in their new country (Nazroo, 1997). In addition, being non-English speaking is likely to hamper socio-economic gains in the UK, and is also likely to cause difficulties accessing health care, as translation services (e.g. the use of interpreters) in the NHS are not yet widespread (Bhopal, 2007).

Over 25% of Pakistani/Bangladeshi women were from non-English speaking households and around 67% were non-UK born, adding to the overall picture of potential disadvantage for this group.

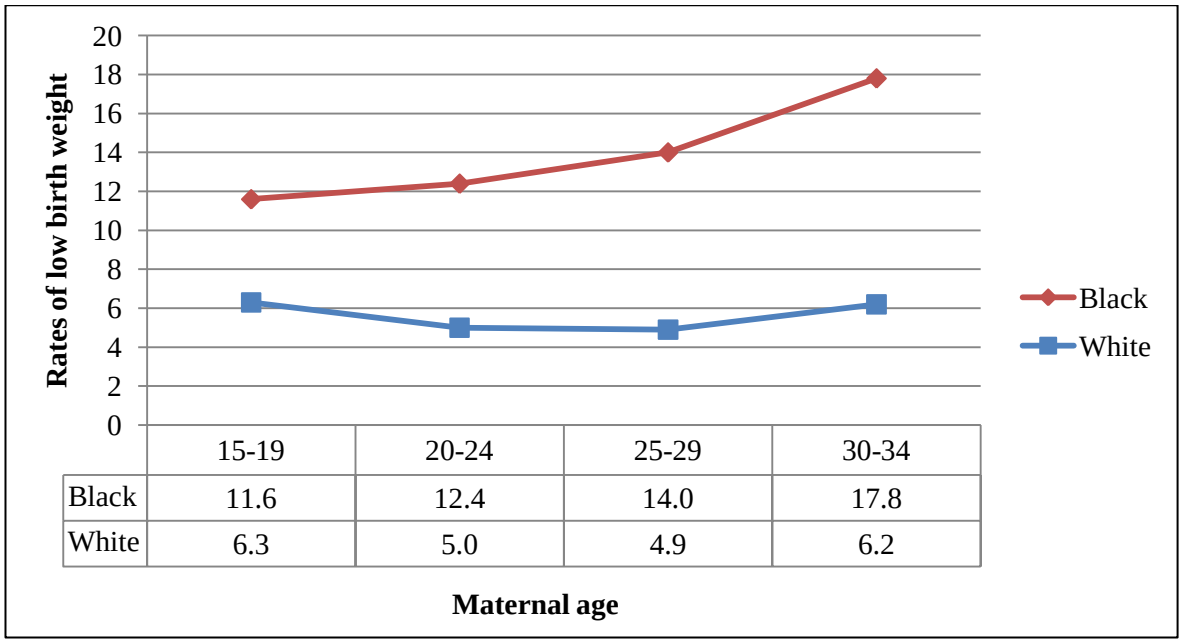
6.3 Is the effect of maternal age on mode of birth modified by ethnicity?

6.3.1 Background

The "weathering hypothesis", proposed by Arline Geronimus, suggests that the impact of maternal age on infant birth outcomes is affected by social inequality, represented by maternal ethnicity. Low birth weight is among numerous adverse outcomes which have been associated with teenage childbearing (Lawlor and Shaw, 2002). Geronimus studied rates of low birth weight in Michigan, USA in 1989 by maternal age and race/ethnicity. Among White mothers, low birth weight rates were highest for teenage mothers and mothers in their thirties, and lowest for mothers who gave birth in their twenties. For Black mothers however, the risk of having a low birth weight infant was *lowest* for teenage mothers, and increased with age (Geronimus, 1996).

Figure 6.7 shows the rates of low birth weight from Geronimus' study (the numbers given below the x axis are the rates of low birth weight from the study).

Figure 6.7: Rates of low birth weight by maternal age (adapted from Geronimus, 1996)



	15-19	20-24	25-29	30-34
Black	11.6	12.4	14.0	17.8
White	6.3	5.0	4.9	6.2

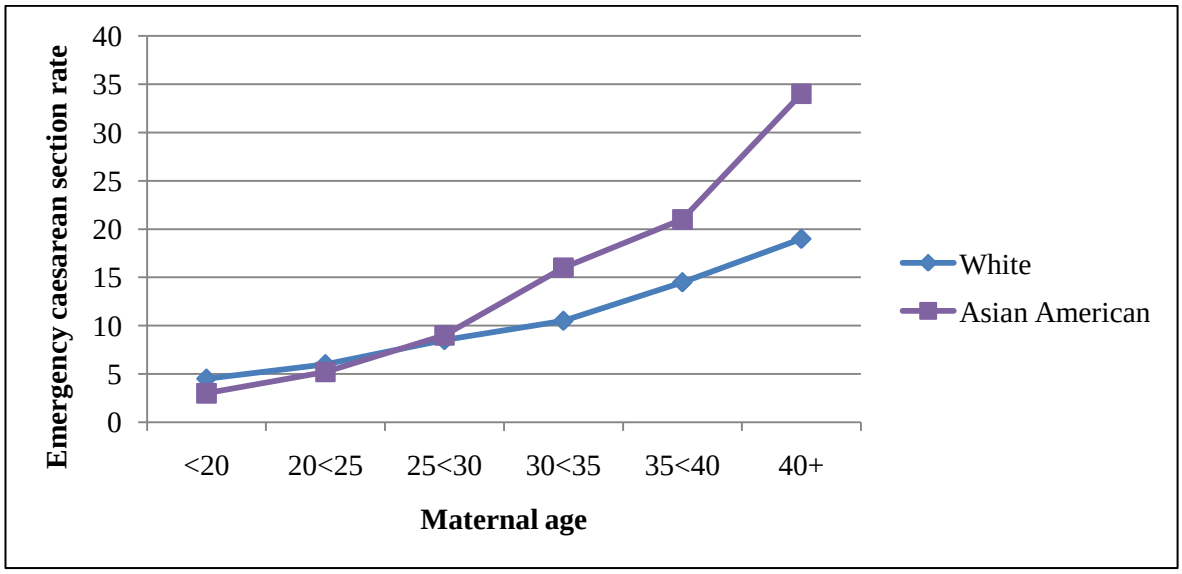
Geronimus suggests that the difference in the relationship between maternal age and infant outcomes by ethnicity is due to an accumulation of the effects of disadvantage and stress for Black mothers, resulting in a more rapid deterioration of health with age.

Numerous studies have investigated the weathering hypothesis, assessing health indicators such as birth weight (Buescher and Mittal, 2006, Rauh et al., 2001), preterm birth, (Ananth et al., 2001, Holzman et al., 2009), infant mortality (Buescher and Mittal, 2006, Wildsmith, 2002), post-

reproductive mortality (Spence and Eberstein, 2009) and allostatic load (physiological stress indicators) (Geronimus et al., 2006), supporting the suggestion of a different relationship between maternal age and reproductive health by ethnic background.

Main and colleagues have examined the relationship between maternal age and emergency caesarean section rates by ethnic background in a sample of over 8,000 primiparous women in America (Main et al., 2000). Asian American women had a two-fold increased risk of emergency caesarean section compared to Caucasian women. When the effect of maternal age on emergency caesarean section was stratified by ethnicity, emergency caesarean section rates were actually slightly lower for young Asian women than for Caucasian until the late twenties (see Figure 6.8). However, after age 30 the effect of age on emergency caesarean section rates for Asian American groups was much more pronounced.

Figure 6.8: The effect of maternal age on emergency caesarean section rates for White and Asian women in an American sample*



* Rates adapted from a graph presented in Main et al. (2000)

The weathering studies discussed above were conducted in America, with the majority comparing Black and White women. Due to the over-sampling of minority ethnic groups in the MCS it is possible to test the hypothesis that the effect of maternal age on mode of birth differs by ethnic background in the UK context.

6.3.2 Results

Table A6.3 gives the frequencies and weighted percentages of mode of birth by ethnic groups, along with the unadjusted relative risk ratios for the effect of ethnicity on mode of birth from

multinomial logistic regression models. Models for primiparous and multiparous mothers are presented. Ethnicities for which there was a significant difference compared to White mothers are highlighted. Table A6.4 shows the frequencies and weighted percentages of mode of birth for maternal age groups, stratified by ethnicity and parity.

Table A6.4 illustrates problems with small numbers of women in some groups after stratification. In particular, for some minority ethnic groups there were low intervention rates, or no mothers gave birth at the extremes of age.

Numbers were adequate to assess the effect of maternal age on emergency caesarean section rates for primiparous and multiparous Black mothers compared to White.

Figures 6.9 and 6.10 show the effect of maternal age on emergency caesarean sections for White and Black mothers. Because small numbers of women gave birth over the age of 40, the oldest age group was re-coded to 35 and older. The numbers given under the x axis in both graphs are the adjusted rates of emergency caesarean section.

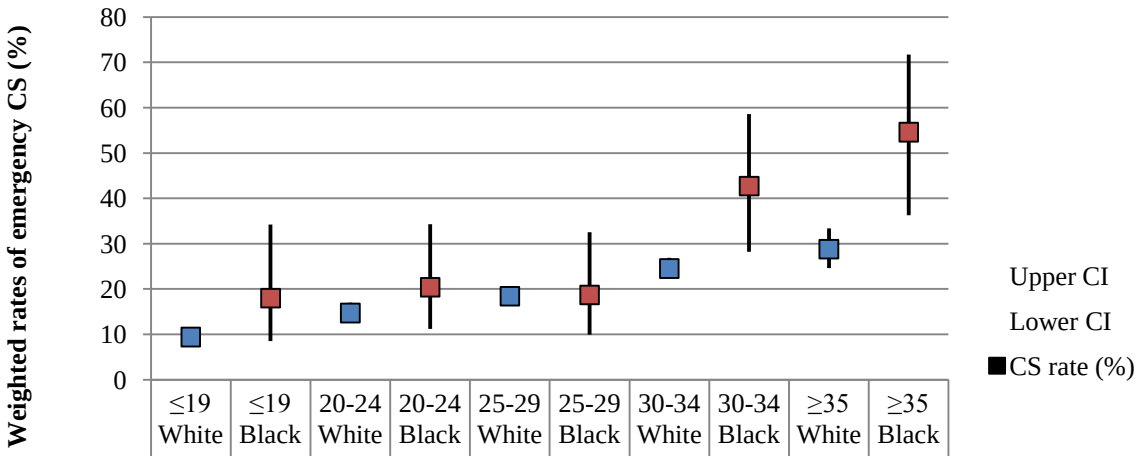
The effect of age on emergency caesarean section rates does appear to differ by ethnic background. For both the primiparous and the multiparous White women, a linear effect of older age on emergency caesarean section rates is apparent, with similar increases in risk for each age category; around 4% for each 5 year increase in age for primiparous women and a less pronounced increase of around 1 or 2% per 5 years for multiparous White women.

Eighteen percent of *primiparous* teenage Black mothers had an emergency caesarean section, almost twice the rate for the youngest White women (9.3%) (see Figure 6.9). The rate increased through the early twenties, decreased in the late twenties and then rose steeply after age 30, with the rate more than doubling to over 40% for Black women in their early thirties, and to greater than 50% after the age of 35. Among *multiparous* Black women, there were only 6 births (which were all unassisted vaginal births) before age 20. Between the early and later twenties, as for primiparous Black mothers, there was no increase in emergency caesarean section rates (see Figure 6.10). After age 30, as with primiparous Black women, the rate more than doubled, although unlike primiparous Black women, rates of emergency caesarean section were slightly lower for the oldest mothers aged over 35.

Due to the small numbers of Black women within each age group (see Table A6.4) confidence intervals are displayed in Figures 6.9 and 6.10 to show the uncertainty around the emergency caesarean section rates. For both primiparous and multiparous groups, until the late twenties, White and Black women were not significantly different in terms of emergency caesarean section rates

within age groups. However, Black women aged 30-34 and 35 and over were significantly more likely to have an emergency caesarean section than their White counterparts of the same age.

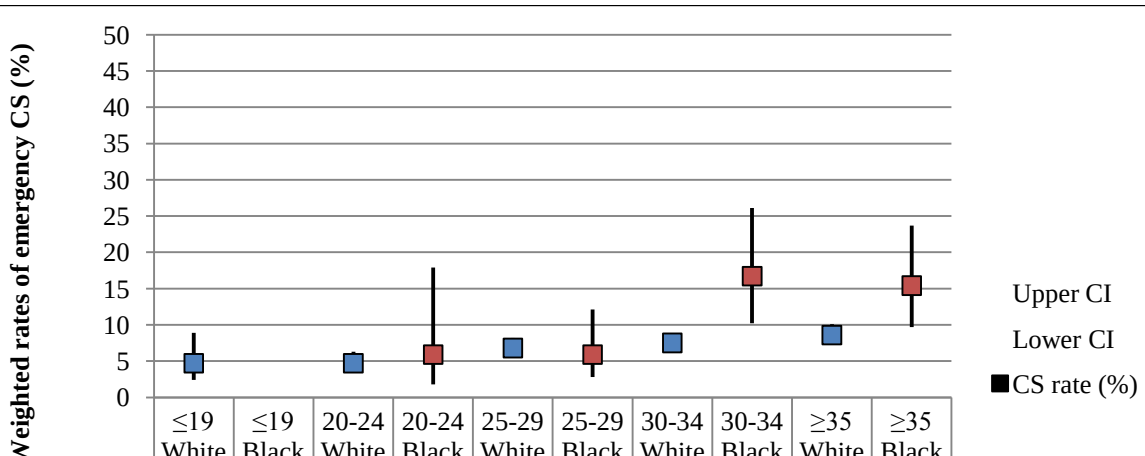
Figure 6.9: The effect of maternal age on emergency caesarean section rates for *primiparous* White and Black women



	≤19 White	≤19 Black	20-24 White	20-24 Black	25-29 White	25-29 Black	30-34 White	30-34 Black	≥35 White	≥35 Black
Upper CI	11.5	34.2	17.0	34.3	20.4	32.5	26.9	58.6	33.4	71.7
Lower CI	7.6	8.5	12.6	11.2	16.6	9.9	22.3	28.2	24.6	36.3
CS rate (%)	9.4	18.0	14.7	20.4	18.4	18.7	24.5	42.7	28.8	54.6

Test for trend = 0.46, p<0.001 for White and 0.54 for Black women (values too small to calculate p-value). For White women confidence intervals may not show for all age groups due to the larger sample sizes.

Figure 6.10: The effect of maternal age on emergency caesarean section rates for *multiparous* White and Black women



	≤19 White	≤19 Black	20-24 White	20-24 Black	25-29 White	25-29 Black	30-34 White	30-34 Black	≥35 White	≥35 Black
Upper CI	8.9		6.3	17.9	8.2	12.1	8.7	26.1	10.1	23.7
Lower CI	2.4		3.6	1.8	5.6	2.8	6.5	10.2	7.3	9.7
CS rate (%)	4.7		4.7	5.9	6.8	5.9	7.5	16.7	8.6	15.4

Test for trend = 0.23, p<0.001 for White and 0.49 for Black women (values too small to calculate p-value). For White women confidence intervals may not show for all age groups due to the larger sample sizes.

6.3.3 Discussion

Many studies have shown increases in operative birth rates with increasing maternal age. However, the majority of previous studies have been dominated by White populations, and only one prior study examined the effect of age on mode of birth by ethnic background. Main and colleagues found a more pronounced effect of maternal age on emergency caesarean section rates for Asian American women, with a much steeper rise in rates with age after age 30, compared to the more gradual increases observed for White women (Main et al., 2000).

To test whether the impact of maternal age on operative birth rates was dependent on ethnic background in a UK setting, comparisons were made within ethnic groups which had shown significantly different rates of operative births, compared to White mothers. Unfortunately, although in the MCS overall there are fairly large numbers of ethnic minority groups, the analyses involved stratification by ethnicity, mode of birth, parity and age, which produced small numbers within some strata. However, the impact of maternal age on emergency caesarean section rates could be compared for White and Black women.

In the comparisons shown in Figures 6.9 and 6.10, each included around 1,200 White women whereas there were only around 60 Black women (see Table A6.3). Smaller numbers within the groups could explain why a less linear effect on emergency caesarean section rates was observed for Black women. However, the confidence intervals confirm a significantly higher rate of emergency caesarean section for Black women aged 30 and over compared to White women of the same age. In addition, a similar pattern was observed for primiparous and multiparous comparisons.

These results could suggest a greater deterioration of maternal health in the *older* childbearing years for UK Black women compared to White women. However, unlike low birth weight and other health outcomes which have been examined in terms of ‘weathering’, reasons for operative birth are multiple and complex, and are not purely a result of physiology and health.

6.4 Is the effect of maternal height on mode of birth modified by ethnicity?

6.4.1 Background

Five studies were identified in the literature review which examined maternal height in relation to mode of birth, with all five finding an *increased* risk of operative birth for mothers of shorter stature (Cnattingius et al., 1998, Gareen et al., 2003, Mahmood et al., 1988, McGuinness and

Trivedi, 1999, Read et al., 1994). Maternal height has been linked to pelvic size, with mothers of shorter stature having smaller pelvises and therefore being less likely to have a unassisted vaginal birth due to cephalopelvic disproportion (Dujardin et al., 1996, Mahmood et al., 1988). However, infant birth weight has been found to reduce with decreasing maternal height (Mahmood et al., 1988), and previous literature has shown an *decreased* risk of operative births for mothers with lighter birth weight infants (see Chapter 2).

Ethnic background may also be an important consideration when examining the link between maternal height and infant birth weight. Women from different ethnic backgrounds have been reported to have varying birth weights. A recent study has examined the reasons for the variation in birth weight among mothers of a range of ethnic backgrounds in the Millennium Cohort Study (Kelly et al., 2009). Indian, Pakistani and Bangladeshi infants were around 280-350g lighter than White infants. Black Caribbean and Black African infants were also lighter than White infants, although to a lesser extent. Socio-economic, maternal and infant factors were important in determining birth weight variance, although there were differences in the extent to which these factors were explanatory across ethnicities (Kelly et al., 2009). Pickett and colleagues examined whether maternal height was an independent predictor of infant birth weight among women who gave birth in a San Francisco hospital (Pickett et al., 2000b). Although maternal height was a significant predictor of birth weight in White, Black and Asian mothers, height was not significantly related to birth weight among Hispanic mothers.

6.4.2 Results

Table A6.5 presents the results of multinomial logistic regression models for the effect of height on mode of birth for both primiparous and multiparous women, with an unadjusted model, and a model adjusted for birth weight. Tables A6.6 and A6.7 present similar models, but for White and non-White women, respectively.

As discussed in Chapter 4, unadjusted rates of caesarean section increased with decreasing maternal height in the MCS**.** In addition, women who gave birth to both low and high birth weight infants had a higher rate of emergency caesarean section than women who had a ‘normal’ weight infant. Table 6.1 shows the mean birth weight for babies born to mothers of different heights, by parity. Birth weight increased with increasing maternal height, with a difference of around 400g between mothers in the shortest and the tallest categories. In a linear regression model a difference in height of 1cm corresponded to a predicted difference in birth weight of 14-18 grams (coefficient 0.016, 95% CI=0.014-0.018).

Table 6.1: Mean birth weight by maternal height and parity

Height	**Mean birth weight in kg (95% CI)***	
	Primiparous	**Multiparous**
<154	3.07 (3.02-3.13)	3.19 (3.13-3.24)
154-159	3.16 (3.12-3.20)	3.29 (3.26-3.32)
160-165	3.31 (3.28-3.33)	3.42 (3.40-3.44)
166-171	3.40 (3.37-3.43)	3.53 (3.51-3.56)
>172	3.46 (3.42-3.51)	3.59 (3.55-3.62)

*Mean estimations survey weighted.

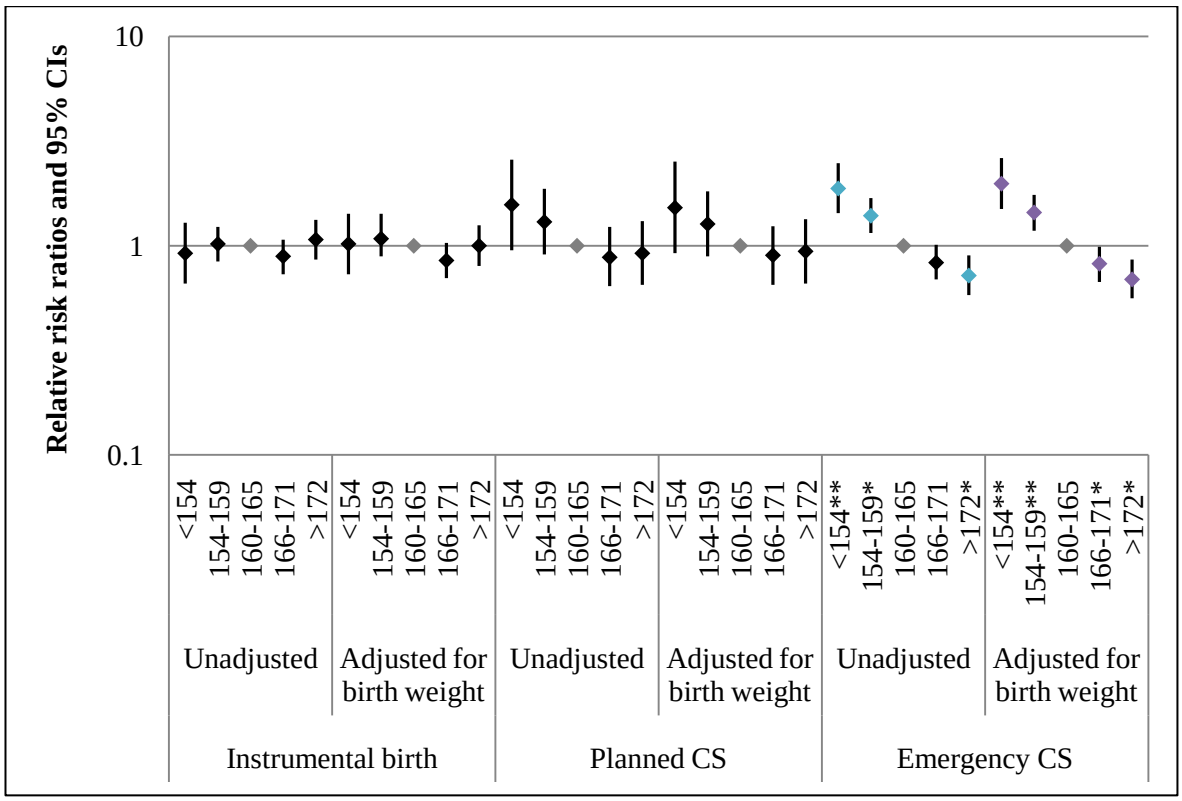
6.4.2.1 The effect of height on mode of birth (all mothers)

The effect of maternal height on emergency caesarean section rates for first-time mothers was strongest, with a gradient of increasing risk of emergency caesarean section with decreasing height (see Table A6.5 and Figure 6.11). Planned caesarean sections and instrumental births did not differ significantly by maternal height.

For multiparous women the effect of height on mode of birth was less apparent; nevertheless, short women were at an increased risk of a planned caesarean section compared to average height women, whereas tall women were at a decreased risk, and shorter women were also more likely to have an emergency caesarean section. (see Table A6.5 and Figure 6.12).

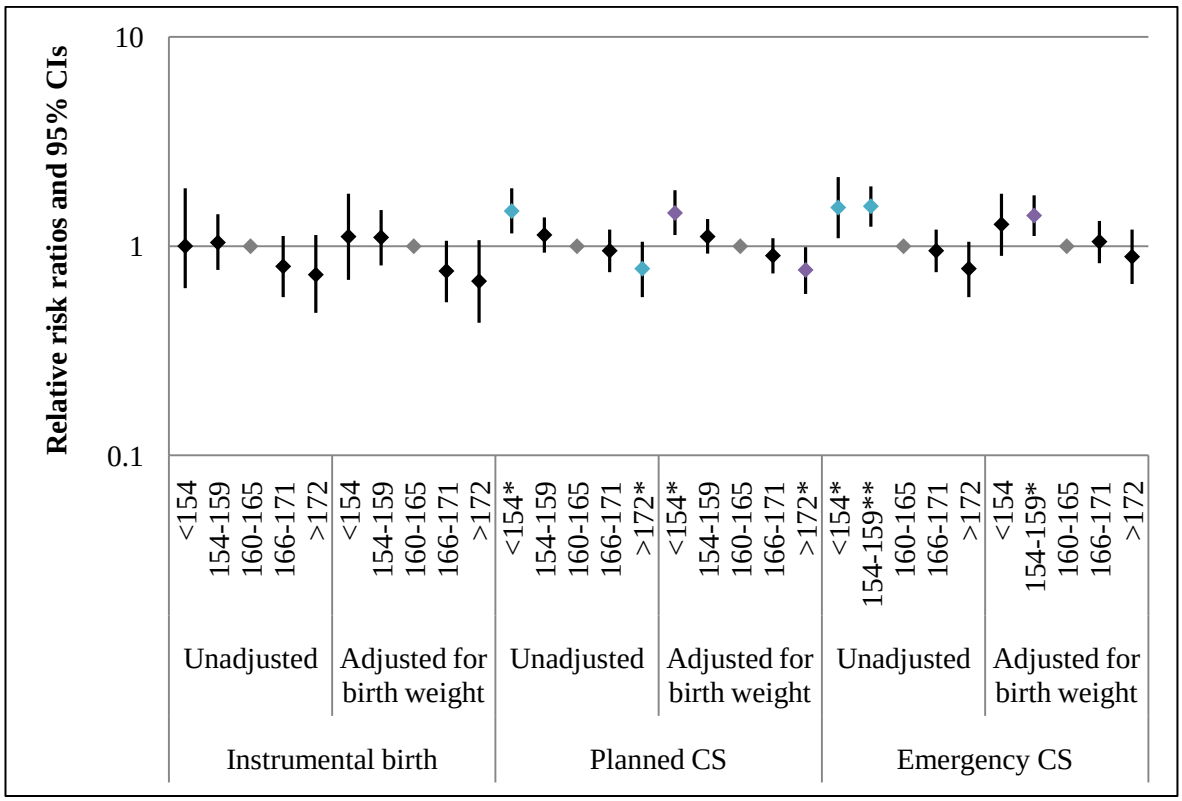
Overall, adjustment for birth weight resulted in only slight changes in relative risk ratios compared to the unadjusted model.

Figure 6.11: The effect of maternal height (cm) on operative birth for primiparous women



**p<0.001 *p<0.05

Figure 6.12: The effect of maternal height (cm) on operative birth for multiparous women



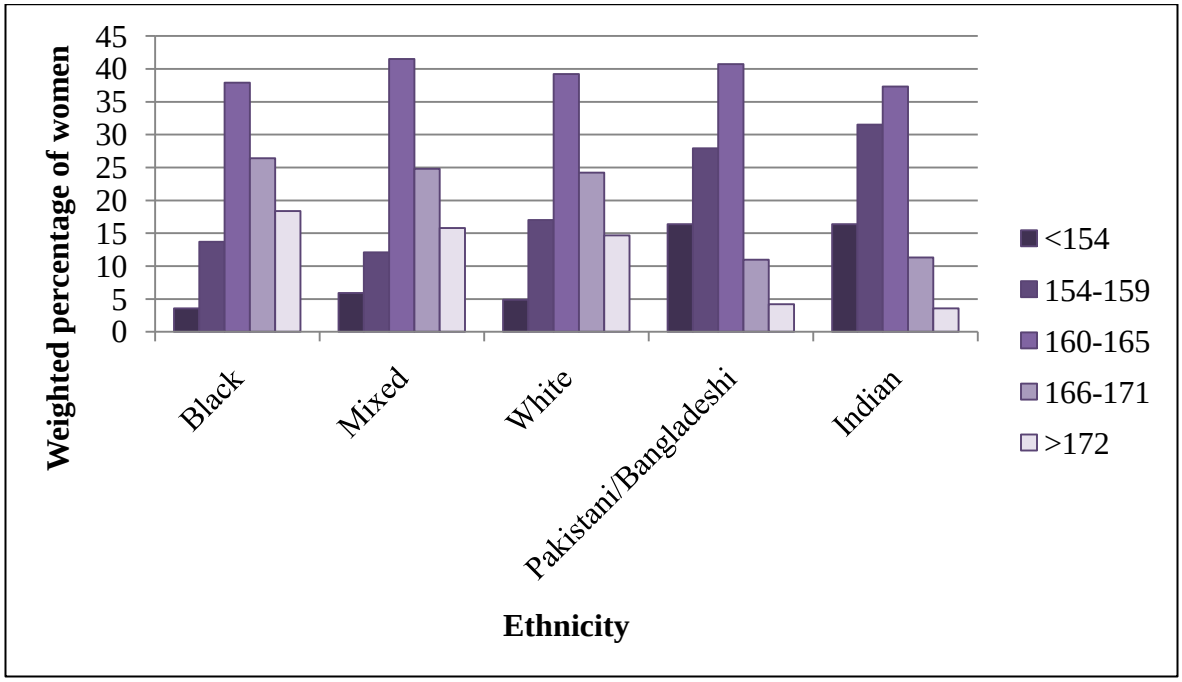
**p<0.001 *p<0.05

6.4.2.2 Maternal height by ethnic group

Figure 6.13 shows the weighted height distribution for mothers of different ethnic backgrounds. Black mothers were tallest with over 18% in the tallest category (around 5ft 7″) and less than 4% in the shortest category (around 5ft 1″). Mothers of White and Mixed backgrounds were also relatively tall with around 15% in the tallest category and less than 6% in the shortest category. Pakistani or Bangladeshi mothers and Indian mothers were the shortest overall, with less than 5% in the tallest category and more than 16% in the shortest category.

Weighted mean heights for mothers were as follows: Black (165.2cm); Mixed (164.5cm); White (164.3cm); Pakistani/Bangladeshi (159.9cm) and Indian (160.0cm).

Figure 6.13: Maternal height by ethnicity for all mothers



6.4.2.3 Birth weight by ethnic group

Table 6.2 presents the mean birth weights for infants of mothers of different ethnic backgrounds, by parity. Compared to White mothers, mothers of all other minority ethnic backgrounds had infants who were lighter, on average. Pakistani/Bangladeshi and Indian infants were lightest on average, at around 340g lighter than infants born to White mothers.

Table 6.2: Mean birth weight by ethnicity and parity

Ethnicity	**Mean birth weight in kg (95% CI)***	
	Primiparous	**Multiparous**
White	3.34 (3.32-3.35)	3.45 (3.44-3.47)
Mixed	3.22 (3.07-3.38)	3.37 (3.22-3.52)
Indian	3.00 (2.89-3.10)	3.07 (2.96-3.19)
Pakistani/Bangladeshi	3.00 (2.90-3.06)	3.20 (3.15-3.24)
Black/Black British	3.18 (3.10-3.27)	3.31 (3.25-3.37)

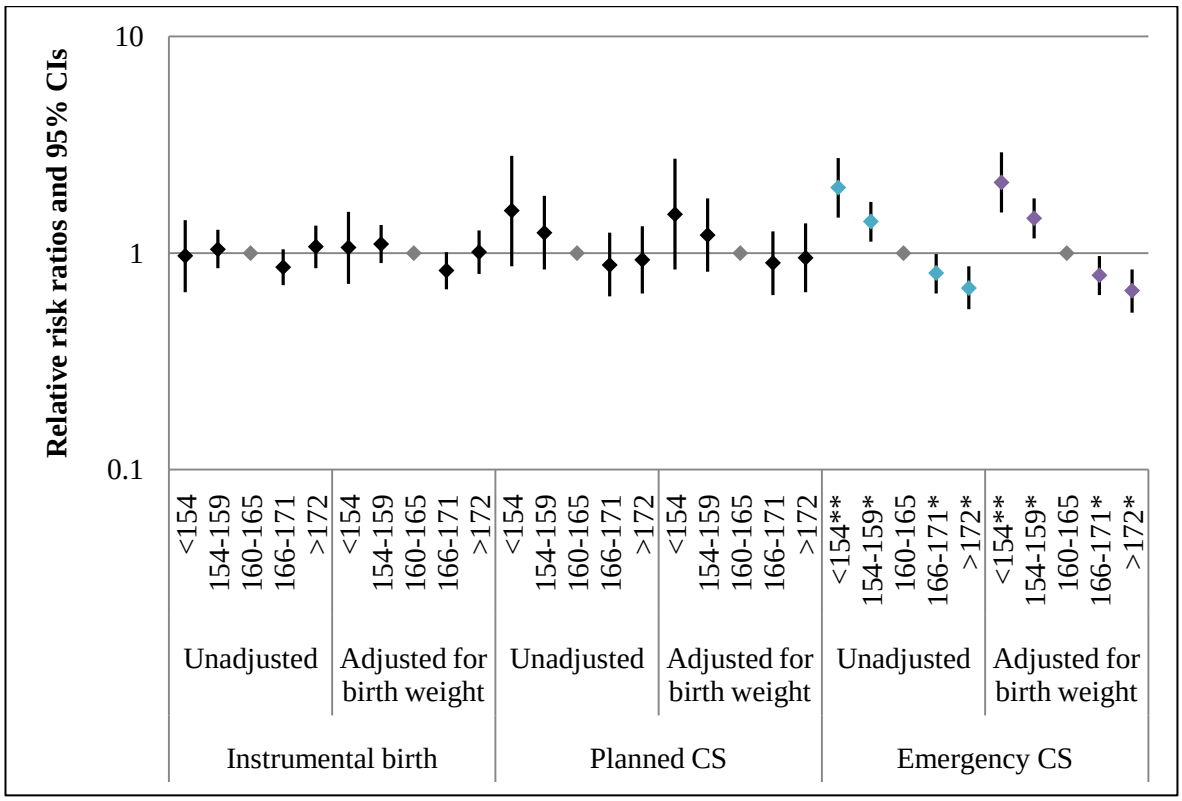
*Mean estimations survey weighted.

6.4.2.4 The effect of height on mode of birth (White vs. non-White mothers)

Given the overall shorter stature and lower birth weight of infants born to minority ethnic mothers compared to White mothers, regression models were stratified by ethnicity. The ethnic groups as described in Figure 6.13 were too small to sufficiently power a model of the effect of maternal height on mode of birth, stratified by ethnicity. In order to power a regression analysis, all non-White minority groups were combined to create a non-White group. The results from multinomial logistic regression analyses are shown in Table A6.6 for White women and Table A6.7 for non-White women, including unadjusted models and models adjusted for birth weight.

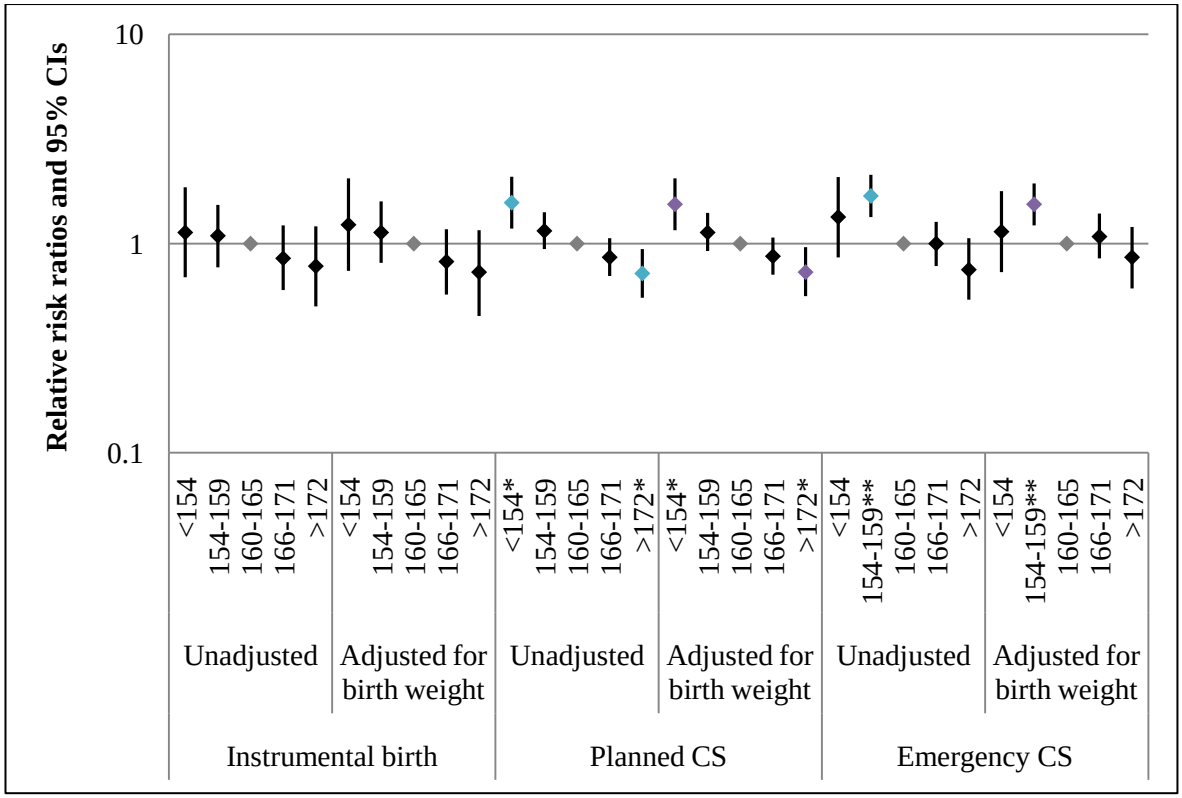
In multinomial models predicting mode of birth, maternal height was a statistically significant predictor of mode of birth among *White* women, particularly for emergency caesarean section (see Figures 6.14 and 6.15). The risks were similar to those observed in Table A6.5 for mothers of all ethnicities. Compared to average height primiparous White women, White women in the shortest category were around twice as likely to have an emergency caesarean section (RRR adjusted for birth weight = 2.12 for White mothers <154cm tall) and the risk of emergency caesarean decreased with increasing maternal height. Maternal height was also a significant predictor of mode of birth among White multiparous women, with the most significant effect for planned caesarean sections, most likely reflecting repeat caesarean sections.

Figure 6.14: The effect of maternal height (cm) on operative birth for primiparous *White* women



**p<0.001 *p<0.05

Figure 6.15: The effect of maternal height (cm) on operative birth for multiparous *White* women



**p<0.001 *p<0.05

Among *non-White* women, maternal height did not have the same influence on mode of birth. The only association among non-White women was for shorter primiparous women who were more likely to have a planned caesarean section compared to the tallest non-White women, but this result was of borderline significance (unadjusted RRR=3.83, p=0.08 for non-White women 154-159cm tall and RRR=4.16, p=0.05 when adjusted for birth weight).

Figure 6.16: The effect of maternal height (cm) on operative birth for primiparous *non-White* women

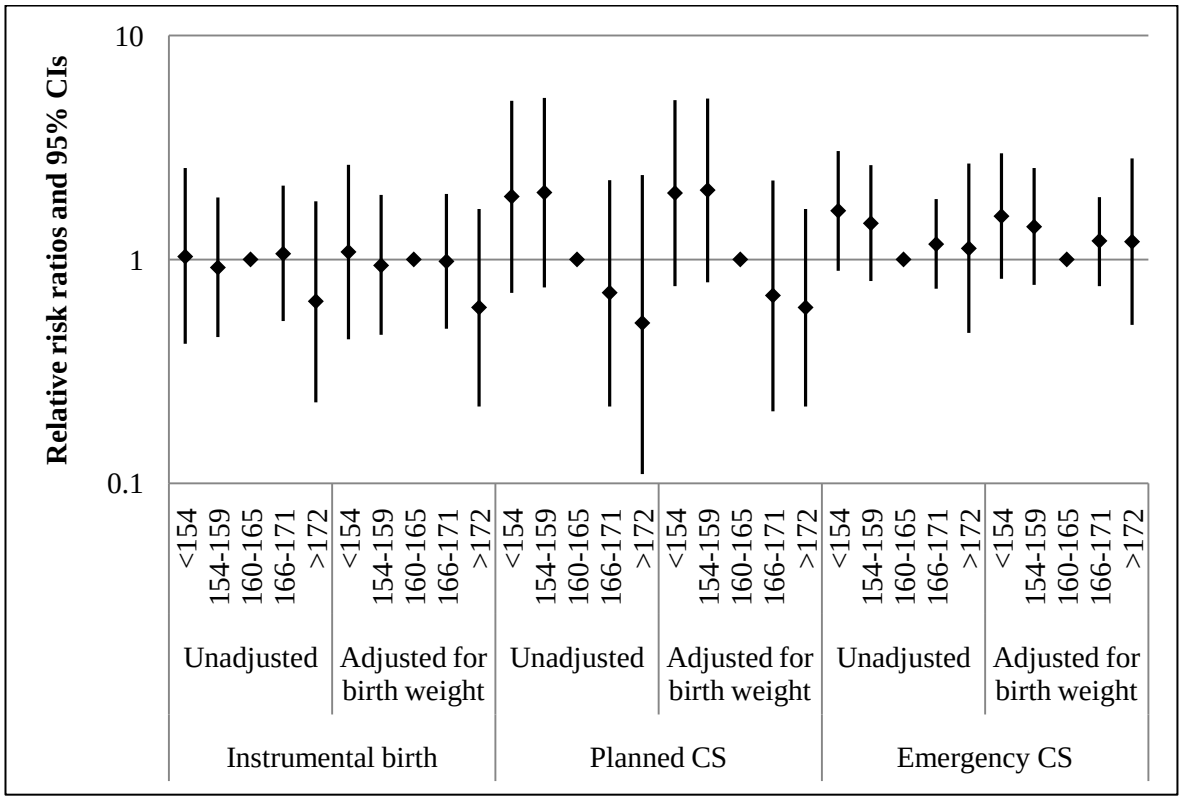
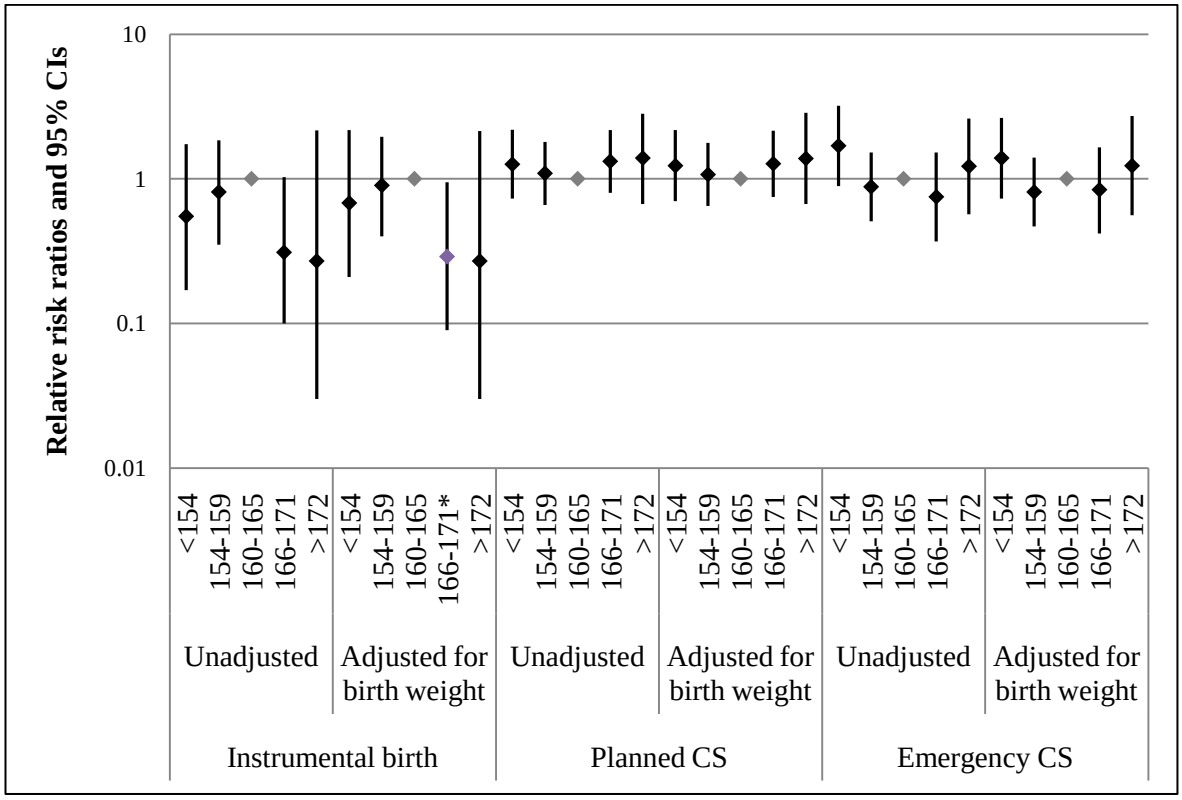


Figure 6.17: The effect of maternal height (cm) on operative birth for multiparous *non-White* women



*p<0.05

6.4.3 Discussion

Previous studies have suggested that maternal height is an indicator of pelvic size, with mothers of shorter stature having smaller pelvises, which may make them less likely to have a unassisted vaginal delivery. The findings from my bivariate analyses indicated a strong relationship between shorter maternal height and increased rates of caesarean sections.

Consistent with the findings of Mahmood and colleagues (Mahmood et al., 1988) mean birth weight increased with maternal height. Results from literature in Chapter 2 and bivariate analyses in Chapter 4 indicated an increased risk of operative birth for women having high birth weight infants. I investigated whether adjusting for birth weight would attenuate or eliminate the effect of maternal height on mode of birth.

When comparing mean birth weights for height categories, mothers in the shortest category had a mean birth weight of only around 400 grams less than mothers in the tallest category. Mean birth weights for each height category were all within the normal range (between 2.5 and 4kg). In addition, adjustment for birth weight only slightly altered the relative risk ratios for mode of birth by maternal height in a multinomial logistic regression model. Reductions in infant birth weight

associated with decreased maternal height are therefore not large enough to influence the effect of height on mode of birth, which is likely caused by smaller pelvic dimensions for shorter mothers.

Although some previous research has examined the effect of maternal height on mode of birth, none has examined whether the effect is modified by ethnic background. In order to sufficiently power the multinomial regression analyses, non-White mothers had to be combined. Given the variance in maternal height and infant birth weights among minority ethnic groups the combining of non-White mothers may have masked differential effects of height on mode of birth in certain ethnic groups. However, numbers of minority women were too small in this sample to detect these possible differences. Research including larger numbers in ethnic minority groups is needed in order to explore if there are differences in the predictive value of height on mode of birth among different ethnic minority groups in the UK.

6.5 Health during pregnancy

6.5.1 Background

The health of some minority ethnic groups is generally poorer than for White women in the UK. The 2004 Health Survey for England focused on minority ethnic groups (Sproston and Mindell, 2006). As well as poorer self-reported general health, specific problems such as obesity, diabetes and hypertension were significantly more prevalent for Black African, Black Caribbean, Pakistani and Bangladeshi women, compared to White women. In addition, Indian women were also more likely to report having diabetes. The health for Chinese and Irish women was not found to differ significantly to health of White women in the outcomes assessed.

Issues such as obesity, diabetes and hypertension have been found to increase the risk of operative birth if present during pregnancy (see Chapter 2). Black African, Black Caribbean and Pakistani mothers have been found to be at a higher risk of severe maternal morbidities such as acute fatty liver and eclampsia compared to White women in a UK sample (Knight et al., 2009).

In order to explore health during pregnancy, self-reported pre-pregnancy BMI and problems or illness during pregnancy were explored in the MCS sample.

6.5.2 Results

Tables A6.8 and A6.9 present the frequencies and weighted percentages of pre-pregnancy BMI and complications during pregnancy, according to women's ethnic background. P-values are given from chi-squared tests. Tables A6.10 and A6.11 present the results of multinomial logistic

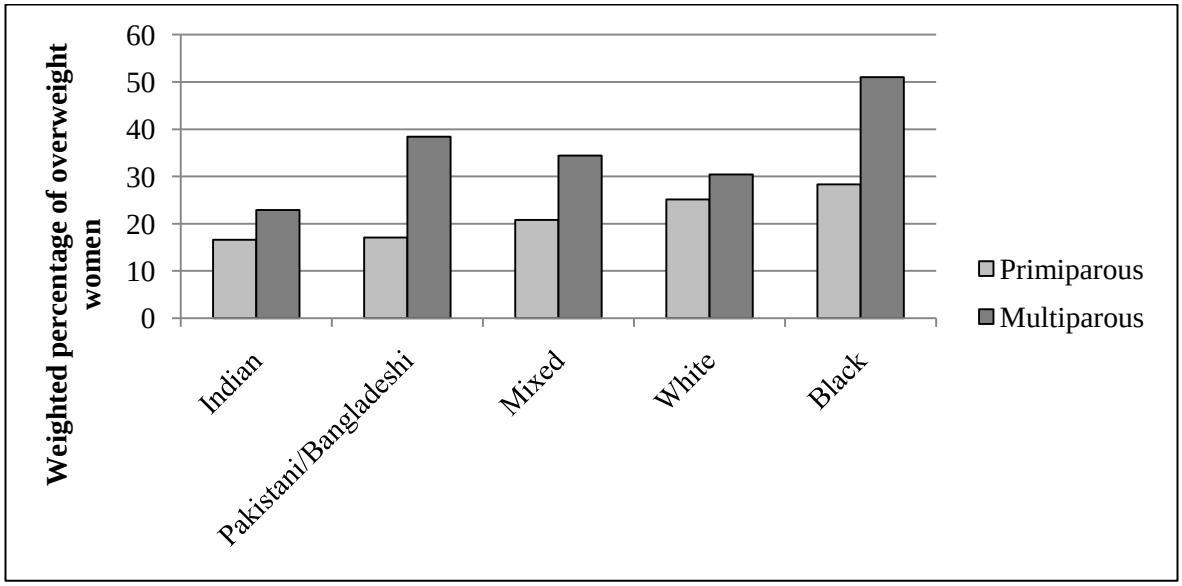
regression models predicting mode of birth; pregnancy factors found to differ significantly in Tables A6.8 and A6.9 were added to models individually.

6.5.2.1 Overweight

Figure 6.18 shows for different ethnic groups, the proportion of women with a BMI classed as overweight according to their self-reported pre-pregnancy weight. The bars are ordered from the smallest proportion overweight to the largest (for primiparous women). Black women were in the highest proportion overweight with over 28% of primiparous Black women and over half of multiparous Black women overweight. In all ethnic groups multiparous women were in a higher proportion overweight. However, in some groups there was a more marked difference in the weight of primiparous and multiparous women; for example, more than double the number of multiparous Pakistani or Bangladeshi women were overweight compared to primiparae. These findings were due to a greater increase in BMI with age in some ethnic groups (data not shown).

When adjusted for, BMI did not explain the variation in mode of birth by ethnicity for primiparous women (see Table A6.10). Among multiparous women BMI explained some of the excess risk of emergency caesarean section for Black women (unadjusted RRR=1.94 $p<0.001$; adjusted RRR=1.63 $p<0.05$, see Table A6.11).

Figure 6.18: Percentage of women overweight prior to pregnancy according to ethnicity and parity



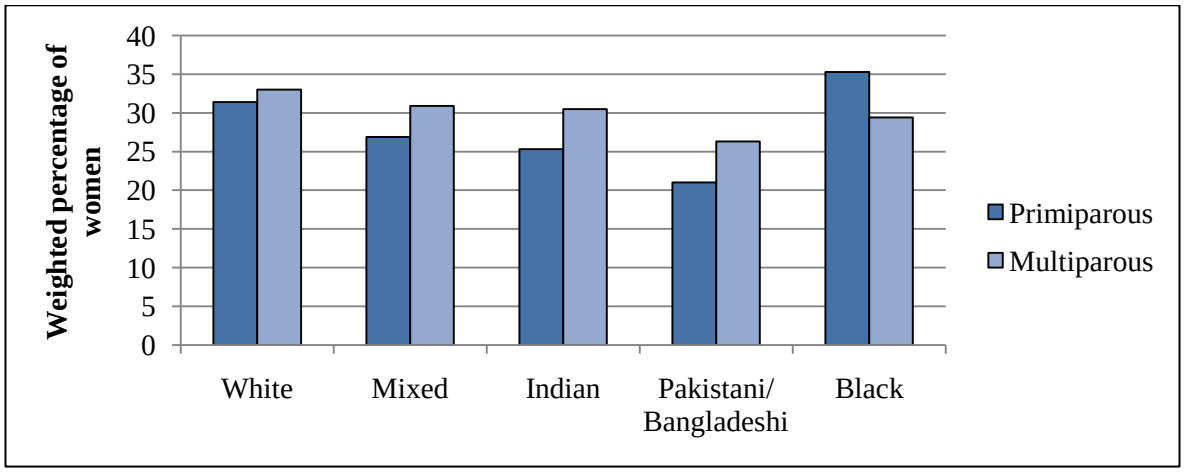
6.5.2.2 Complications during pregnancy

The MCS question from which information on complications in pregnancy are derived asked: "*Did you have any illnesses or other problems during your pregnancy that required medical attention or*

treatment?" If the woman responded that she had had a complication, then she was asked about the nature of the illness or problem. Women could report more than one problem. Problems were coded as those that could complicate birth (e.g. bleeding in later pregnancy, pre-eclampsia, diabetes, symphysis pubis dysfunction, fetal distress, placenta praevia) and the remainder of complications were coded as 'other' (e.g. vomiting, urinary infection, allergies, backache, early rupture of membranes) (see Appendix 3 for details of coding). According to the chi squared analyses, 'other' complications during pregnancy differed significantly by ethnic group for both primiparous and multiparous women (see Figure 6.19), but 'CS risk factors' did not differ significantly.

Pakistani/Bangladeshi women were the least likely to report having a complication or illness during pregnancy that required medical attention. First-time Pakistani/Bangladeshi women had the lowest rate of 'other problems' at 21%, whereas over 35% of Black mothers reported experiencing an 'other' problem in pregnancy. Among multiparous women, White women were the most likely to report having an 'other' problem, with a third reporting this type of complication in pregnancy. Complications during pregnancy did not explain variation in mode of birth by ethnic group (see Tables A6.10 and A6.11).

Figure 6.19: 'Other' problems during pregnancy by ethnic group



6.5.3 Discussion

In the 2004 Health Survey for England obesity rates were significantly higher for Black Caribbean, Black African and Pakistani women compared to White women (Sproston and Mindell, 2006). As discussed at the outset of this chapter, due to the small numbers of ethnic minority groups when needing to stratify analyses, some combined groups were used. Consequently Black Caribbean and Black African women are in the 'Black' group and Bangladeshi women, who were not significantly

more obese in the Health Survey, were included with the Pakistani women. However, Pakistani women represent over 70% of the women in the 'Pakistani/Bangladeshi' group.
Self-reported pre-pregnancy weight was used to calculate BMI for women as a proxy for weight at birth. As women gain weight during pregnancy these figures are likely to be an underestimation of women's weight at birth.

Primiparous and multiparous Black women were in a higher proportion overweight compared to all other ethnic groups. In addition, a high proportion of *multiparous* Pakistani/Bangladeshi women were overweight. BMI did not explain variation in mode of birth by ethnic group for primiparous women, but it did explain some of the excess risk of emergency caesarean section for multiparous Black women.

Problems during pregnancy were found to differ significantly by ethnic group for primiparous women. In particular, first-time Pakistani/Bangladeshi women were the least likely to report having any problem during pregnancy. Given the very open nature of the question used in the MCS, asking about *"any illness or other problems"*, this result seems unusual. The literature from the UK indicates that Pakistani and Bangladeshi groups experience much poorer health than the White majority, and compared to most other ethnic groups (Nazroo, 1997, Nazroo, 2003, Sproston and Mindell, 2006).

As the MCS question asked for problems which required 'medical attention', the response may indicate differences in health-seeking behaviour in the Pakistani and Bangladeshi women, and may not accurately reflect their health in pregnancy. Qualitative research in the UK has identified discrepancies between the way the Bangladeshi women perceived their health, and their medical records (Katbamna, 2000). In Katbamna's study several Bangladeshi women who had received treatment for high blood pressure and anaemia reported having no illnesses and being healthy during pregnancy. Katbamna suggested two explanations for these findings; that Bangladeshi women may perceive their health as better than it is, or, more worryingly, that due to their low levels of English, health professionals had not been able to convey the health issues effectively to the women. These health-seeking behaviours will be discussed in greater detail in Chapter 9 with reference to antenatal care attendance.

Despite significant differences in 'other' pregnancy complications or illnesses between ethnic groups, these problems did not explain any variation in mode of birth by ethnic group.

6.6 Events during labour

6.6.1 Background

Scant literature has documented the outcomes during labour for women of different ethnic groups. However, there has been some suggestion that induction or augmentation rates differ between UK ethnic groups (Ibison, 2005, Parsons et al., 1993, Richardson and Mmata, 2007), and interviews with UK midwives suggest potential differences in the use of pain relief (Puthussery et al., 2008). In addition, the indication of fetal distress for caesarean section has been found to be higher for non-White women compared to White women in a large English sample (Ibison, 2005). Labour outcomes were explored in the MCS by ethnic group.

6.6.2 Results

The labour-related outcomes are displayed in Table A6.8 for primiparous women and Table A6.9 for multiparous women by ethnic group. P-values are given from chi-squared tests. Tables A6.12 and A6.13 present the results of multinomial logistic regression models with ethnicity predicting mode of birth; labour-related factors found to differ significantly in Tables A6.8 and A6.9 were added to models individually.

6.6.2.1 Complications during labour

In the MCS, women were asked *"Were there any complications during [baby name] birth?"* Women could give more than one response. Responses were re-coded into four main groups; no complications, fetal distress, malpresentation and 'other' which included a range of maternal and progress of labour complications (see Appendix 3).

Self-reported labour complications were found to differ significantly by ethnicity for both primiparous and multiparous women. Among *primiparous* women, Mixed ethnicity and White women experienced the highest rates of complications overall, with over half of the women in both groups reporting complications in pregnancy. Malpresentation differed significantly by ethnic group and was highest for White and for Black women (see Figure 6.20). Fetal distress was reported by around a quarter of White and Mixed ethnicity women, whereas around 11% of Pakistani or Bangladeshi women reported fetal distress in labour (see Figure 6.21).

Overall, for *multiparous* women, complications were again highest for mothers of Mixed ethnicity, and low for mothers of Pakistani/Bangladeshi ethnicity. As for primiparous women, fetal distress was reported most often by White and Mixed ethnicity women. In addition, Indian women had low rates of fetal distress. 'Other' complications were much higher for Mixed ethnicity women at

almost 18% compared to White women (10%, see Figure 6.22). Malpresentation did not differ significantly by ethnic group for multiparous women.

Adjusting for malpresentation attenuated some of the associations between ethnic groups and emergency caesarean section, but by a small amount. In addition adjusting for malpresentation strengthened the association between Pakistani/Bangladeshi ethnicity and increased risk of planned caesarean section.

Adjusting for fetal distress somewhat strengthened the association between Indian and Black ethnicity and increased risk of emergency caesarean section, but weakened the association between Pakistani/Bangladeshi ethnicity and a decreased risk of instrumental birth.

Adjusting for 'other' complications made little difference to relative risk ratios.

Figure 6.20: Malpresentation among primiparous women by ethnic group

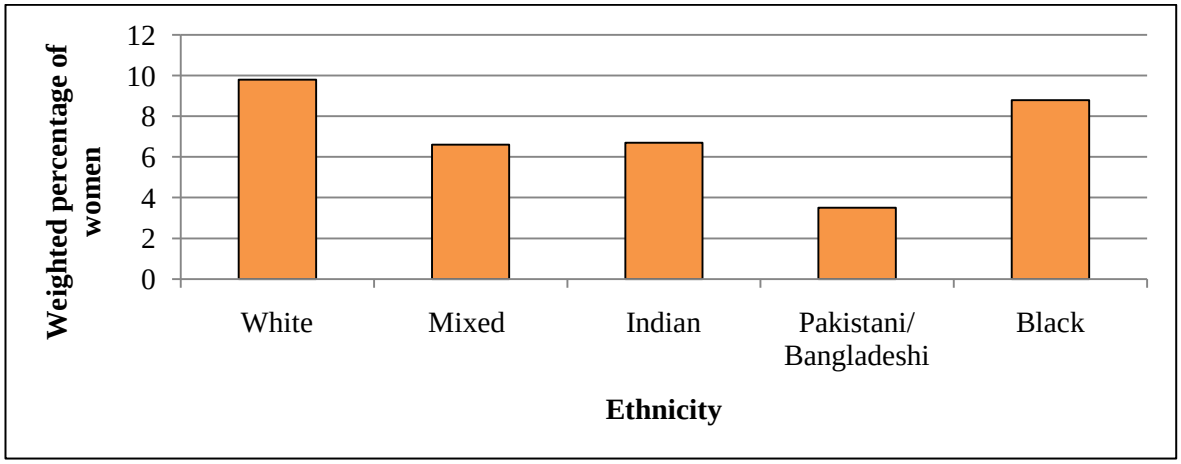


Figure 6.21: Fetal distress by ethnic group

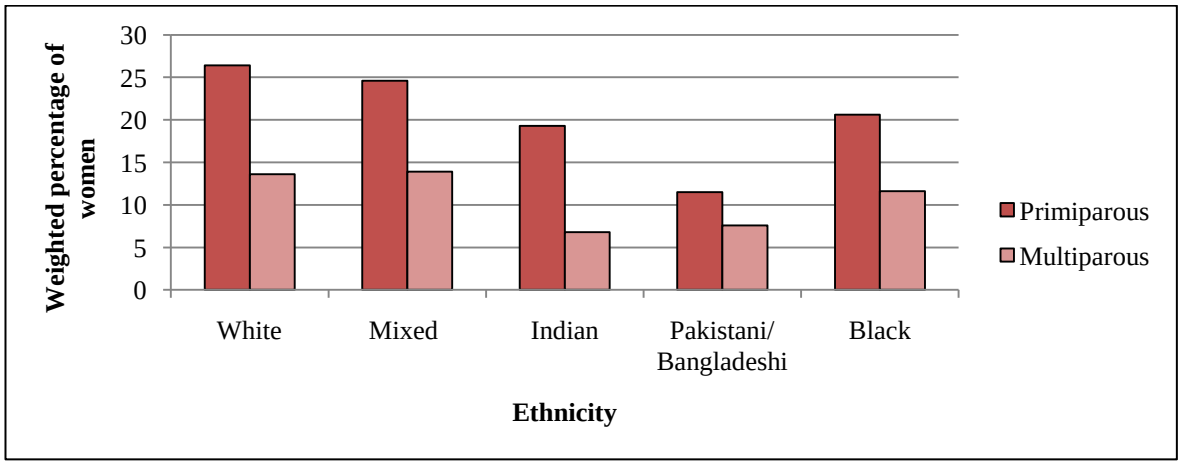
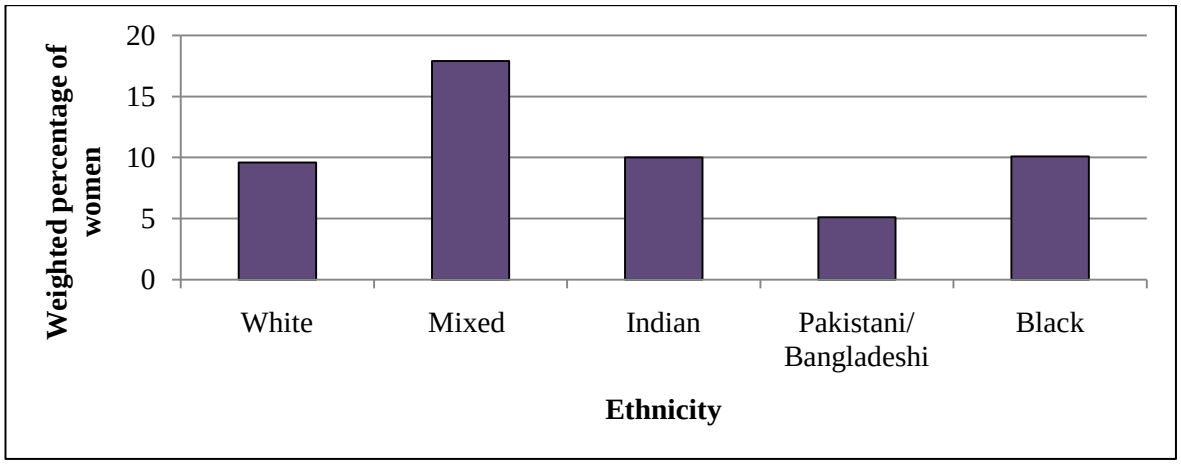


Figure 6.22: Other labour complications among multiparous women by ethnic group



6.6.2.2 Induction of labour

Induction of labour differed significantly by ethnic group for both primiparous and multiparous women (although for multiparous women the relationship was of borderline significance). Among primiparous women, Mixed ethnicity women had the highest rate of induction, with over 47% induced, whereas Indian mothers had the lowest induction rates, with less than a quarter induced (see Figure 6.23). Induction rates were generally lower for multiparous women, and differences in induction rates between ethnic groups were less apparent. Interestingly, multiparous Indian women had the highest induction rate (see Figure 6.24).

Variation in gestational age has been identified for women of different ethnic groups, with Black and Asian women delivering earlier on average than White women (Parsons et al., 1993, Patel et al., 2003). As women who go post-term are much more likely to be induced, different gestational age could potentially explain differences in induction rates between ethnic groups.

As shown in Figure 6.23, rates of induction were attenuated but very similar for primiparous women who gave birth at term, compared to all primiparous women, and the rates of induction also differed significantly between ethnic groups who gave birth at term (χ^2 $p<0.05$). Among multiparous women, when examining differences in induction rates by ethnicity for women who gave birth at term only, the differences between the groups were no longer significant (χ^2 $p=0.20$). However, induction did not explain variation in mode of birth by ethnic group (see Tables A6.12 and A6.13).

Figure 6.23: Rates of induction for primiparous women by ethnic group

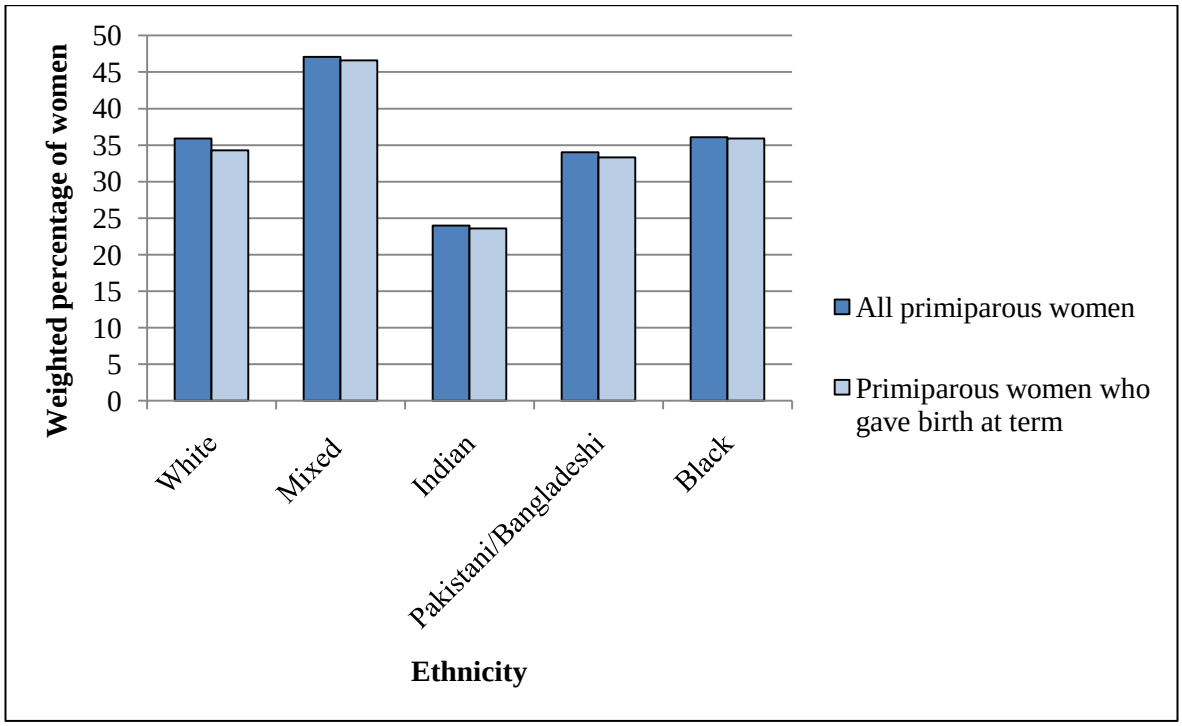
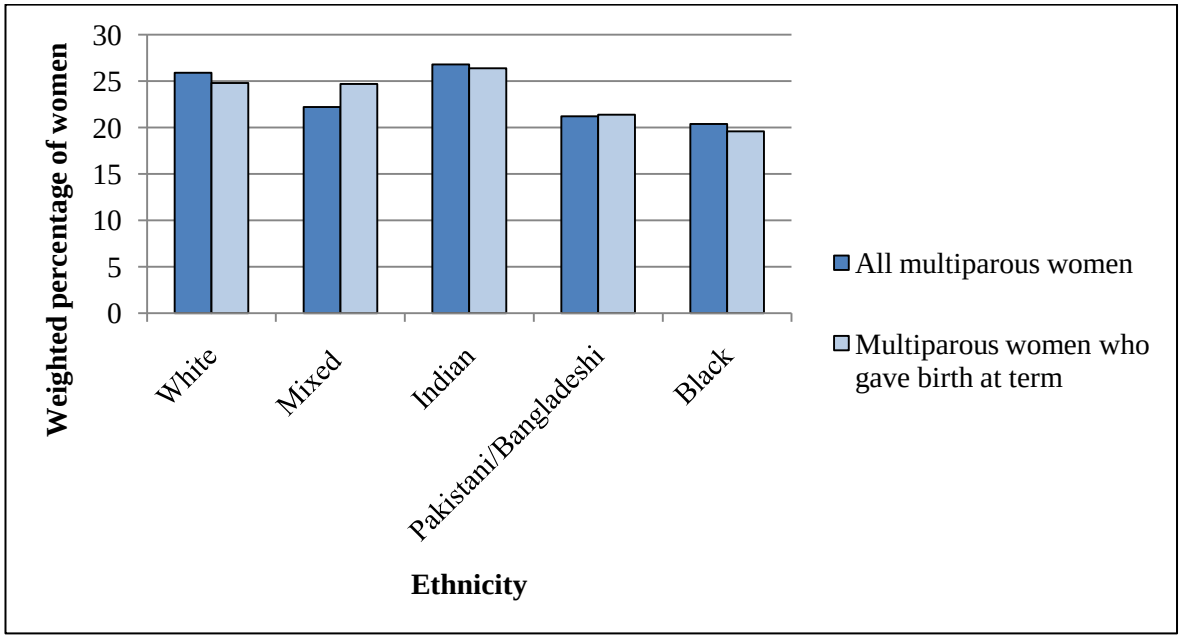


Figure 6.24: Rates of induction for multiparous women by ethnic group



6.6.2.3 Length of labour

Length of labour was also examined by ethnic group. Length of labour did not differ significantly among multiparous women; however, primiparous Pakistani/Bangladeshi women had an average length of labour over two and a half hours shorter than White women (unadjusted regression coefficient -2.63, $p<0.05$). When adjusted for, length of labour did not explain the reduced risk of

unplanned operative births for Pakistani/Bangladeshi women compared to White women (see Table A6.12).

6.6.3 Discussion

Complications during labour were found to differ significantly by ethnic group, with Mixed ethnicity mothers experiencing the highest rates of complications overall, whereas Pakistani and Bangladeshi mothers experienced the lowest. White mothers also experienced fairly high rates of fetal and maternal complications compared to other ethnic groups, and particularly first-time White mothers experienced almost as many complications as Mixed ethnicity mothers.

The low rates of complications found for Pakistani/Bangladeshi mothers is an interesting finding. Although no other study was identified which assessed complications during labour, Ibison (2005) reported indications for caesarean section. Caesarean sections conducted for fetal distress were most common for both Pakistani and Bangladeshi women, compared to all other ethnic groups. Although indication for caesarean section is not available in the MCS, women were asked *"were there any complications during [baby name] birth?"* As the complications were self-reported this information is reliant on the mother being informed of difficulties in labour. Over a quarter of the Pakistani/Bangladeshi mothers were from non-English speaking households and over 67% were non-UK born. The low rates of complications in these women may be a marker of less effective communication between the health professionals and the Pakistani/Bangladeshi women. Interviews with 30 health professionals from eight English maternity units revealed that staff find it easier to provide care to UK-born women, due to fewer cultural and communication barriers compared to migrant women (Puthussery et al., 2008).

Labour complications were added individually to regression models with ethnicity predicting mode of birth. Malpresentation attenuated some effect sizes by a small amount. Fetal distress *strengthened* the association between Indian and Black ethnicity and increased risk of emergency caesarean section. Pakistani/Bangladeshi women reported the lowest rates of fetal distress. Controlling for fetal distress accounted for some of the decreased risk of instrumental births for multiparous Pakistani/Bangladeshi women. The addition of 'other' labour complications to a model did not explain any variation in mode of birth.

Rates of labour induction varied significantly by ethnic group. Almost half of primiparous Mixed ethnicity mothers reported having an induced labour, nearly double the rate for Pakistani/Bangladeshi women who had the lowest rates. Previous research has suggested differential gestational age for infants born to mothers of different ethnic groups, which could explain variation in induction rates. In analyses including only women who gave birth at term, the

significant variation in induction rates by ethnic group remained for primiparous women, although it became non-significant for multiparous women. Induction did not explain variation in mode of birth.

Length of labour was found to be significantly shorter for primiparous Pakistani/Bangladeshi women compared to White women. As previously discussed, the Pakistani/Bangladeshi women in the MCS comprise a high number of non-UK born women. Interviews with Bangladeshi women conducted by Katbamna (2000) revealed how many cultural childbirth traditions have remained with Bangladeshi women when they move to the UK. One tradition is that a woman will continue with her normal activities until it is almost time to give birth. Katbamna discovered that most of the women in her study arrived at the hospital in advanced stages of labour.

When adjusted for, length of labour did not explain the reduced risk of unplanned operative birth for Pakistani/Bangladeshi women. However, length of labour was self-reported in the MCS and as such should be interpreted with caution as will be discussed further in Chapter 10.

6.7 Conclusion

MCS analyses revealed significant differences in the health during pregnancy and labour experiences of women by ethnic group. However, these differences did not explain the variation in mode of birth by ethnic group observed for these mothers.

Information on pregnancy and labour-related outcomes in the MCS were based on self-report. The issues of using self-reported data have been touched on in this chapter, but will be discussed further in Chapters 10 and 11.

Little research has documented the outcomes during pregnancy and labour for women of minority ethnic groups in the UK. Some qualitative literature has examined the childbearing experiences of minority ethnic women, as well as the experiences of midwives who care for them (Katbamna, 2000, Puthussery et al., 2008). These studies may help us to understand some possible explanations for the results presented, such as shorter length of labour and the low rate of pregnancy and labour complications among Pakistani and Bangladeshi women. However, as previously noted and described in this chapter, ethnic groups in the UK are not homogeneous. The interpretation of the findings discussed here should therefore be treated with caution, especially as stereotyping can easily occur when research regarding minority ethnic groups is discussed.

6.8 Summary

What is already known on this subject?

- A variety of social and biological factors may contribute to ethnic inequalities in health.
- Few UK studies have documented the relationship between ethnicity and mode of birth. The current literature suggests that non-White women may be at an increased risk of emergency caesarean section, but the effect on planned caesarean sections and instrumental births is unclear.

What does this study add?

- Ethnic background modifies the effect of maternal age and maternal height on mode of birth:
    - Although the effect of maternal age on emergency caesarean sections was linear for White women, for Black women, the effect of age was less important during early childbearing years and much stronger during the later childbearing years.
    - Although shorter maternal height increases the risk of operative birth for White women, for non-White women maternal height was not predictive of mode of birth.
- Significant differences in the health of ethnic groups were identified. In particular, Black women and multiparous Pakistani/Bangladeshi women were in a high proportion overweight pre-pregnancy. In addition, the reported labour experiences of women differed significantly by ethnic group.
- The addition of some pregnancy and labour factors to regression models explained only a small degree of variation in mode of birth by ethnicity. For example, BMI explained some of the excess risk of emergency caesarean section for multiparous black women.

CHAPTER 7: The Millennium Cohort Study: Fetal sex and mode of birth

7.1 Background

Much research has shown health and developmental disadvantages for males which persist into later life. In particular, several outcomes have been found to be worse for newborn males including neonatal mortality, respiratory distress syndrome and acidaemia (low blood pH) (Ingemarsson, 2003).

Sex of the fetus has also been linked to events of labour and birth. Several studies identified in the literature review assessed the impact of fetal sex on mode of birth, with all finding an increased risk of caesarean section for mothers carrying a male fetus (Bekedam et al., 2002, Cesaroni et al., 2008, Eogan et al., 2003, Hall and Carr-Hill, 1982, Lieberman et al., 1997, Read et al., 1994, Viegas et al., 2008, Agarwal et al., 2009), and some also finding an increased risk of instrumental vaginal births (Bekedam et al., 2002, Eogan et al., 2003, Hall and Carr-Hill, 1982, Read et al., 1994, Agarwal et al., 2009).

Of the eight studies identified in the review, four presented only unadjusted analyses (Cesaroni et al., 2008, Eogan et al., 2003, Hall and Carr-Hill, 1982, Viegas et al., 2008). Although it is unlikely that any maternal factors determine fetal sex, and could therefore confound the relationship, male fetuses have been found to be larger on average than female fetuses (Copper et al., 1993). In addition, there is evidence that male infants are more likely to be born both pre and post-term than females (Di Renzo et al., 2007, Hall and Carr-Hill, 1982, Ingemarsson, 2003). Literature from Chapter 2 outlined the increased risk of operative birth for mothers having a high birth weight infant, as well as for mothers giving birth both pre and post-term. The studies which did not statistically adjust for fetal size and gestational age could therefore show misleading results.

Of the remaining four studies, all found an increased risk of operative birth for male infants after adjustment (Bekedam et al., 2002, Lieberman et al., 1997, Read et al., 1994, Agarwal et al., 2009). Read and colleagues adjusted for numerous maternal factors and birth weight, but did not adjust for gestational age in a sample of around 3,600 Australian women. A 33% increased risk of instrumental births was found for male infants compared to females after adjustment, but the increased risk of emergency caesarean section found in unadjusted analyses was no longer significant (Read et al., 1994).

Agarwal and colleagues assessed outcomes in a sample of over 600 women who were induced at an English hospital during the period 2001 through 2003 (Agarwal et al., 2009). The rate of emergency caesarean section was significantly higher for male infants (14%) compared to females (9%), but there was no significant difference in instrumental birth rates. The authors found that the association remained after adjusting for fetal size through head circumference and birth weight (results not presented by authors), but also did not adjust for gestational age.

Lieberman and colleagues conducted a study to assess the impact of fetal sex on the rate of caesarean sections in Boston, USA (Lieberman et al., 1997). In addition to birth weight, analyses were adjusted for gestational age and head circumference as further measurements of fetal size. Mothers with male infants were twice as likely to have a caesarean section for *fetal distress*, as mothers with female infants (adjusted OR=2.2 95% CI 1.3-4.0), but there was no relationship between fetal sex and caesarean section for *failure to progress* after adjustment for fetal size (adjusted OR 1.04 95% CI 0.8-1.4). The authors suggested that male fetuses may have higher rates of distress during labour. Of the 55 infants delivered by caesarean section for fetal distress, a higher proportion of males had a low Apgar score compared to females (45.7% vs. 15%).

A much larger study of over 400,000 women was conducted in The Netherlands to establish the relationship between male sex and fetal distress (Bekedam et al., 2002). The authors assessed operative births (including emergency caesarean section, vacuum extraction and forceps) performed for suspected fetal distress. Fetal distress was determined by the interpretation of fetal heart rate monitoring by attending staff. Operative births for fetal distress occurred in 9.3% of male infants and 7.0% of female infants, an increased risk for males of 36% (OR=1.36 95% CI 1.33-1.39). After adjustment for birth weight and gestational age, the risk increased for males to almost a 50% increased risk (adjusted OR=1.48 95% CI 1.44-1.51). There was also a 27% increased risk of low Apgar score and perinatal death among male infants compared to females, after adjustment[3].

The results from previous literature indicating an elevated risk of unplanned operative birth, in addition to poorer outcomes for male newborns, could indicate a tendency for male fetuses to fare worse during labour. Cord blood glucose levels have been found to be higher in male newborns than females, although in the same study no differences in glucose levels were observed for infants born by planned caesarean section. It has been suggested that glucose levels therefore represent a differential stress response to labour between sexes (Ingemarsson, 2003). In addition, computer analyses of continuous fetal heart rate traces from the last hour of labour have shown different heart rate patterns for male and female fetuses (Dawes et al., 1999). Males were significantly more likely

[3] The increased risk of low Apgar score and perinatal death were reported in the overall sample, rather than among infants with fetal distress as in Lieberman et al (1997).

to have slow heart rates than females, who tended to have more accelerated heart rates, and the association remained after adjustment for other labour factors e.g. epidural. Analyses comparing traces at different stages, including pre-labour, concluded that the differences only appeared during labour.

7.2 Results

Table A7.1 shows a comparison of the characteristics of male and female infants at birth, and the incidence of both pregnancy and labour complications, stratified by parity. P-values are given from chi-squared analyses. Any factors found to be significantly related to fetal sex were added into multinomial logistic regression models for fetal sex predicting mode of birth (see Table A7.2).

As can be seen in Figures 7.1 and 7.2, mothers with a male fetus were more likely to have either an instrumental vaginal birth or an emergency caesarean section in unadjusted analyses (see Table A4.2 of Chapter 4 for frequencies and percentages).

Figure 7.1: Mode of birth by infant sex for primiparous women

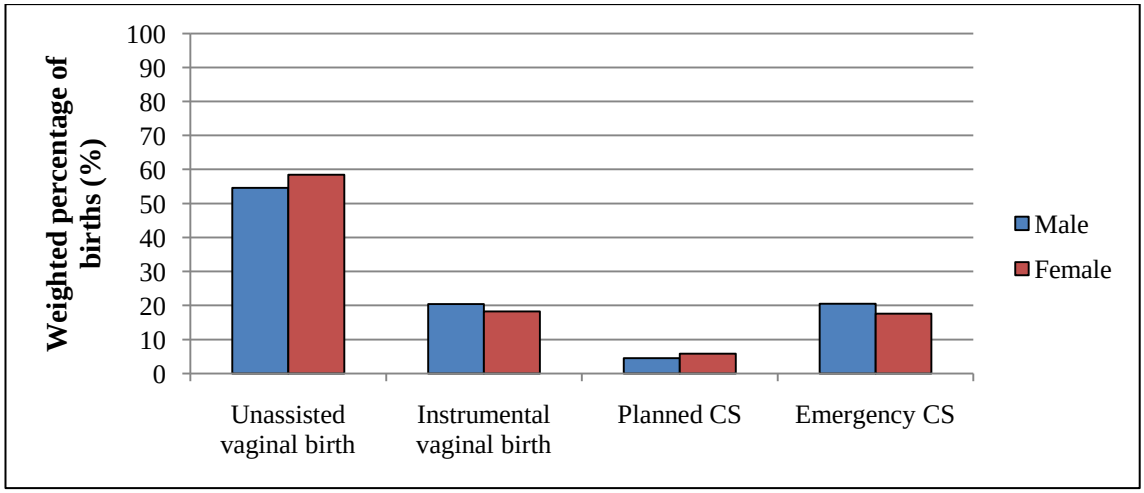
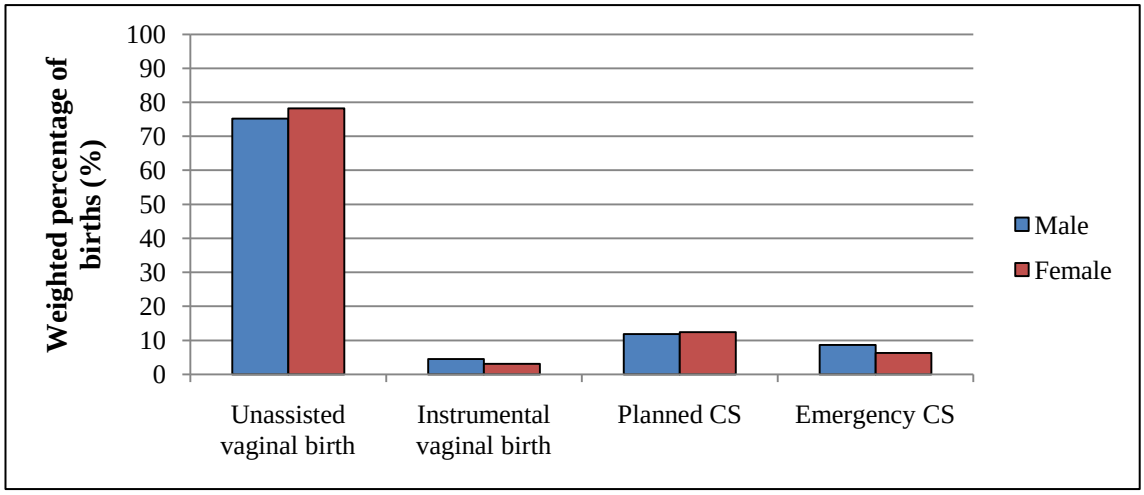


Figure 7.2: Mode of birth by infant sex for multiparous women



7.2.1 Pregnancy, labour and infant characteristics by sex

Birth weight was significantly associated with fetal sex for both infants who were first-born, and those born to multiparous women. In particular, male infants were significantly more likely to be high birth weight, weighing more than 4kg at birth (12% vs. 8% for primiparous women and 18% vs. 11% among multiparous women). For gestational age there was no significant association with fetal sex among first-born infants. For infants born to multiparous women however, male infants were significantly more likely to be preterm.

Although mothers carrying male and female fetuses did not differ in complications during pregnancy, they did differ in complications during labour. Female infants born to primiparous women were more likely to be malpresented, but there was no association between fetal sex and presentation for multiparous women. Mothers with a male fetus were significantly more likely than mothers with a female fetus to report fetal distress (28% vs. 23% for primiparous women and 14% vs. 12% for multiparous women). 'Other' complications in labour were also higher for mothers with male infants, but the results were of borderline significance.

7.2.2 Unadjusted effect of fetal sex on mode of birth

In unadjusted regression analyses, primiparous mothers who had a male infant were at a 20% increased risk of instrumental birth and a 25% increased risk of emergency caesarean section compared to mothers who had a female infant. For multiparous mothers, the increased risk of instrumental vaginal birth and emergency caesarean section was more marked, at 48% and 41%, respectively.

7.2.3 Controlling for fetal size

For primiparous women, analyses controlling for fetal size were adjusted for birth weight only (as gestational age did not differ significantly by sex). Birth weight accounted for some of the excess risk of instrumental births for women with male fetuses (adjusted RRR=1.15, p=0.06 compared to females), although for emergency caesarean sections adjustment made little difference (adjusted RRR=1.23, $p<0.05$). For multiparous women, controlling for both birth weight and gestational age made little difference to the excess risk of unplanned operative birth for male infants, with only slight attenuation in relative risk ratios.

7.2.4 Controlling for fetal size and labour complications

As malpresentation was more likely for females, controlling for malpresentation somewhat strengthened the association between male sex and unplanned operative birth. Fetal distress explained the increased risk of instrumental vaginal births for primiparous women with male infants (adjusted RRR=1.10, p=0.24). In addition the relationship between male sex and emergency caesarean section became of borderline significance when fetal distress was controlled for (adjusted RRR=1.16, p=0.06).

Among multiparous women fetal sex remained a significant predictor of mode of birth when included in a model with gestational age, birth weight and fetal distress, with only slight attenuation of risk. Mothers carrying a male fetus were significantly more likely to have an unplanned operative birth, with a 38% increased risk of both instrumental birth and emergency caesarean section after adjustment. Infant sex was not related to planned caesarean sections in either unadjusted or adjusted analyses.

7.3 Discussion

Previous studies have shown an increased risk of unplanned operative birth for mothers carrying a male infant. Male infants are likely to be larger than females and are also more likely to be born both pre and post-term, which could confound the results of unadjusted studies. However, in studies adjusted for both birth weight and gestational age a residual effect of fetal sex on mode of birth has been identified (Bekedam et al., 2002, Lieberman et al., 1997).

Millennium Cohort Study analyses showed that male infants were more likely to be high birth weight, supporting the previous literature indicating that male infants are larger. Males were also more likely to be born preterm, although this was only significant for multiparous mothers.

In agreement with the previous literature, initial unadjusted analyses indicated that mothers in the MCS with a male fetus were significantly more likely to have an instrumental birth or an emergency caesarean section, than those with a female fetus.

For *primiparous* women, controlling for birth weight explained the significant increased risk of instrumental vaginal births for mothers with a male infant, although the adjusted result was of borderline significance. However, mothers with a male infant remained 23% more likely to have an emergency caesarean section. For *multiparous* women, after adjustment for gestational age and birth weight, mothers carrying a male fetus remained significantly more likely to have both an instrumental birth or an emergency caesarean section, with around a 40% increased risk of both compared to women who had a female infant. Notably, adjusting the model for fetal size made little difference to the risk estimates.

The cause of the increased risk of operative birth for male infants is unknown. Previous studies have found higher incidences of maternal pregnancy complications such as gestational diabetes in mothers carrying a male fetus (Di Renzo et al., 2007). In the MCS no significant infant sex differences were detected in women reporting complications during pregnancy.

The study by Dawes and colleagues suggested differential fetal heart rate patterns among male and female fetuses, with males having significantly slower heart rates than females during labour (Dawes et al., 1999). There could be two explanations for this finding. Firstly, male fetuses may have a slower 'normal' heart rate pattern. As the fetal heart rate is the primary indicator used for fetal distress this could indicate a lower threshold for intervening with operative births for male fetuses. Secondly, male infants may respond less well during labour, and slower heart rate patterns could represent genuine fetal distress. Previous studies have suggested that fetal distress could be higher for male fetuses during labour, and may explain the higher incidence of operative births for male infants (Bekedam et al., 2002, Lieberman et al., 1997). In support of this a higher proportion of low Apgar scores were observed for male infants compared to females (Bekedam et al., 2002, Lieberman et al., 1997).

Lieberman and colleagues found that after adjustment for fetal size and gestational age, male infants were significantly more likely to be born by caesarean section for fetal distress, but no significant differences were found for caesarean section for failure to progress (Lieberman et al., 1997). In the MCS, the reason for the caesarean section is not available. However, when asked if there were complications during their birth, women who had a male infant reported fetal distress more often than women with a female infant, and this was particularly apparent for first-time mothers. The greater incidence of fetal distress for male fetuses may support theories that males

respond less well during labour, especially as fetal distress included not only heart rate indication, but also signs of meconium and incidences of the cord being around the fetal neck.

For primiparous women, fetal distress explained the significant variation in mode of birth by fetal sex. However, the addition of fetal distress to models for multiparous women did not explain variation in mode of birth; in fact the adjustment made little difference to relative risk ratios. Fetal distress was less common for multiparous women; 13% vs. 24% and also differed by a smaller proportion between females and males, which may account for the lesser impact of controlling for fetal distress in the model.

It is interesting to note that the effect of fetal sex on mode of birth was stronger for multiparous women, and unlike for primiparous women was not explained by fetal size or fetal distress. Previous studies have not separated primiparous and multiparous women in their analyses. The reasons for the greater increased risk of unplanned operative births for multiparous women with male infants are unclear and warrant further investigation.

Scans conducted in the second trimester of pregnancy can often determine the fetal sex and some women choose to find out the sex of the baby from the scan. Consequently a proportion of women going into labour will do so with the knowledge of their infant's sex, and health professionals caring for these women are also likely to be aware of the infant sex. If health professionals are conscious of differences in fetal responses to labour, their knowledge of the infant sex could change their behaviour and might explain the differences in operative birth rates by sex. However, there were no significant differences in planned caesarean section rates by fetal sex, which would seem to add further support to a differential fetal response to labour.

7.3.1 Strengths and limitations

The Millennium Cohort Study provided a large, contemporary UK dataset in which to explore the effect of fetal sex on mode of birth. The impact of fetal sex was investigated for instrumental births, emergency caesarean section and planned caesarean section and was adjusted for birth weight, gestational age and labour complications. In addition, analyses were stratified by parity, with interesting results, which to my knowledge have not been demonstrated previously.

The use of secondary data did impose limitations. Most importantly pregnancy and labour experiences were self-reported nine months after birth and therefore the information may be subject to recall bias. In addition the data were dependent on the quality of the information provided to women by health professionals, and their understanding of the information, which could be

compromised during the stressful labour experience. However, there is no reason to believe that recall error would differ by fetal sex.

7.4 Summary

What is already known on this subject?

- Previous literature has suggested that male infants are more likely to be born by unplanned operative birth than female infants, after adjustment for their larger size.
- Some studies have suggested increased fetal distress for males during labour, which could explain the increased risk of unplanned operative birth.

What does this study add?

- In agreement with previous literature, mothers in the MCS who were carrying a male fetus were significantly more likely to have an instrumental birth, or an emergency caesarean section. However, there was no association between fetal sex and planned caesarean section.
- Differences in pregnancy, labour and infant characteristics were examined by fetal sex. Male infants were on average larger. Although pregnancy complications did not differ by sex, fetal distress in labour was more often reported by mothers of male infants.
- Unlike previous studies, analyses were stratified by parity.
    - Among primiparous women, birth weight accounted for the increased risk of instrumental birth for males. The addition of fetal distress to the model also explained the excess risk of emergency caesarean section for male fetuses.
    - For multiparous women the effect of sex on mode of birth was stronger and was only slightly attenuated after adjusting for gestational age, birth weight and fetal distress.
    - These differences in the effect of fetal sex on mode of birth by parity have not been demonstrated previously and warrant further exploration.

Section B:

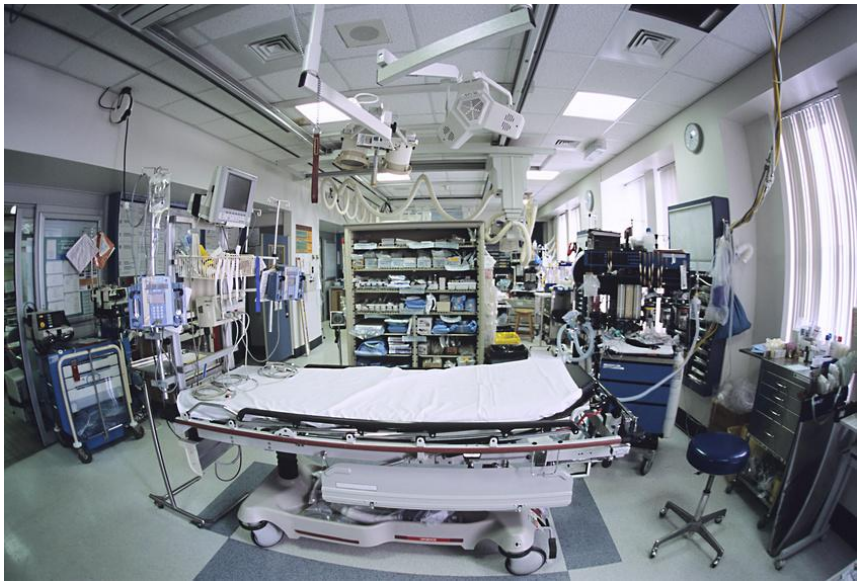
The maternity service factors which relate to mode of birth

CHAPTER 8: Literature review: Maternity service factors and mode of birth

8.1 Introduction

The picture below (Figure 8.1) is one of the first images produced by ‘Clip Art’ in Word when a search for ‘hospital’ is entered. This picture encapsulates for me the idea of medicalisation. The photograph, of an operating theatre, is comparable to the setting in which around a quarter of UK mothers will give birth today.

Figure 8.1: An image from 'Clip Art' for 'hospital'



This chapter describes maternity service influences during antenatal and intrapartum care, which could affect mode of birth. In this chapter I describe how mode of birth may not be fully explained by the individual characteristics of a mother and her fetus, as described in Chapter 2, but how it may also be shaped by the care she receives. This chapter is in three main sections, covering antenatal care, place of birth and interventions in labour.

8.2 Antenatal care

Antenatal care refers to the care provided for women during their pregnancy, with the purpose of identifying any potential problems early and preparing women for pregnancy, childbirth and parenthood. It is recommended that women in England have their initial booking appointment with a midwife by 10 weeks (National Institute for Health and Clinical Excellence, 2008a). At this initial appointment, a large volume of information is collected by the midwife through questions, medical checks and tests, and a large amount of information is also given to the woman. A plan of care for the pregnancy is discussed including screening and lifestyle considerations, amongst other factors. Women are also seen during specific weeks throughout pregnancy, dependent on their parity and care needs.

Additionally, antenatal care in the UK can involve antenatal classes, which women can attend to learn about labour, birth and early parenthood. Classes are provided by the NHS in most places, typically with three classes in the later stages of pregnancy. Private classes are also available; for example, the National Childbirth Trust (NCT) is a charity which provides antenatal classes for a charge (National Childbirth Trust, 2009). The literature regarding antenatal care attendance and antenatal class attendance will be discussed separately, as the purpose and implications of attendance for women are very different.

8.2.1 Antenatal care

Women who receive low levels of antenatal care are more likely to be from disadvantaged backgrounds. For example, a large study covering almost a quarter of births in France in 1993 found that women with low attendance at antenatal care (fewer than 4 visits or began care during the last three months of pregnancy) were more likely to be younger, single, of higher parity and to have no health insurance, than women with higher attendance (Blondel and Marshall, 1998). A review of studies assessing attendance at antenatal care in the UK found that women of manual classes were more likely to book late or attend fewer antenatal visits than women from other classes. In addition, women of Asian background were more likely to book late for antenatal care compared to White British women (Rowe and Garcia, 2003). An evaluation of NHS maternity services in England in 2007 also found that women of Asian and Black origin were more likely to access antenatal services late in pregnancy and were less likely to have a scan at 20 weeks (Healthcare Commission, 2008). Moreover, the review highlighted issues for women whose first language was not English. A great deal of information provided to women during pregnancy is in the form of leaflets. However, not all women received written information in their preferred

languages, and some women emphasised the importance of needing a discussion about their care, rather than just receiving written information.

Although there is some information to suggest that women who access antenatal care late in pregnancy, or attend few visits are from more disadvantaged backgrounds, the review by Rowe and Garcia additionally highlighted the need for more information on women who *do not* access antenatal care (Rowe and Garcia, 2003). The UK Infant Feeding Survey in 2000 found that around 2% of women surveyed had not accessed antenatal care (Hamlyn et al., 2002).

Relatively few studies have examined the relationship between antenatal care and mode of birth (see Table A8.4). A Cochrane review of RCTs included trials comparing patterns of antenatal care for low-risk women (Villar et al., 2001). The trials, from a mixture of developing and developed countries, randomised women to receive differing numbers of antenatal visits. The pooled estimate indicated no significant difference in caesarean section rates between the groups who received more or less care. However, in five of the seven trials the difference in the number of visits between the trial arms was either very small, or none. In the four trials conducted in developed countries, the recommended number of visits was not strictly followed in either group, making it difficult to establish if there was truly an intervention. Studies conducted in developed countries where the average number of antenatal visits is high, and the importance of antenatal care relatively less than in developing countries, may be unlikely to find a difference in outcomes if there is only a small difference in the number of visits between the trial arms.

Although literature from observational studies is also scant, the outcomes assessed may be more clinically relevant than those in the randomised controlled trials discussed above. Most studies assessed women who had attended few antenatal visits (Behague et al., 2002, Gissler and Hemminki, 1994, Gomes et al., 1999, Simoes et al., 2005), or started care late in pregnancy (Braveman et al., 1995, Gissler and Hemminki, 1994) and one study examined women who received no care vs. any care (Gareen et al., 2003). Despite the paucity of available literature, the evidence from the observational studies, which were from several countries, seemed to suggest that mothers who have little or no antenatal care are at a *decreased* risk of caesarean section. This seems counterintuitive for three reasons. Firstly, mothers who do not access antenatal care, or access care late in pregnancy, have been found to be from more disadvantaged backgrounds. Secondly, antenatal care is intended to identify complications in pregnancy, therefore, without such care it could be expected that some women may go into labour with unidentified underlying problems, which could put them at higher risk of complications in labour. Thirdly, women who attend antenatal care should be more prepared for childbirth (especially if they have attended antenatal classes).

If all studies had conducted only crude analyses, the relationship could perhaps have been explained by confounding factors. However, only two studies presented only unadjusted results (Behague et al., 2002, Simoes et al., 2005). In the remaining studies the association remained after adjustment for maternal factors, including socio-economic factors (Braveman et al., 1995, Gareen et al., 2003, Gissler and Hemminki, 1994, Gomes et al., 1999, Petrou et al., 2003), and in one study the effect size actually increased after adjustment (Gareen et al., 2003).

The authors of most of the observational studies discussed here did not attempt to explain why women who had low attendance at antenatal care were at a decreased risk of caesarean section. This may be due to the fact that in most cases the studies were not primarily assessing the relationship between antenatal care and mode of birth, but were simply adjusting for antenatal care amongst many other factors related to mode of birth. As a result it is possible that the authors of the studies assumed that their finding was an anomaly, and therefore chose not to discuss it further.

One large Finnish study had aimed to assess childbirth and infant outcomes for women according to the antenatal care they received (Gissler and Hemminki, 1994). Gissler and Hemminki found that among more than 57,000 women, those that had attended care early in pregnancy, and those that attended many visits were at a higher risk of having a caesarean section. The authors suggested that an earlier start to antenatal care may indicate an earlier transition to becoming a patient, and that this could result in behaviour changes among women and increased impatience for women who went over their due date.

Another hypothesis for why women who are poor attenders at antenatal care may be at a decreased risk of caesarean section could relate to the attitudes of health professionals. We know from previous literature (discussed in Chapter 2) that ‘high risk’ women (with underlying health problems in pregnancy) are much more likely to receive interventions in their birth. It has also been suggested that for high risk women there is a ‘self-fulfilling’ prophecy, with health care professionals having a lower threshold for intervening when a woman is thought to be high risk (Kirz et al., 1985). Women with complications in pregnancy who do not attend antenatal care may go into labour with those complications undetected, and thus they will not be treated as high risk women. However, contradictory to this hypothesis, a woman presenting to maternity staff in labour, who did not attend antenatal care, would be classed as ‘high risk’ *because* of their non-attendance.

8.2.2 Antenatal classes

As with antenatal care, mothers from more disadvantaged backgrounds are less likely to attend antenatal classes (Cliff and Deery, 1997, Fabian et al., 2004). One small English study found that women who were younger, single and from working class backgrounds were less likely to attend antenatal classes than their more advantaged counterparts. When interviewed the women who did not attend classes felt that they would be stigmatised and looked down on by the other mothers at the classes (Cliff and Deery, 1997). Additionally, there has been some research to suggest that of the women who do attend antenatal classes, women from more disadvantaged backgrounds are less likely to find the classes helpful. In a study from Sweden, over one thousand women were surveyed about antenatal classes. Women who responded that they had not found the classes helpful in preparing them for childbirth were likely to be younger, single, with lower levels of education and to be smoking before and during pregnancy, than women who found the classes helpful (Fabian et al., 2005).

Table A8.5 details the studies which assessed antenatal education and mode of birth. One study examining antenatal class attendance found no effect on mode of birth either before or after adjustment for other maternal factors (Gareen et al., 2003). In the remainder of studies however, unadjusted analyses suggested a higher risk of caesarean section for women who had attended more classes, compared to those who had attended few or none (Artieta-Pinedo et al., 2010, Fabian et al., 2005, Gunn et al., 1983, Patel et al., 2005, Sturrock and Johnson, 1990). Two of these studies did not include further adjustment for maternal factors (Sturrock and Johnson, 1990), or included poor adjustment (Gunn et al., 1983). Failing to adequately control for maternal background may lead to misleading results. For example, women who attend antenatal classes are often older than non-attenders, and older maternal age is a significant risk factor for caesarean section (see Chapter 2).

All studies which adjusted for maternal factors found no residual effect of antenatal class attendance after adjustment (Artieta-Pinedo et al., 2010, Fabian et al., 2005, Gareen et al., 2003, Patel et al., 2005). The only English study by Patel and colleagues assessed antenatal class attendance among a variety of factors relating to planned and emergency caesarean section (Patel et al., 2005). In unadjusted analyses, women who did not attend antenatal classes were less likely to have an emergency caesarean section. However, non-attenders to antenatal classes were at an increased risk of a planned caesarean section. This may be because women who knew they were having a caesarean section did not feel that childbirth classes were as relevant to them. However, after Patel and colleagues adjusted for other maternal factors, antenatal class attendance was not significantly related to mode of birth (Patel et al., 2005).

Although only few studies were identified which assessed antenatal class attendance in relation to mode of birth, generally the studies were large and well-adjusted for maternal background. Overall, although antenatal care attendance appears to be related to mode of birth, antenatal class attendance does not appear to contribute to the relationship.

The relationship between antenatal care and class attendance will be further examined in Chapter 9.

8.3 The birth setting

Although in the UK, there are national guidelines for intrapartum care, there is wide variation between hospitals in both rates of interventions in labour (which are discussed in detail later in this chapter), and in rates of instrumental vaginal births and caesarean sections. Variation in rates of interventions between hospitals and other places of birth are evident across the world. In this section of the chapter I reflect on how the place of birth is related to mode of birth, including types of institution and staff present during the labour and birth. Unfortunately, there is very little literature available from UK settings on some of these issues, so examples will be considered from other developed countries to shed light on some of the reasons for variations in care in the UK context.

Factors regarding place of birth that will be discussed in this section are:

- Place of birth,
- Birth attendant, i.e. which care providers are present at the birth.

8.3.1 Place of birth

Despite national guidelines for intrapartum care (National Institute for Health and Clinical Excellence, 2007), and specifically for caesarean sections (National Institute for Health and Clinical Excellence, 2004b), NHS maternity statistics show significant variation between hospitals in terms of both caesarean section and instrumental vaginal birth rates (Richardson and Mmata, 2007). It is clear that maternal or hospital level factors must influence these rates. A study by Paranjothy and colleagues used data from the National Sentinel Caesarean Section Audit (NSCSA) to investigate the differences in caesarean section rates between all 216 maternity units in England and Wales in a period of three months in 2000 (Paranjothy et al., 2005). The data included 99% of registered births for that period. The overall caesarean section rate was 20.5%, but the rate ranged from 6% to 66% across all maternity units. The authors ran logistic regression models to adjust for case-mix factors such as age, ethnicity, previous birth modes and birth weight. Adjusting for maternal and infant factors only explained 34% of the variance in caesarean section rates. Although

the authors did not adjust for all maternal and infant factors related to mode of birth (see chapter 2), their results highlight the need to adjust hospital intervention rates for case-mix, as has been suggested previously (Aron et al., 1998). The results also indicate that substantial heterogeneity remains between hospitals, which is not related to case-mix. Aron and colleagues in an American study addressed the need to adjust hospital caesarean birth rates for case-mix differences and discuss how women of different backgrounds may attend different hospitals and how women with more high-risk pregnancies may be referred to specific hospitals which could lead to 'referral bias' (Aron et al., 1998). However, in their study, substantial variation remained after adjustment for case-mix.

Studies from a range of countries have shown variation in caesarean section rates associated with the type of hospital a woman gives birth in. For example, in countries where private care models are more apparent like the USA, Brazil and Australia, women who give birth in private hospitals are much more likely to have a caesarean section than women in public hospitals, leading some to suggest that economic gain may have a part to play in caesarean section rates (Potter et al., 2001). Potter and colleagues conducted a study in Brazil assessing rates of caesarean section between private and public hospitals. Women were interviewed before and after birth regarding the type of birth they would prefer, and the type of birth they subsequently had. Mothers in private hospitals were much more likely to have a caesarean section, but this was not related to their preferences. After adjustment for whether the woman had had a previous caesarean section, there was almost no difference in the expressed preferences for type of birth between women who gave birth in private or public hospitals (Potter et al., 2001). Teaching hospital status has also been related to caesarean section rates, with two American studies finding lower caesarean section rates among women who gave birth in teaching hospitals, after adjustment for case-mix factors (Braveman et al., 1995, Oleske et al., 1991).

Within the UK there has been much less research into variation in hospital caesarean section rates, probably due to the nationwide availability of public care through the NHS, with private maternity care being uncommon. In the UK almost all women give birth in an NHS maternity unit setting, with only 2.6% of births taking place at home according to 2005-06 maternity statistics (Richardson and Mmata, 2007). Very little data is available about births that take place in private hospitals, or about those attended by independent midwives, but these account for a very small proportion of births. For example, in 2005-06 less than 500 births in England were attended by independent midwives (Richardson and Mmata, 2007).

8.3.1.1 Home births

At under 3%, the UK has a low home birth rate (Richardson and Mmata, 2007). Consequently, a relatively small quantity of literature is available from a UK setting comparing outcomes for women who give birth at home, compared to those who give birth in hospital. Much of the literature on home births is from the Netherlands due to their high home birth rate of around 23% (Maassen et al., 2008), although this rate is much lower than 40 years ago when two-thirds of Dutch births occurred at home (Wiegers et al., 1998). A recent and large retrospective study from the Netherlands found that low-risk women who intended to give birth in hospital had higher rates of operative deliveries (caesarean sections and instrumental vaginal births) than similar low-risk women who planned to give birth at home and laboured at home (Maassen et al., 2008).

Olsen conducted a review of good quality observational studies comparing planned home births and planned hospital births (Olsen, 1997). The criteria for inclusion specified that the home birth group should comprise all planned home births irrespective of actual place of birth and it should contain no planned hospital births occurring at home (intention-to-treat analysis). Six studies from a range of countries met the inclusion criteria. Despite significant heterogeneity in study designs, of the five studies that examined mode of birth as an outcome, all found significantly lower operative birth rates in the home birth group. However, home birth studies with an observational design could be biased by self-selection, as women who *choose* to give birth at home may be different from those who do not, in unmeasured ways, not least in the fact that they almost certainly want a normal birth. Van Der Hulst and colleagues conducted a study in the Netherlands comparing intended place of birth (home or hospital), eventual place of birth and birth outcomes (van Der Hulst et al., 2004). Women with a more receptive attitude towards technology were much more likely to opt for a hospital birth. Of the women who had ultimately had a hospital birth, multiparous women who had intended to have a hospital birth were much more likely to receive interventions than women who had intended to have a home birth.

Ordinarily, randomisation can reduce biases introduced by unmeasured differences between two groups. However, there has been heated debate regarding the feasibility of a trial of home versus hospital birth (Dowswell et al., 1996b). A small feasibility trial including 11 women was conducted in England in 1994 (Dowswell et al., 1996a). A Cochrane review of RCTs of home versus hospital birth, most recently updated in 2006, identified no further trials (Olsen and Jewell, 2006). Dowswell and colleague's feasibility trial highlights issues with randomising women for home or hospital birth (Dowswell et al., 1996b). Women often have strong views about where they would like to give birth – both for home and for hospital birth. The ethics of randomisation when such strong views are held about the superiority of a trial arm have been questioned previously with regards to obstetrics (Lilford, 1987). Only 11 of 71 women who were eligible, and were informed

about the trial, consented to take part. Of the 10 women who eventually did take part (one was withdrawn for medical reasons) all four women allocated to home birth were pleased with their allocation, whereas 4 of the 6 women allocated to hospital birth were disappointed. In addition many women who declined to take part felt very strongly about their choice. This would seem to suggest that women who agree to take part in an RCT of home versus hospital birth may be more open to the idea of home birth, making the generalisability of a trial to the general population uncertain.

Due to gaps in the evidence base regarding outcomes for women in the UK based on planned place of birth, a large programme of research including several studies is currently ongoing, with funding until 2011 (National Perinatal Epidemiology Unit, 2011). The Birthplace in England Research Programme (A.K.A Birthplace), funded by the National Institute for Health Research (NIHR) and NICE, aims to compare outcomes for births planned at home, in different types of maternity units, and in hospital units with obstetric services.

8.3.1.2 Birth centres

Over the past few decades the centralisation of the NHS led to the closure of many small midwife-led units. However, interest in midwife-led care and birth centres has increased (Walsh and Downe, 2004). Midwife-led birth centres can be incorporated into existing maternity hospitals, known as integrated birth centres (IBCs) or they can be free-standing and geographically separate (FSBCs). Birth centre care is characterised by a philosophy of normality of childbirth in a more home-like setting, with a much smaller number of annual births compared to most hospitals. Women booked to give birth in a birth centre must be deemed to be at low risk of obstetric emergency, as staff and equipment are not suitable for emergency care. In the case of complications a woman will be transferred to the nearest hospital (or ward in the case of IBCs), with the appropriate facilities (Hodnett et al., 2005).

It is difficult to know what proportion of births in the NHS take place in birth centres. Data summarising NHS maternity units in England are not readily available. NHS maternity statistics for 2005-06 use data from the Office of National Statistics (ONS) (Richardson and Mmata, 2007). However, the information is insufficient to describe NHS place of birth due to the way the data are collected and some inaccuracies in the way the data have been extracted. For example, data from the ONS is provided mainly by NHS Trusts, with few Trusts providing information on individual maternity units (Spiby et al., 2007). Table 8.1 describes NHS place of birth according to the 2005-06 maternity statistics.

Table 8.1: Place of birth according to 2005-06 maternity statistics

Place of birth	**Percentage of all NHS births**
Consultant ward	50%
GP ward	2%
Consultant/ midwife/ GP ward	42%
Midwife ward/ other ward	7%

It would seem from the NHS maternity data that birth centre care would fall under midwife/other ward, but this is unclear. Researchers have attempted to survey maternity units in the UK to establish what options are available to women (Smith and Jewell, 1991, Smith and Smith, 2005). The findings highlight the continued changes to maternity care which almost certainly make the most recent survey from 2001-02 outdated. In a more recent study of early labour (OPAL study), Spiby and colleagues collected data from Heads of Midwifery regarding maternity units in 2005 (Spiby et al., 2007). Data from 178 maternity units were collected and are described in Table 8.2. The authors highlight the difficulties in knowing to what extent their data is representative of England as a whole due to the issues with maternity data described above, making comparisons difficult. However, the data represented 89% of NHS maternity trusts (each trust covers one or several maternity units) and comparisons with birth centre websites suggested that if anything the number of reported birth centres in the OPAL study may have been slightly under-reported (Spiby et al., 2007).

Table 8.2: Types of maternity unit in the OPAL study

Type of unit	**Frequency**	**Percentage**
NHS consultant unit including a midwifery-led care area	77	43.3%
NHS consultant unit without a midwifery-led care area	64	36.0%
Stand-alone birth centre	32	18.0%
Birth centre alongside a consultant unit	5	2.8%
Total	178	100.0%

Walsh (2005) conducted an ethnographic study at an FSBC, including observation of the care provided, and interviews with women three months postnatally (Walsh, 2006). Walsh observed that the smaller number of annual births at the birth centre allowed the midwives to focus on supporting the woman in labour, and also allowed the midwives to look after the needs of family and friends

attending the birth. Walsh described a more relaxed environment with less regimented care to that in hospital units. He compared hospital care to car assembly-lines, with a focus on time (in terms of length of labour) due to high birth volumes.

In earlier work, Walsh and several other colleagues conducted a review of observational studies comparing FSBCs with consultant hospital units (Walsh and Downe, 2004). Only studies which used a controlled comparative design by attempting to match women according to their risk status were included. Women eligible for the control group were at low risk and thus would have been eligible for birth centre care. Five studies were included in the review; three from the USA, one from the UK and one from Germany. Four of the five studies reported rates of caesarean section and in all four studies, rates of caesarean section were lower in the FSBC group than in the control group.

As with home birth studies, observational studies looking at outcomes for women who give birth in integrated and stand-alone birth centres, compared to the more conventional labour ward environment could be biased by self-selection. Unlike women receiving standard hospital maternity care, women would need to be low-risk in order to qualify for birth centre care. Despite the fact that many observational studies attempt to account for this bias by only including low-risk women, the women who elect for birth centre care may also be different in other unmeasured ways, not least in the fact that they almost certainly want a normal birth. Studies have found demographic differences between women depending on place of birth. A review of observational studies comparing FSBCs to hospital units, found that women in the birth centre groups in the included studies were more likely to be from higher socio-economic backgrounds (Walsh and Downe, 2004).

Research regarding place of birth utilising a randomised controlled trial design eliminates the bias introduced by self-selection. However, it should be noted that women who agree to take part in a trial of place of birth may be different to those who decline to participate (see discussion above Re. home births). A Cochrane review by Hodnett and colleagues included RCTs comparing home-like versus conventional institutional birth settings (Hodnett et al., 2005). Six trials were identified, all of which had examined some form of integrated home-like environment such as home-like birth rooms or units, or birth centres. No trials examining free-standing birth centres were identified. Women at low risk of obstetric complications were randomised in each of the trials to give birth in either a home-like setting or in a conventional hospital setting. The risks of instrumental vaginal birth and caesarean section were significantly lower for the women in the home-like birth settings. This finding is likely to be diluted by the fact that all trials had substantial crossover, with women being transferred to standard care due to complications either in late pregnancy or in labour. In fact,

rates of transfer from the home-like settings ranged from 34% to 77% across the trials. Women transferred in labour were transferred due to failure to progress, fetal distress or desire for analgesia. In addition, because of the large variability in the home-like settings, no recommendations can be made for an effective model of care.

Outcomes for home-like and birth centre settings appear to indicate a lower risk of eventual caesarean section or instrumental birth. However, these units are rare in the UK and further restrictions are imposed by the fact that women must be of low risk to be eligible for birth centre care. In addition, it seems women who choose to attend birth centres may be very different to women who choose standard care as they may desire a normal birth, with minimal intervention.

The following factors are generally synonymous with birth centre care:

- midwife-led,
- philosophy of one-to-one care,
- home-like environment,
- few interventions are available for use,
- philosophy of normality,
- women who choose birth centre care may be more likely to want a normal birth.

Due to the very different model of care provided in birth centre settings, it is difficult to disentangle what could be driving the better outcomes for women in these environments.

8.3.1.3 Other models of maternity care

In addition to birth centre care models in the UK, there are other unique models of care which have proved to be very successful with regard to outcomes for women. One well-documented example is that of the Albany midwives (Sandall et al., 2001). The Albany Midwifery Practice team were initially self-employed and self-managed midwives working in Peckham, London in 1994. In 1997 they gained a contract with the local Health Authority and NHS funding. Peckham and the area served by the midwives is highly deprived, with a high proportion of births to women over the age of 35 and teenagers, as well as women from minority ethnic backgrounds. The area also has higher rates of stillbirth and low birth weight births compared to the national average. Despite serving a deprived community, a detailed report conducted by Jane Sandall and colleagues from the nearby King's College Hospital found better outcomes for women under the care of the Albany midwives than those who gave birth at the King's College Hospital, who serve a similar population. The latest year in the report is 1999, when over 200 births were attended by Albany midwives and over

4,000 births took place in King's College Hospital. A variety of outcomes are described in the report; Table 8.3 shows some outcomes relating to place of birth and mode of birth:

Table 8.3: Birth outcomes for Albany Midwifery Practice and King's College Hospital, 1999

Birth outcomes (%)	**Albany Midwifery Practice (n=206 women)**	**King's College Hospital (n=4044 women)**
Home birth*	43%	7%
Induction	5%	11%
No pain relief	69%	16%
Epidural	17%	35%
Instrumental vaginal birth	5%	10%
Caesarean section (emergency CS)	18% (16%)	25% (18%)

* Including unplanned

As well as better birth outcomes, women cared for by Albany Midwives also reported having more choice and being more involved in decision making, and felt that their midwives had a better attitude than women from the King's College Hospital.

The Albany Midwifery Practice is different to the standard model of care offered to NHS women in several ways, with a founding aim to provide continuity of carer:

- philosophy of normality;
- the practice was set up in a community centre, close to the women they care for;
- women allocated a primary midwife – in 1999, 89% of women were attended during childbirth by their primary midwife;
- booking visits primarily occurred in the woman's home;
- midwives were on call 24 hours per day;
- early labour assessment was done at the woman's home and the midwife would take equipment for home birth in all cases, giving the woman the choice of home birth;
- Albany Midwives could attend the births of their women at the King's College Hospital.

This model of care, with a focus on continuity of carer, was clearly working for the Albany Midwifery Practice (the practice may now be under threat as King's College Hospital terminated their contract with the Albany Practice in December 2009 (Boseley and Domokos, 2009)). However, caseload midwifery (when a midwife is responsible for a specified number of women) can be stressful for midwives as being on call and long, unsociable hours interfere with their social

and domestic lives (Green et al., 1998a). In addition, models of care such as the Albany Midwifery Practice are unique in terms of staff, population, practices, as well as other factors and thus may not be easily generalisable, or replicable. Other examples of different midwifery models in the UK have been reviewed, however; similar to birth centre care, the complex nature of the models means it is difficult to establish the causes of outcomes (Green et al., 1998a).

8.3.2 Staffing

Between and within countries, different models of care are provided for childbearing women. In some countries, for example North America, care is primarily provided by doctors. In the UK, midwives are the main providers of care for women throughout pregnancy as well as during labour and birth. If a midwife detects any abnormalities in the pregnancy that could put the woman at higher risk, a referral is made to the care of an obstetrician until the problem is resolved. Similarly, midwives care for women during labour and birth, but if there are complications, the assistance of obstetricians is sought. However, within the UK there are variations in the model of care provided, with combinations of midwife-led, obstetric-led and shared models available (see Table 8.1 and Table 8.2 and discussion above).

A Cochrane review of midwife-led versus other models of care has been conducted (Hatem et al., 2008). Despite similarities to a previously discussed review of home-like birth centres (Hodnett et al., 2005), which are midwife-led in nature, in this review midwife-led care could take place in any setting, rather than just in a birth centre setting. Midwife-led care indicates that the midwife is the lead professional from antenatal through to postnatal care. It is also theoretically defined by a philosophy of normal birth, continuity of care and continuous attendance during labour amongst other factors, although these elements may not always occur in practice. In other models of care the lead professional may be an obstetrician, family doctor, or the responsibility may be shared between different health professionals. Eleven trials were identified which compared midwife-led to other models of care. Despite substantial variation in the model of care provided, and the risk status of the participating women and the practice settings, the pooled estimate indicated a decreased risk of regional analgesia and instrumental births for women randomised to midwife-led care, although there was no significant difference in caesarean section rates between the groups. Due to the variety of models of care provided, it is difficult to unpick the reasons why a midwife-led model of care may decrease instrumental birth rates. In addition, in some trials there may have been some confounding effects of the practice setting, although the authors felt that the observed effects were likely to be due to the model of midwife-led care rather than the practice setting.

In the Cochrane review of home-like versus conventional birth settings by Hodnett and colleagues described above, staff in four of the six trials were separate from the labour ward staff and they worked solely in the IBC (Hodnett et al., 2005). In sub-group analyses, women who received care from staff who worked solely in the IBC were more likely to have a spontaneous vaginal birth than women in standard care, but when care was provided by staff who worked in both the IBC and on the labour wards there was no significant impact on spontaneous vaginal birth rates. This suggests that something about the staff working wholly within the birth centre was different, perhaps their philosophy, as suggested by Walsh in his ethnographic birth centre study (Walsh, 2006). However, in all four studies where staff worked solely in the birth centre, the staff also provided greater continuity of care, so it is difficult to disentangle the effects of the staff model over the effects of greater continuity of care. A recent Canadian study investigated continuity of nursing care for women in labour (Gagnon et al., 2007). For each additional nurse caring for a woman in labour, there was a 4% to 32% increased risk of caesarean section, after adjusting for length of labour, and other factors. The authors did not discuss why continuity of nursing care may have an effect on birth outcomes. However, from qualitative research concerning support during labour, it is apparent that women feel more comfortable when they have established a relationship with their midwife, and that changing caregivers is a source of anxiety for women. Furthermore, as the labour progresses, communication can become more difficult for the labouring woman, hindering the relationship with a new midwife (Bowers, 2002).

It would seem from the evidence that in care models where obstetricians are more involved, intervention rates are higher. It might be reasonable to hypothesise that obstetricians are not as familiar with the concept of ‘normal’ birth as, particularly in the UK context, they care for women when pregnancy or labour is ‘non-normal’, and that this could influence their attitudes and behaviours. Studies examining the attitudes of health professionals towards caesarean section could shed light on this hypothesis. In a study conducted in Italy in 2005/06, both midwives and obstetricians were interviewed regarding their attitudes towards caesarean section (Monari et al., 2008). Two-thirds of midwives interviewed believed that the caesarean section rate on their ward was too high, in comparison to only one-third of obstetricians. In addition, attitudes of midwives and obstetricians differed with regard to the complications of elective caesarean section they judged to be more important. For midwives, fetal distress, emotional stress and risks with anaesthesia were judged to be more important, whereas for obstetricians risks associated with infection were more significant. These differing attitudes also affected their discussions with women regarding risks. Other studies concerning attitudes have focused on clinicians’ own preferences for childbirth. A survey of London-based obstetricians in the 1990s found that, among the female obstetricians surveyed, 31% would choose an elective caesarean section for themselves (Al-Mufti et al., 1997), which is substantially higher than the elective caesarean section rate at that

time. Most cited long-term consequences of vaginal birth as the reason for their choice. A 2001 survey of trainee obstetricians preferences for childbirth in the UK found a lower number: 14.6% of female trainee obstetricians would elect to have a caesarean section (Wright et al., 2001). However, this number is still very high as the vignette with which they were presented described a first, uncomplicated, single pregnancy with cephalic presentation at term. In response to the earlier survey of obstetricians by Al-Mufti and colleagues, Dickson and Willett surveyed 135 practising midwives in Manchester. Although presented with a similar vignette of an uncomplicated singleton pregnancy with cephalic presentation and no obstetric problems, 129 (96%) responded that they would choose a vaginal birth (Dickson and Willett, 1999). More recently, in 2006, a survey of specialist obstetricians and trainee obstetricians in Australia was conducted regarding elective caesarean sections for maternal request (Robson et al., 2009). In Australia, in public practice, many hospitals have regulations against elective caesarean sections for maternal request. The anonymous survey found that over 70% of obstetricians, with either part or all of their practice in a public hospital setting, would say "yes" to a request for an elective caesarean section, and of those obstetricians, 7.1% said they would falsify the indications for the caesarean.

Some research suggests that obstetrician characteristics may exert an effect on caesarean section rates. Rates of caesarean section can vary widely between obstetricians, even within the same hospital, leading some researchers to investigate the characteristics of obstetricians relative to caesarean section rates. For example, an American community hospital had large variations in caesarean section rates between obstetricians, despite them serving similar populations of women. When obstetrician characteristics were examined, those with higher rates of caesarean section were more likely to be over the age of 40 and to have joined the department earlier (Poma, 1999). In the previously discussed Australian survey, obstetricians were more likely to agree to requests for elective caesarean section if they worked in urban rather than rural areas and, unlike the American study, if they had been qualified for less than 10 years rather than more (Robson et al., 2009). However, it should be noted that the Australian study focused only on elective caesarean sections for maternal request, which make up a very small percentage of all caesarean sections. An American study by Burns and colleagues investigated the predictors of over 7,000 caesarean section deliveries in Arizona in 1989 (21% of the total number of deliveries) (Burns et al., 1995). Physician factors, hospital factors and patient level factors were investigated using logistic regression modelling. Although patient factors appeared to be the most important predictors of caesarean section rates, physician factors appeared to have more of an effect than hospital factors. Specifically, the probability of performing a caesarean section increased with the physician's rate of caesarean section in the previous year. In addition, some evidence was provided for the role of convenience factors, as the probability of caesarean sections was higher between 6am and 6pm and during weekdays. However, the study assessed the overall caesarean section rate which also

includes the elective caesareans which would be scheduled for daytime. An overall pattern of higher birth rates during weekdays has been identified previously, when timing is more convenient and practical for the hospital (Lerchl, 2005). One study found that highest rates of 'urgent' caesarean sections were in normal working hours (08.00-14.00), whereas the lowest rates were very early morning (05.00-06.00) (Goldstick et al., 2003).

It is clear that the staff providing care for a woman can have an influence on the type of birth she has. For women who experience a midwife-led care model this effect can be very positive; however, standard care in the UK is on consultant-led wards, which have higher rates of instrumental births and caesarean sections. Some studies have suggested that informing clinicians about their rates can help to reduce them. In one study the reasons for caesarean sections were audited by the labour ward staff and consequently the management of care was altered, leading to a reduction in the caesarean section rate (Robson et al., 1996).

8.4 Interventions in labour

In the UK, and in developed countries around the world, childbirth has become a medicalised and technological process, with many interventions routinely used in the labour process. In this section I will review the literature regarding obstetric and social interventions during labour and how they relate to mode of birth.

Factors surrounding the labour process included in this section are:

- Induction/augmentation of labour
- Epidural anaesthesia
- Fetal heart rate monitoring
- Active management of labour
- Social support during labour.

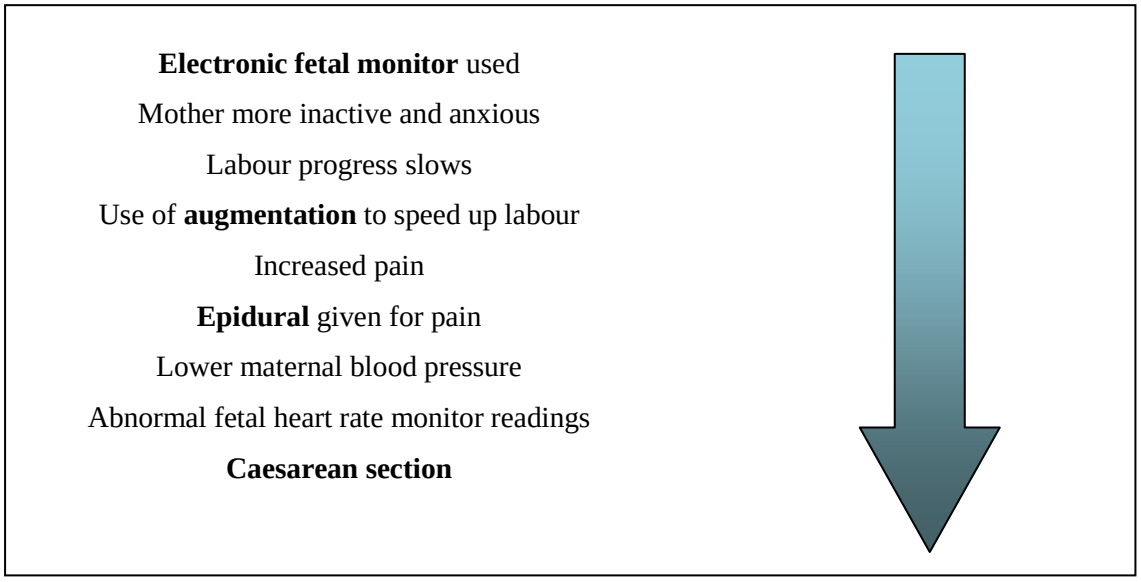
8.4.1 Cascade effect

In order to understand the impact of interventions during labour on the birth process, it is important to understand the context of the birthing environment. In many developed countries, including the UK, birth has become a medicalised process, with routine use of technology the norm. The use of one intervention may lead to the use of further interventions. For example, if a woman is induced, or has an epidural, electronic fetal monitoring will be used to monitor fetal wellbeing.

Many studies have demonstrated links between interventions administered in labour. For example, observational studies have found that women who are induced have higher rates of epidural use (Cammu et al., 2002, Roberts et al., 2000, Seyb et al., 1999, Shorten and Shorten, 2007, Tracy et al., 2007). The link between interventions has been frequently referred to as the "cascade effect".

To my knowledge the term "cascade of intervention" first appeared in a book written by Inch in 1982 (Inch, 1982). Inch referred to a possible chain of events after induction of labour by ruptured membranes, resulting in a more complicated labour and birth. Since then the term has frequently been used to describe the sequence of events which can occur in the labour process. An article by Deyo in 2002 described several examples of cascade effects in medical technology, including a theory of how electronic fetal monitoring could lead to a series of interventions (see Figure 8.2) (Deyo, 2002):

Figure 8.2: An example of the cascade effect



Although causal links have not been established for all these associations, it is important to consider that some interventions described below are unlikely to occur independently of others, and that this could have a cumulative effect on the risk of caesarean section and instrumental vaginal births.

8.4.2 Induction

Induction of labour is the process by which labour is artificially started, generally because it is believed that the outcome would be better than if the pregnancy were left to progress naturally. For example, mothers whose pregnancies progress beyond term may be at greater risk of serious

problems such as neonatal death and postpartum haemorrhage (Gulmezoglu et al., 2006). A variety of methods of induction are available including pharmacological e.g. prostaglandins and oxytocin; non-pharmacological e.g. membrane sweeping; and surgical e.g. amniotomy, most of which attempt to replicate the natural process of labour onset (National Institute for Health and Clinical Excellence, 2008b).

Induction of labour is often performed for clinical indications such as pre-labour rupture of membranes (PROM) (Mozurkewich et al., 2009, National Institute for Health and Clinical Excellence, 2008b), but in some settings it is performed electively, i.e. without clinical indication. In countries such as Belgium and the USA, elective inductions account for a large proportion of all inductions (Cammu et al., 2002, Dublin et al., 2000). Elective inductions are generally performed to bring about birth at a time that is convenient to the woman, or to the health care providers, for example during the daytime when more administrative staff are available (Cammu et al., 2002, Dublin et al., 2000, Rayburn and Zhang, 2002).

Over the past decades use of induction in labour has been increasing worldwide, and it is now a common procedure performed in obstetric care. In the most recent NHS Maternity Statistics for England 2005-06, 20.2% of women were induced (Richardson and Mmata, 2007). Suggested reasons for the increased use of induction include; increasing availability of cervical ripening agents, medical liability from expectant management, and more relaxed attitudes towards elective inductions (Rayburn and Zhang, 2002). Although as discussed above, induction of labour is often performed to prevent foreseeable complications, induction can itself cause complications, particularly when the uterus and cervix are not ready for labour, which can in turn lead to the need for an assisted birth (Gulmezoglu et al., 2006). Complications arising from induced labours may be partly explained by the fact that uterine contractions after induced labour are often stronger and more painful than in spontaneous labour (National Institute for Health and Clinical Excellence, 2008b).

The majority of observational studies, which have discussed elective inductions have reported an increased risk of caesarean section for mothers who were induced, with risk estimates ranging from 1.37-2.7 (see Table A8.6). These studies typically adjusted for other maternal and birth factors, and found an independent significant effect of induction.

Numerous randomised controlled trials have examined induction of labour. A Cochrane review of RCTs by Gülmezoglu and colleagues (Gulmezoglu et al., 2006) compared pharmacological induction of labour with expectant management of labour (allowing pregnancy to progress naturally and labour to start spontaneously). Sub-groups of meta-analyses were conducted

according to completed weeks of gestation. Contrary to the results of the observational studies, women who had an induction at 37 to 40 completed weeks were at decreased risk of caesarean section compared to mothers who experienced expectant management. For mothers who gave birth at 41 and 42 weeks there was no significant difference in caesarean section rates between the induction and expectant management groups. A further Cochrane review by Boulvain and colleagues assessed the use of membrane sweeping for induction of labour (Boulvain et al., 2005). Membrane sweeping is a reasonably simple technique which is commonly tried before more formal pharmacological or surgical induction methods. During vaginal examination, a clinician introduces a finger to the opening of the cervix, separating the membranes from the lower uterine segment. The separation of the membranes has been shown to increase the local production of prostaglandins and therefore induce labour. Pooled estimates from the review indicated no significant difference in caesarean section rates between the membrane sweeping and control groups (Boulvain et al., 2005).

Only four studies specifically examined the relationship between induction of labour and instrumental births. One large Belgian matched cohort study compared 7,683 women who had an elective induction to 7,683 women who had spontaneous onset of labour (Cammu et al., 2002). Unadjusted rates indicated around a 10% increased risk of instrumental births for mothers who had an elective induction, compared to those who began labour spontaneously. Another large study from America examined the births of over 12,500 mothers and found that mothers who had an elective induction were at around a 20% increased risk of instrumental birth (Dublin et al., 2000). The Cochrane review by Gülmezoglu and colleagues also found an increased risk of instrumental birth for mothers who had an induction. The combined risk estimate from a meta-analysis of 10 RCTs examining instrumental birth indicated a 70% increase in risk for mothers who had an induction at term, compared to those in the expectant management group. However, sub-group meta-analyses at 41 and 42 weeks indicated no significant difference in instrumental birth rates between mothers in the induction and expectant management groups (Gulmezoglu et al., 2006). Boulvain and colleagues found no significant difference in rates of instrumental vaginal births between mothers randomised to membrane sweeping and those in the control group (Boulvain et al., 2005).

The evidence from both observational and experimental studies typically indicate that induction of labour increases the risk of instrumental birth. The effect on caesarean section rates however, is not consistent. Despite all evidence from observational studies demonstrating an increased risk of caesarean section for mothers who have induction of labour, combined results of randomised controlled trials (recognised as the gold standard in research terms) do not. In fact, for mothers at term, the pooled estimates from the meta-analysis of RCTs indicate a decreased risk of caesarean section for mothers who had an induction at term, compared to those who did not.

One hypothesis to explain the contradictory results could be related to methods in the observational studies. Labours induced for maternal or fetal medical reasons may be more likely to result in assisted birth due to the reasons for induction, rather than due to the induction itself. Therefore, studies observing an increase in interventions in birth for mothers induced for clinical reasons could falsely attribute this rise to the induction. The majority of observational studies focused solely on elective inductions however, or reported outcomes separately for women who had elective inductions and those who had inductions for clinical indication (medical induction). Studies which collected data retrospectively from hospital records did therefore rely on the accurate reporting of indication for induction. Seyb and colleagues (Seyb et al., 1999) assessed mothers who had either a medical or an elective induction. Women were classified as being electively induced if the indication was stated as elective, or if the indication did not meet pre-specified criteria for a medical induction (e.g. PROM was a pre-specified criterion). However, details of the elective induction sample reveal over 30% had an induction for other medical reasons, e.g. suspected pre-eclampsia and decreased amniotic fluid.

Cervical status before induction is important. If the cervix is more favourable at the time of induction it can increase the likelihood of the procedure being successful (Gulmezoglu et al., 2006). Yeast and colleagues compared the rates of caesarean section for women with favourable and unfavourable cervix. Among primiparous women with a favourable cervix induction the risk of caesarean section was 1.7 times that of women who entered labour spontaneously, but for women with an unfavourable cervix their risk was almost tripled (Yeast et al., 1999). Some observational studies and trials included in the 2006 Cochrane review did not account for cervical status.

Although RCTs are recognised as the gold standard in research, problems in the design and implementation of trial protocols can introduce bias and influence results. In the 2006 review by Gülmezoglu and colleagues, 18 induction trials report on caesarean section as an outcome (Gulmezoglu et al., 2006). However, sub-group meta-analyses by gestational age were reported in the review. For the meta-analysis indicating a decreased risk of caesarean section for women induced at term, only three trials were included in the sub-group, which were conducted at 37-40 weeks' gestation. On closer inspection of the three trials, which are heterogeneous in terms of design, problems with unclear randomisation procedure and lack of measurement of cervical status are apparent. In addition, the largest trial which provided most weight in the analysis had substantial crossover. Only 173 of 481 women in the induction group actually received an induction (Breart et al., 1982). The problems highlighted here indicate that a degree of caution should be taken when interpreting the result of a decreased risk of caesarean section for women induced at term from the review.

As inductions are commonplace, even a small increased risk of caesarean section or instrumental birth for induced women could significantly impact rates of assisted birth. It seems clear that more research is needed to clarify the relationship between induction and mode of birth. The 2004 NICE guidelines on caesarean section recommended that induction of labour should be offered beyond 41 weeks as it reduces the risk of caesarean section (National Institute for Health and Clinical Excellence, 2004b). This recommendation was made based on the 2003 version of the Cochrane review on induction of labour (Crowley, 2003), whereas the 2006 version found no significant difference in caesarean section rates between women in the induction and the expectant management group at 41 weeks (Gulmezoglu et al., 2006). The authors of the updated 2006 version of the induction review stated that they used more strict methodological criteria which excluded eight trials, and six new trials were added. In more recent guidelines for induction of labour, induction is still recommended beyond 41 weeks, but this is to reduce the risks associated with prolonged pregnancy (National Institute for Health and Clinical Excellence, 2008b).

8.4.3 Augmentation

Methods used to induce labour can also be used in order to accelerate already established labour (augmentation). Delays in labour, particularly in the second stage, can lead to operative intervention. Augmentation of labour is also a component of active management of labour, and will therefore be discussed further later in this chapter.

A Cochrane review of RCTs examined the use of amniotomy (or ‘breaking of the waters’) for speeding up contractions and therefore shortening labour (Smyth et al., 2007) (see Table A8.6). Across nine trials including over 4,000 women, there was no evidence of shortening of labour for the women in the amniotomy group compared to the women who did not have an amniotomy. Women in the amniotomy group had an increased risk of emergency caesarean section, although this did not reach statistical significance. Due to the possible increased risk of caesarean section, with no associated shortening of labour, the authors concluded that amniotomy should not be used routinely.

Wei and colleagues conducted a Cochrane review of studies where the experimental group were given early amniotomy and early oxytocin for delay, or prevention of delay, in the first stage of labour (Wei et al., 2009). Of the twelve studies, ten were ‘Prevention Trials’ including women in early spontaneous labour and two were ‘Therapy Trials’ including women with an established delay in labour. In contrast to the amniotomy review, women randomised to amniotomy and oxytocin were at a slightly reduced risk of caesarean section, although this was not statistically significant. The authors conducted stratified analyses by study type. For the two ‘therapy’ trials

amniotomy and oxytocin had no effect on caesarean section rates. However, with these studies excluded, results for the ten 'prevention' trials suggested a small reduction in caesarean sections for women in the early augmentation group. For instrumental vaginal births there was no evidence that early amniotomy and oxytocin had an effect on rates.

8.4.4 Epidural

Epidural anaesthesia provides the most effective form of pain relief during labour, involving blocking the central nerve by injecting local anaesthetic into the lower region of the spine (Anim-Somuah et al., 2005). Over the past decades the use of epidural has increased dramatically and it is now a commonly used method of pain relief during labour (Lieberman and O'Donoghue, 2002). In 2007-2008 over 17% of women had an epidural during labour and birth (Hospital Episode Statistics, 2009). Many health care professionals believe that the use of epidurals increases the likelihood of caesarean section (Tracy et al., 2007); however, there has been much debate over the issue (Lieberman and O'Donoghue, 2002). This debate has led to a great deal of research, both through observational studies and randomised controlled trials.

Among the literature from observational studies, a consistent relationship was found between epidural use in labour and increased risk of caesarean section, with risk estimates ranging from 1.3 to 48 times the risk compared to women who did not have an epidural (see Table A8.7). The reasons for the wide variation in risk estimates could be numerous. Different study populations, hospital rates of epidural use and caesarean sections, and management styles within the hospitals could all contribute. In a 2005 Cochrane review and meta-analysis of RCTs, Anim-Somuah and colleagues compared epidural to other forms of pain relief in labour (Anim-Somuah et al., 2005). In their review of twenty studies from several countries there was no statistically significant difference in the risk of caesarean section between the groups.

The evidence from observational studies suggests that epidurals increase the risk of caesarean section, whereas the meta-analysis of RCTs indicates that the use of epidurals in labour has no significant impact on caesarean section rates. These results draw attention to the ongoing debate regarding the relationship between epidural use and caesarean sections. In observational studies of epidural use it is not always clear that the epidural was given for pain relief during labour, rather than the purpose of the caesarean section. Not excluding mothers who had an epidural for the purpose of a caesarean section would make the risk of caesarean appear greater than in reality. However, in the literature review by Lieberman and O'Donoghue, observational studies were excluded which examined epidurals for the purpose of anaesthesia for caesarean section, and the included studies still showed an increased risk (Lieberman and O'Donoghue, 2002). Randomised

controlled trials are not immune to problems which could influence the result of a meta-analysis. In addition to heterogeneity between the studies in terms of populations and epidural regimen, some trials included in the 2005 Cochrane review had substantial crossover, where women randomised to receive no epidural did receive an epidural, and vice versa. Because analyses were conducted by intention to treat this does make the results more difficult to interpret (Anim-Somuah et al., 2005).

Timing of administration of epidurals has also been highlighted as key to their effect on caesarean section, and this has been suggested as a possible explanation for the lack of significant effect in the Cochrane review (Klein, 2006). Klein conducted a sensitivity analysis of the trials included in the 2000 version of the Cochrane review (Howell, 2000), excluding studies that randomised women in the active phase of labour (≥4cm cervical dilation). When the three trials where women were randomised in the active phase of labour were excluded, the odds ratio for the remaining studies in the meta-analysis was 2.59 (95% CI=1.29-5.23) (Klein, 2006). However, it should be noted that four trials remained in the analysis, with only 172 mothers in total.

Further research examining the timing of epidurals is clearly needed. As Cochrane reviews are regarded amongst the highest level of evidence their results can be very influential. The 2004 NICE guidelines for caesarean section state that epidural analgesia has no influence on the likelihood of caesarean section (National Institute for Health and Clinical Excellence, 2004b), and this conclusion is made partly based on the 2000 Cochrane review (Howell, 2000).

For instrumental births the literature is more consistent. Across observational studies an increased risk of instrumental birth for mothers who had an epidural was apparent, with risk estimates ranging from 1.3-9.4 (see Table A8.7). In addition, the 2005 Cochrane review and meta-analysis showed a 40% increased risk of instrumental births for mothers who had an epidural across the 17 included trials (Anim-Somuah et al., 2005).

A further Cochrane review by Torvaldsen and colleagues examined whether discontinuing epidurals late in labour has an effect on outcomes. The meta-analyses showed no significant differences in rates of caesarean section or instrumental births between groups who discontinued epidural in the late stage of labour, and those that continued. However, the discontinuation group were more likely to report inadequate pain relief (Torvaldsen et al., 2004).

8.4.5 Fetal heart rate monitoring

Monitoring of the fetal heart during labour is done with the aim of identifying if the baby is short of oxygen (fetal hypoxia). Fetal hypoxia can lead to death or long-term brain damage, including

cerebral palsy in infants. Along with many other interventions in the labour process, the use of fetal monitoring has increased since it was introduced widely in the UK in the 1970s, and it is now a common part of care during labour (Royal College of Obstetricians and Gynaecologists, 2001). Changes in heart rate influence the decision to intervene and deliver the baby either using instruments such as a vacuum extractor or forceps, or through caesarean section (Alfirevic et al., 2006).

Although fetal heart rate (FHR) monitoring was introduced with the aim of avoiding hypoxia-induced fetal deaths during labour, despite its long-term use, this has not been achieved (Alfirevic et al., 2006, Royal College of Obstetricians and Gynaecologists, 2001). Concerns have also been raised about the safety of fetal monitoring (Thacker et al., 1995), especially in relation to the interpretation of data from monitoring equipment (Gibb and Arulkumaran, 1997).

There are two main types of fetal monitoring; continuous electronic fetal monitoring (EFM) where electrodes are placed either externally on the mother's abdomen or internally on the fetal scalp and monitoring is continuous, and intermittent auscultation (IA) where the FHR is monitored occasionally with the use of either a fetal stethoscope or a hand-held Doppler ultrasound monitor (Alfirevic et al., 2006). A recent Cochrane review of RCTs by Alfirevic and colleagues included studies which compared continuous EFM to intermittent auscultation (Alfirevic et al., 2006) (see Table A8.8). The pooled estimate for 10 RCTs including around 30,000 women indicated that women who had continuous EFM were over 60% more likely to have a caesarean section and over 15% more likely to have an instrumental vaginal birth, than women who had intermittent auscultation. In addition, although continuous EFM was associated with a decreased risk of neonatal seizures, there was no decreased risk of perinatal death and no decrease in the occurrence of cerebral palsy. Meta-analyses were also conducted by risk status, with similar results for both women of low and high risk status.

It is likely that, the reason for the increased risk of caesarean section and instrumental birth associated with more continuous monitoring of the fetal heart is related to difficulties interpreting the FHR pattern. Monitoring the fetal heart is complicated by the fact that the heart rate can fluctuate naturally, particularly during contractions (Alfirevic et al., 2006). Studies assessing the reliability and validity of FHR monitoring have found substantial inter-observer and intra-observer variation in interpreting FHR tracings (Parer and King, 2000). Attempts have been made to define and assess when FHR patterns are normal and when they are abnormal, including the use of computerized systems used to develop algorithms and decision-making tools (Parer et al., 2009, Parer and King, 2000). However, despite much research, computerized systems have not been

shown to improve upon the interpretation of professionals (National Institute for Health and Clinical Excellence, 2007).

Additional tests such as fetal blood sampling (FBS) are available to assess if the unborn baby is truly compromised when a FHR reading is believed to be abnormal. The pooled risk estimates discussed earlier from the Cochrane review included five studies where the experimental group had FBS in addition to continuous EFM (Alfirevic et al., 2006). The authors of the review conducted separate analyses for mothers who had continuous EFM only, and found an even higher increased risk of caesarean section, with women who had continuous EFM at almost twice the risk compared to mothers who had intermittent auscultation. However, although the use of FBS alongside continuous EFM appears to be beneficial in reducing the risk of caesarean sections, in practice further diagnostic tests such as FBS are not always carried out.

Current NICE guidelines for intrapartum care recommend intermittent auscultation should be used for low-risk women, with auscultation for at least one minute every fifteen minutes (National Institute for Health and Clinical Excellence, 2007). However, in practice continuous EFM is used widely (Alfirevic et al., 2006), and interviews with UK midwives have revealed a tendency to apply continuous EFM, regardless of a woman's risk status (Hindley et al., 2006). A further finding from the interviews was that EFM was used as a substitute for the presence of a midwife on busy shifts, who would otherwise use their clinical skills to monitor fetal wellbeing (Hindley et al., 2006).

8.4.6 Active management of labour

Research on active management of labour was first published in 1969, spearheaded by Kieran O'Driscoll, a Clinical Professor at the National Maternity Hospital in Dublin (O'Driscoll et al., 1969). Active management of labour was proposed as a package of care allowing for control of labour, with the aim of shortening the labour process, particularly for primiparous women, who are known to have longer labours (O'Driscoll et al., 1969, O'Driscoll et al., 1973). Components of the active management package included:

- one-to-one continuous support from a nurse during labour;
- routine artificial rupture of the membranes (amniotomy);
- use of intravenous drug oxytocin to increase the frequency and intensity of uterine contractions;
- strict criteria for the diagnosis of labour;
- strict monitoring of the progress of labour (through plotting progress on a partogram);

- strict criteria for identifying slow progress and fetal compromise;
- peer review of assisted births.

Since its introduction, components of active management of labour, particularly amniotomy and early use of oxytocin, have become more widely used. Given that many caesarean sections are performed for 'failure to progress', an intervention with the potential to shorten labour could also possibly reduce caesarean sections. Due to the interventionist nature of some aspects of the package, active management has come under some criticism. Thornton and Lilford in 1994 published a review of research issues surrounding active management (Thornton and Lilford, 1994). Randomised controlled trials conducted on the separate components of active management up to that point (amniotomy, early oxytocin and both combined) had shown no statistically significant reduction in caesarean sections. Although, as pointed out by O'Driscoll in a response to the review, caesarean section rates were not a motivating factor when active management of labour was introduced, as rates of caesarean section were very low at the time (O'Driscoll, 1994).

More recently, two Cochrane reviews have been published regarding active management of labour (see Table A8.9). Brown and colleagues reviewed trials where the experimental group involved a package of care including more than two or all of the key elements of active management as described above (Brown et al., 2008). In all trials the comparison group was routine care. Seven studies from a variety of countries were included in the review. A meta-analysis indicated a reduced risk of caesarean section for women randomised to the active management group, but this was not statistically significant. For instrumental births there was no significant difference between the two groups.

Wei and colleagues conducted a similar review, but focused on studies where the experimental group were given early amniotomy and early oxytocin for delay, or prevention of delay, in the first stage of labour (Wei et al., 2009) (see more detailed description in 'augmentation' section). In addition to the seven studies included in the review by Brown and colleagues (Brown et al., 2008), five more studies were included. Women randomised to amniotomy and oxytocin were at a slightly reduced risk of caesarean section, although this was not statistically significant. For instrumental vaginal births there was no evidence that early amniotomy and oxytocin had an effect on rates.

Studies assessing the efficacy of a package of care can be problematic. In the two main reviews discussed here, and particularly for the Brown and colleagues review, there was substantial heterogeneity between the study interventions, with different studies adopting different components of the active management package, with doubtless differences in routine care comparison groups also, which were often not described. The problem arises when trying to establish what aspects of

the management package are effective, or whether they exert a combined effect. Although Wei and colleagues attempted to standardise their experimental groups by only including studies which adopted early amniotomy and early oxytocin, studies differed in the timing of these interventions, the routine care received by the control group and in addition, three trials included more components of active management. Exclusion of the three trials which included additional components did not affect risk estimates however.

In the aforementioned 1994 review, Thornton argued against the use of active management, as RCTs conducted at that point in time did not indicate a reduction in caesarean section for individual components of the package. The only evidence of a significant reduction in caesarean sections had been for support during labour (Thornton and Lilford, 1994).

8.4.7 Support during labour

The benefits of one-to-one support during labour have been well documented, with research from qualitative and quantitative studies suggesting a variety of positive outcomes for women who are well supported. The benefits of support include birth outcomes such as reduced length of labour (Klaus et al., 1992, Klaus et al., 1986, Langer et al., 1998, Scott et al., 1999, Sosa et al., 1980) and a decreased need for pain relief (Hodnett et al., 2007, Scott et al., 1999). For the mothers, additional benefits include increased satisfaction and increased perception of the birth as a positive experience (Hodnett et al., 2007, Hofmeyr et al., 1991, Klaus et al., 1992, Langer et al., 1998, Tarkka and Paunonen, 1996, Zhang et al., 1996), and there has also been a link to increased breast feeding (Hofmeyr et al., 1991, Klaus et al., 1992, Langer et al., 1998, Zhang et al., 1996).

When childbirth moved from home to hospital, many traditional childbirth practices were lost or altered, including companionship in labour. In the past it was common for a woman to be supported by other women (Lozoff et al., 1988). Currently, in the UK context, most fathers now attend the birth of their baby (Somers-Smith, 1999). However, support during labour can be provided by a variety of individuals; including the partner, a family member or friend. A midwife can also provide support to a woman during labour. However, in practice, due to shortages of staff and busy labour wards, many midwives are frequently caring for more than one woman at a time, impeding their ability to provide continuous support (Page, 2003).

Recently, media attention regarding midwife shortages has made reference to the use of doulas (Campbell, 2009). A doula is a woman experienced in childbirth who provides continual physical, emotional and informational support to women before, during and just after birth (Langer et al., 1998). Although doula care is more popular in America (Trainor, 2002), there has been increased

interest in doula care in the UK (Campbell, 2009). In the UK, women can pay for doula care during the antenatal, intrapartum and postnatal periods. Doula UK was established in 2001 as a network of doulas, allowing women to find a doula local to them (Doula UK, 2005). There has also been government recognition of doula care as more recently, in 2008, the Department of Health provided funding for a project providing volunteer doulas for deprived women (Goodwin Development Trust, 2009).

Literature from both observational and experimental studies has consistently shown fewer caesarean sections for mothers who are supported during labour (Table A8.10). In a previous research project, I conducted a study utilising data from the Millennium Cohort Study to explore which women were more likely to be unaccompanied during labour (other than by health staff), and to examine the consequences of being unaccompanied. Those who did not have a companion were more likely to be single, multiparous women from more disadvantaged backgrounds and they were at an increased risk of emergency caesarean section, amongst other outcomes, compared to mothers who reported that they were accompanied (Essex and Pickett, 2008). A Cochrane review of RCTs compared women who were randomised to receive continuous one-to-one care during labour from a health professional or lay person (including doulas, childbirth educators, retired nurses and female relatives or friends), with women who received routine care. Despite heterogeneity between the studies in terms of country and support provider, data from over 13,000 women across 16 trials indicated a moderate but significant reduction in both caesarean sections and instrumental births (Hodnett et al., 2007).

It seems plausible that supporting a woman during her labour and birth can reduce the need for medical intervention. In qualitative studies, mothers describe how a support partner can act as a distraction from pain (Bowers, 2002, Campero et al., 1998). If women are more able to cope with pain they are less likely to need pain relief such as an epidural, and they may also be less likely to encounter a cascade of events as described at the beginning of this section, concluding with an instrumental birth or caesarean section. Theoretical explanations for the link between support and outcomes suggest that support reduces the reliance on medical technology by enhancing the physiology of labour, and increasing a woman's sense of control (Hodnett et al., 2007). Furthermore, health professionals could modify their behaviour regarding interventions, as they are aware they are being observed by a paraprofessional etc.

Support during labour may act as a buffer against the need for some obstetric interventions. Because of these beneficial associations, the importance of the support provided for a woman during labour has received growing interest. In fact, in the recent NICE guidelines for intrapartum care, support in labour was highlighted as a key priority, with recommendations that women should

receive supportive one-to-one care and that women in established labour should not be left on their own, except for short periods of time (National Institute for Health and Clinical Excellence, 2007).

8.5 Conclusions

Over the years, changing childbirth practices and organisation of maternity care in the UK have led to the centralisation of maternity services. Consequently, most women are giving birth in hospitals, on consultant-led wards. In addition, many interventions are routinely used in intrapartum care, demonstrating the medicalisation of birth and an increasing reliance on technology. Research has demonstrated that some labour interventions can increase the risk of caesarean section or instrumental birth.

Rates of caesarean section and instrumental births vary widely across maternity units. Midwife-led and birth centre care models appear to improve outcomes, with lower rates of caesarean section and instrumental vaginal birth. However, as these models of care are very different from conventional hospital care, it is difficult to disentangle what is causing better outcomes. Additionally, birth centres are rare, and are not suitable for all women, e.g. women at a high risk of complications in labour.

What is common to both birth centre and midwife-led care is the aim of providing continuous support during labour. As birth centres and midwife-led units are generally small, midwives may be more able to provide one-to-one care than their counterparts working in conventional hospital units, who are more likely to be caring for more than one woman at a time. Hodnett and colleagues' review highlights the benefits of one-to-one support during labour, including a reduction in caesarean sections and instrumental vaginal births, across a range of settings (Hodnett et al., 2007). The review also highlights that support during labour does not need to come from a health professional, but that benefits of one-to-one support are observed from lay persons. Midwives should be aware of how the support they provide to women has the potential for short-term and long-term impact. Women should also be informed of the benefits of support so that they can bring a suitable support partner with them, which could be especially important on busy labour wards. My earlier research with the Millennium Cohort Study has demonstrated that around 5% of UK women may not have a support partner with them during labour, and that these women are generally from a more disadvantaged background and at risk of poorer outcomes (Essex and Pickett, 2008).

8.6 Research questions

- What are the characteristics of the women in the MCS who did not attend antenatal care compared with those who attended (a) antenatal care only or (b) both antenatal care and antenatal classes?
- What is the effect of antenatal care/class attendance on mode of birth, after adjusting for predictors of antenatal attendance?

CHAPTER 9: The Millennium Cohort Study: Antenatal care and mode of birth

9.1 Background

Few studies have investigated the relationship between antenatal care (and/or classes) and birth outcomes, including mode of birth (see further discussion of literature in Chapter 8). However, the modest quantity of literature which has examined this relationship has predominantly indicated a surprising result; that women who do not attend antenatal care are at a *decreased* risk of caesarean section (Behague et al., 2002, Braveman et al., 1995, Gareen et al., 2003, Gissler and Hemminki, 1994, Gomes et al., 1999, Simoes et al., 2005, Petrou et al., 2003). Many of these studies were simply adjusting for antenatal care as a covariate when examining risk factors for mode of birth (Braveman et al., 1995, Gareen et al., 2003, Gomes et al., 1999). In addition, there is some evidence, although weaker than that for antenatal care, that women who receive more education antenatally are at a higher risk of caesarean section (Gunn et al., 1983, Sturrock and Johnson, 1990). Because only a small number of studies have investigated the association between antenatal care and mode of birth, and because some of the studies which have, did not explicitly set out to do so, the unusual relationship appears to have been largely overlooked in previous literature.

As the aforementioned studies used observational data, there are issues regarding selection bias when interpreting their results, as women who choose to attend antenatal care or classes are likely to be different to those who do not. In fact, studies have shown that women who receive little antenatal care are more likely to be from disadvantaged backgrounds in terms of age, socio-economic position and ethnicity (Healthcare Commission, 2008, Rowe and Garcia, 2003), and that these women are also less likely to attend antenatal classes (Cliff and Deery, 1997, Fabian et al., 2004), or to find them beneficial if they do attend (Fabian et al., 2005). We know from the extensive literature described in Chapter 2 that many of these characteristics are also related to mode of birth.

The previous literature examining the relationship between antenatal care and mode of birth has, in most cases, adjusted for these types of covariates. However, it is possible that in previous studies there were unmeasured differences between women who attended antenatal care and non-attenders, and that these differences confounded the relationship between antenatal care and mode of birth.

There has also been little research done to identify the characteristics of women who do not receive any antenatal care, mainly due to the difficulties of identifying women who do not access care. The Infant Feeding Survey from 2000 found that around 2% of women in their UK survey had not attended antenatal care (Hamlyn et al., 2002). The retrospective nature of the questions regarding antenatal care in the MCS provides a distinct opportunity to assess the characteristics of women who reported receiving no antenatal care, and to explore what happens to them during labour and birth.

9.2 Antenatal care in the MCS

To assess the antenatal care women received, the responses (yes or no) to the following MCS questions were examined;

- *When you were pregnant with [baby name], did you have any antenatal care from a midwife, your GP or at a hospital?*
- *Did you attend any antenatal classes?*

For the purposes of the analyses the variables were combined as described in Chapter 3 resulting in a variable with three categories; (1) received care and attended classes, (2) received care but did not attend classes and (3) did not receive any care.

9.3 Unadjusted analyses with mode of birth

Figures 9.1 and 9.2 display rates of different modes of birth according to women's receipt of antenatal care (frequencies and percentages are detailed in Table A9.2). In agreement with some of the previous literature described above and in Chapter 8, results for both primiparous and multiparous mothers indicated that when compared to mothers who received antenatal care and attended classes, mothers who did not receive antenatal care or did not attend classes were at a decreased risk of having a caesarean section or an instrumental birth. Chi squared analyses indicated that the relationship was significant for primiparous mothers ($p<0.001$) and of borderline significance for multiparous mothers ($p=0.05$).

As can be seen in Figures 9.1 and 9.2, some women who reported having no antenatal care also reported having a planned caesarean section. As a planned caesarean section would be organised during the antenatal period during a consultation between a woman and a health care professional, this result appears to be an anomaly, and will be examined further in the discussion at the end of this chapter.

Figure 9.1: Mode of birth according to level of antenatal care for *primiparous* mothers

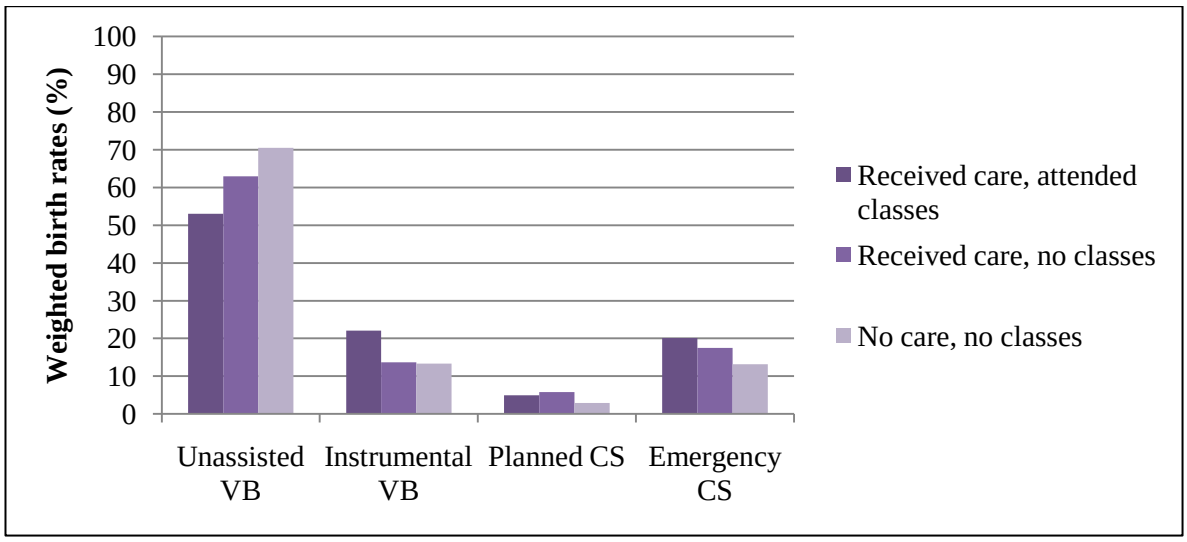
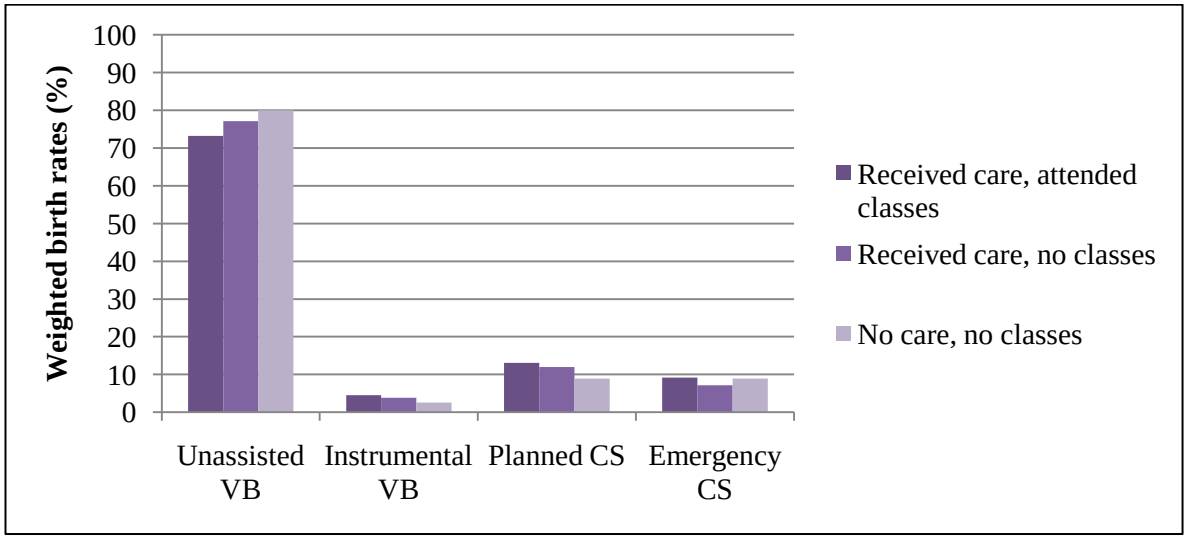


Figure 9.2: Mode of birth according to level of antenatal care for *multiparous* mothers



9.4 Analytical methods

The backgrounds of women who did or did not receive antenatal care or attend classes were explored by examining a variety of demographic characteristics including socio-demographic, socio-economic, psychosocial and pregnancy-related factors. In addition, as previous research has suggested that the association between antenatal care attendance and higher rates of operative births could be due to high-risk women being more likely to attend antenatal care (Gissler and Hemminki, 1994), differences in pregnancy complications between antenatal groups were also assessed. Unweighted frequencies and weighted percentages are presented, stratified by parity, and all unadjusted analyses were tested for significance using chi squared tests.

To identify the important characteristics which predict attendance at antenatal care and antenatal classes, characteristics found to be significant in the unadjusted analyses were modelled together within each domain in multinomial logistic regression models. Domains with only one covariate, e.g. psychosocial, were not modelled. For example, ethnicity, first language and migration status were modelled together to see which factors were independently and significantly related to antenatal attendance. Characteristics found to be significantly related to antenatal attendance from each domain were added into a final model. Figures 9.3 and 9.4 display models for primiparous and multiparous mothers.

Birth weight and gestational age were assessed for each antenatal group (see Table A9.8). Women who give birth before term may not be able to attend classes scheduled late in the third trimester. Also, women from more disadvantaged backgrounds are more likely to have preterm or low birth weight infants, both of which are related to mode of birth. Labour events across antenatal groups were also investigated (Table A9.9); including induction of labour, complications during labour and length of labour.

Maternal factors found to be important in predicting antenatal care and class attendance in the final models from Tables A9.4 through A9.7 were included as covariates in adjusted models assessing antenatal care in relation to mode of birth. Interactions between maternal factors and antenatal care were also explored in relation to mode of birth, with any significant interactions were also controlled for. Additionally labour and infant factors found to be significantly different between antenatal groups were also controlled for.

9.5 Results

The characteristics of mothers according to their antenatal care are presented in Table A9.3. Results were stratified by parity as first-time mothers were much more likely to receive care and attend classes (67.5% of first-time mothers) than multiparous mothers (14.5%).

9.5.1 Receipt of antenatal care; unadjusted characteristics of mothers

Mothers who were younger at the time of birth and at age at first birth (for multiparous mothers) were more likely to have received no antenatal care. Non-White women and especially those of Pakistani or Bangladeshi origin, non-English speaking mothers and mothers who were not born in the UK were more likely to have received no antenatal care. Rates of non-attendance at antenatal care were also higher among women of lower socio-economic position as measured by educational level and social class. Mothers who did not receive antenatal care were also more likely to have

been unhappy or not bothered when they discovered they were pregnant, to have not planned the pregnancy and to have smoked during the pregnancy. Additionally, they were more likely to have reported having no medical complications during the pregnancy.

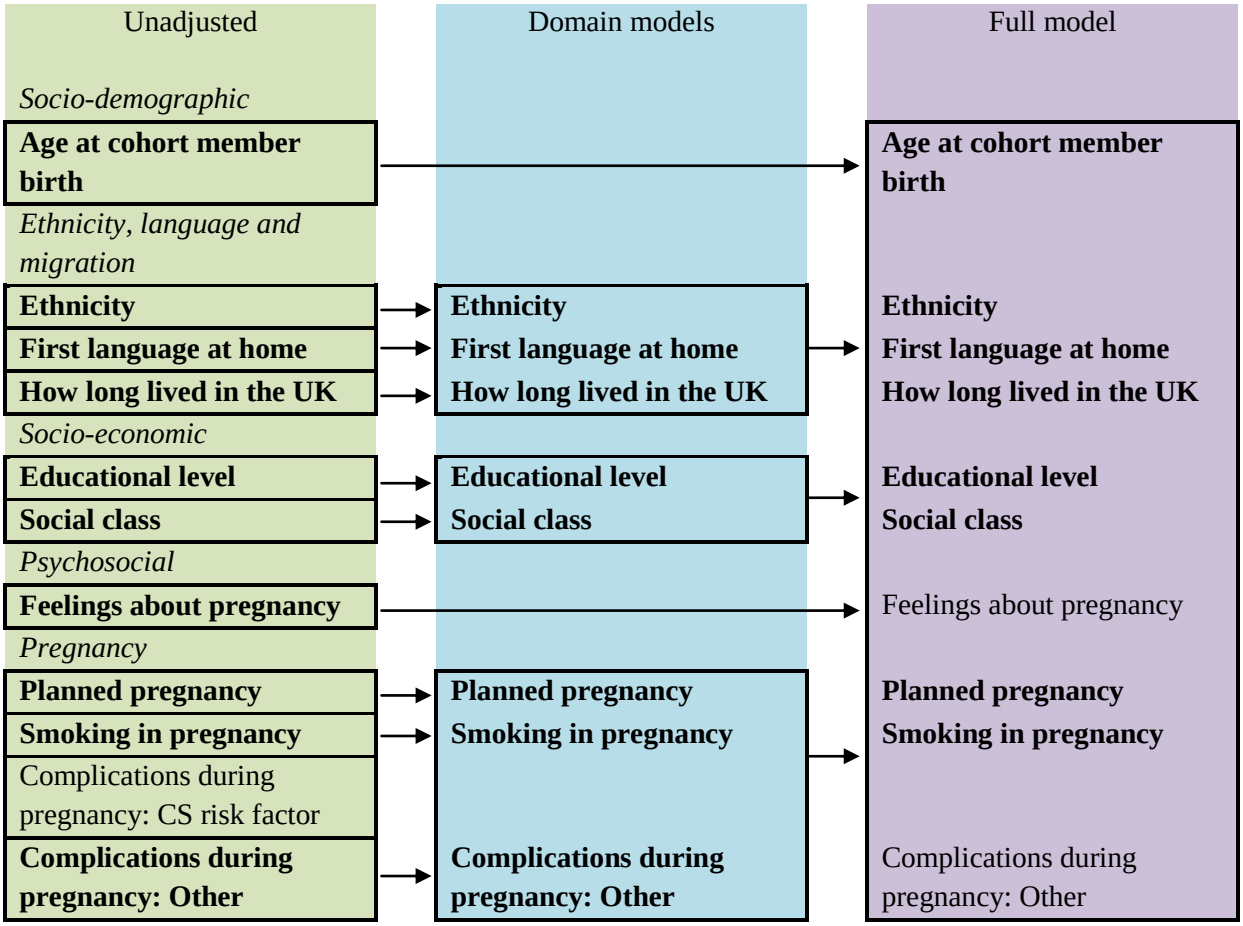
9.5.2 Class attendance; unadjusted characteristics of mothers

Similar factors predicted non-attendance at classes as predicted non-receipt of antenatal care. For example, Pakistani and Bangladeshi mothers were very unlikely to attend classes; among primiparous mothers only 24% of Pakistani and Bangladeshi mothers attended classes compared to 69% of White mothers. Socio-economic status was again highly related to class attendance; over 90% of primiparous women with degree level equivalent qualifications attended classes compared to less than 30% of women who had no qualifications. Similarly, around 90% of women in the highest social class band attended classes compared to 38% in the lowest. Women who smoked during pregnancy were much less likely to attend classes. Among primiparous women who smoked heavily during pregnancy less than 38% attended classes, whereas over three-quarters of women who had never smoked attended classes.

9.5.3 Antenatal care and class attendance; independent predictors

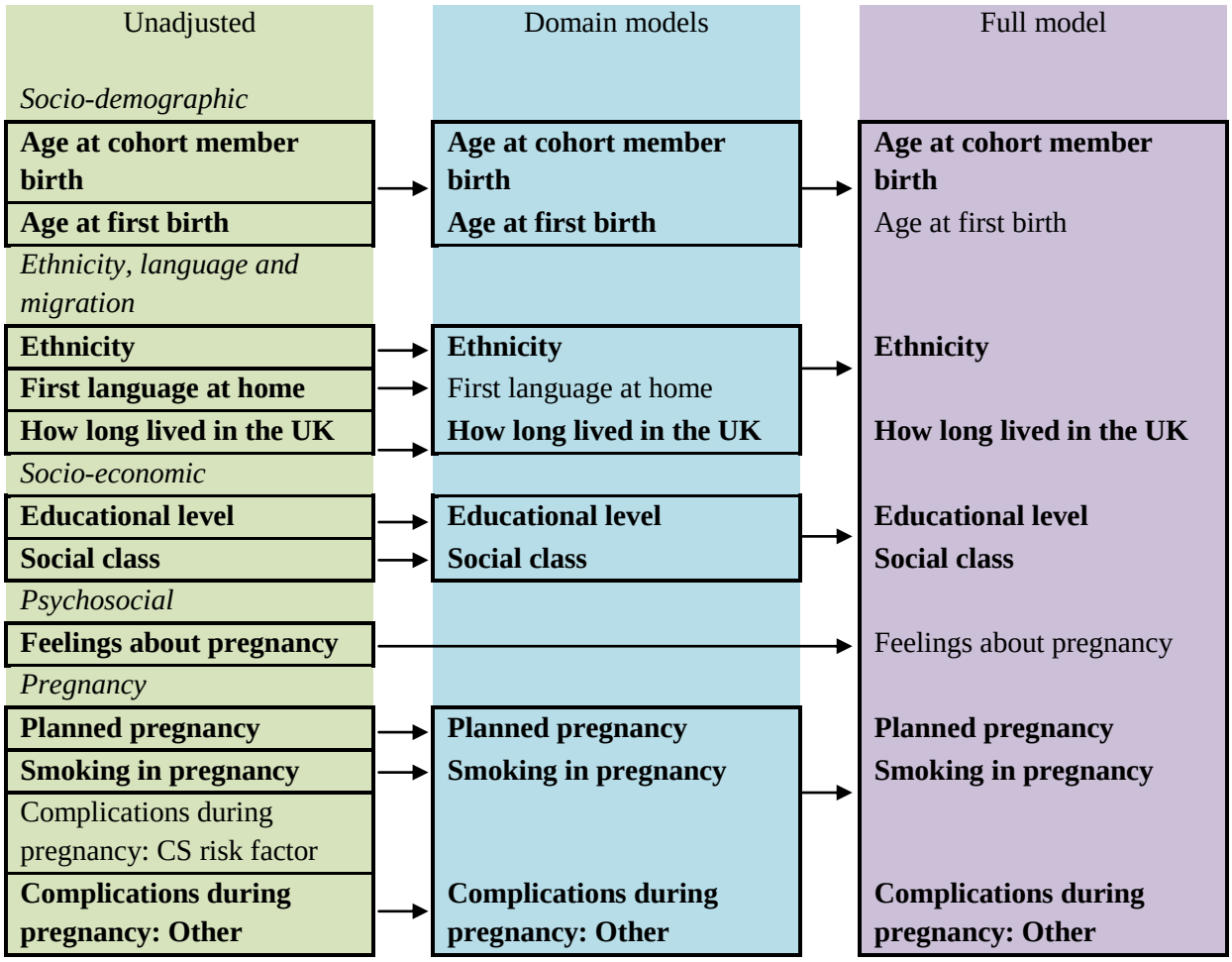
Figures 9.3 and 9.4 summarise the way in which maternal characteristics were modelled in order to establish the independent predictors of antenatal care.

Figure 9.3: Summary of the characteristics of *primiparous* women examined in relation to antenatal care: the significant predictors and the models built for statistical adjustment



Factors in **bold** were significantly related to antenatal care

Figure 9.4: Summary of the characteristics of *multiparous* women examined in relation to antenatal care: the significant predictors and the models built for statistical adjustment



Factors in **bold** were significantly related to antenatal care

Tables A9.4 and A9.5 present models for the characteristics of primiparous women who received different levels of antenatal care (received care and attended classes, received care but did not attend classes or did not receive care), and Tables A9.6 and A9.7 present similar models for multiparous women. For primiparous women, regression models included women who received care and attended classes as the comparator group, as over 67% of primiparous women were in this group. Multiparous women, however, were much less likely to attend antenatal classes for their later pregnancy, therefore the comparator group for the multiparous women was those who received care but did not attend classes (which included over 82% of these women).

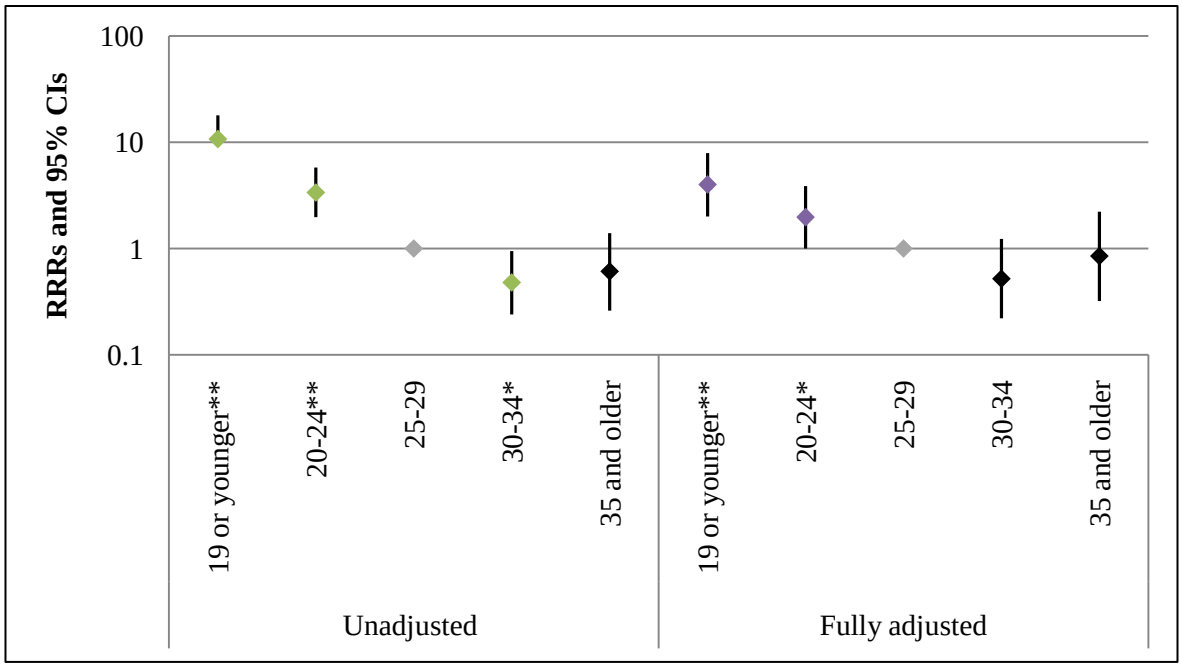
9.5.4 Primiparous women who did not receive antenatal care

Results from the multinomial logistic regression models are presented in Table A9.4. Women who received care and attended classes were the base comparator.

9.5.4.1 Age at birth

Primiparous women who were young were much more likely to receive no antenatal care compared to those aged 25-29 (e.g. fully adjusted RRR for women aged 19 or younger=4.00, p<0.001, see Figure 9.5).

Figure 9.5: The effect of maternal age on non-receipt of antenatal care for primiparous women



**p<0.001 *p<0.05

9.5.4.2 Ethnicity, language and migration

Pakistani or Bangladeshi mothers were at an increased risk of not receiving antenatal care. The association was strong with Pakistani or Bangladeshi mothers, more than 6 times more likely not to have received antenatal care than White women (RRR=6.25, p<0.001).

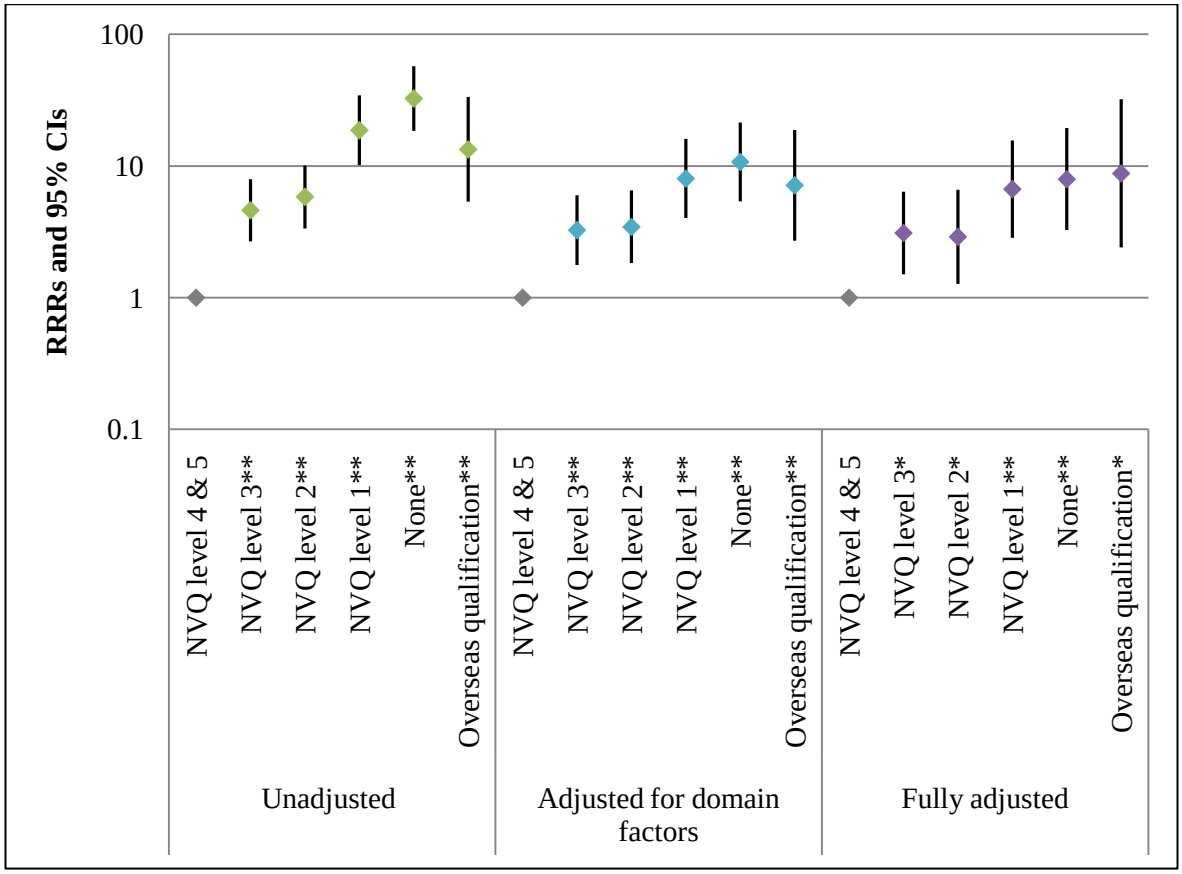
Compared to women who had lived in the UK since birth, women who had migrated to the UK more than five years prior to interview were twice as likely to have received no antenatal care (fully adjusted RRR=2.44, p<0.05), although having lived in the UK for less than five years was not related to receipt of antenatal care after adjustment (RRR=0.71, p=0.54). Although having a

non-English first language appeared to increase the risk of receiving no antenatal care in unadjusted analyses, when fully adjusted, language was not related to antenatal care attendance.

9.5.4.3 Socio-economic status

Lower educational level notably increased the risk of primiparous women not receiving antenatal care. Although the risk was attenuated in the fully adjusted model (see Figure 9.6) the significant association remained (e.g. fully adjusted RRR=7.95, p<0.001 for women with no qualifications compared to degree-qualified women). Although lower social class was similarly associated with non-receipt of antenatal care in the unadjusted and domain model, when adjusted for all other significant maternal factors in the full model, social class was not significantly related to receipt of antenatal care.

Figure 9.6: The effect of educational level on non-receipt of antenatal care for primiparous women



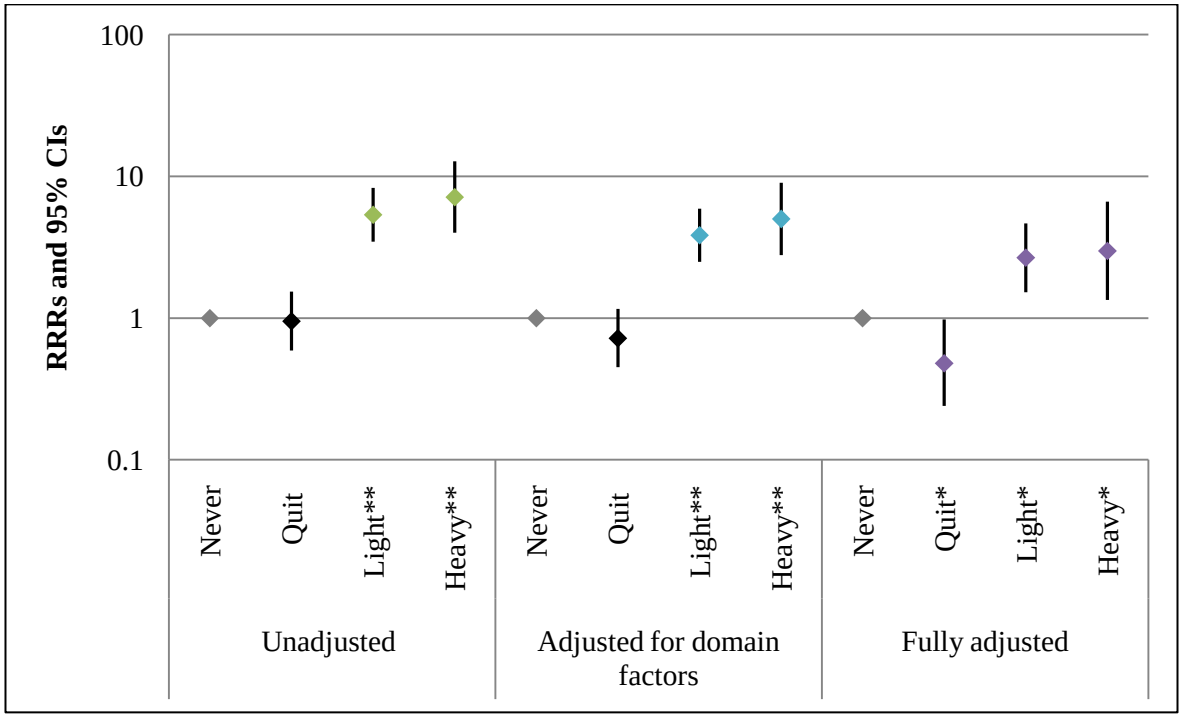
**p<0.001 *p<0.05

9.5.4.4 Smoking in pregnancy

Women who smoked during pregnancy were much more likely to have received no antenatal care (see Figure 9.7). In fact mothers who smoked heavily were more likely to have received no

antenatal care than mothers who were light smokers (unadjusted RRR=5.36, p<0.001 for light smokers and RRR=7.15 for heavy smokers compared to non smokers). Although the strength of the association attenuated with adjustment for other pregnancy factors, and more so when fully adjusted, there remained a significant effect with mothers who smoked during pregnancy being more than twice as likely to not receive antenatal care (fully adjusted RRR=2.67, p<0.05 for light smokers and RRR=2.98, p<0.05 for heavy smokers compared to non smokers). In addition, in the fully adjusted model, women who quit smoking in pregnancy were *more* likely to have received antenatal care than women who had never smoked (fully adjusted RRR=0.48, p<0.05).

Figure 9.7: The effect of smoking during pregnancy on non-receipt of antenatal care for primiparous women



**p<0.001 *p<0.05

9.5.4.5 Other pregnancy factors

Feelings about the pregnancy, whether the pregnancy was planned and complications during pregnancy were unrelated to receipt of antenatal care when fully adjusted for other maternal factors.

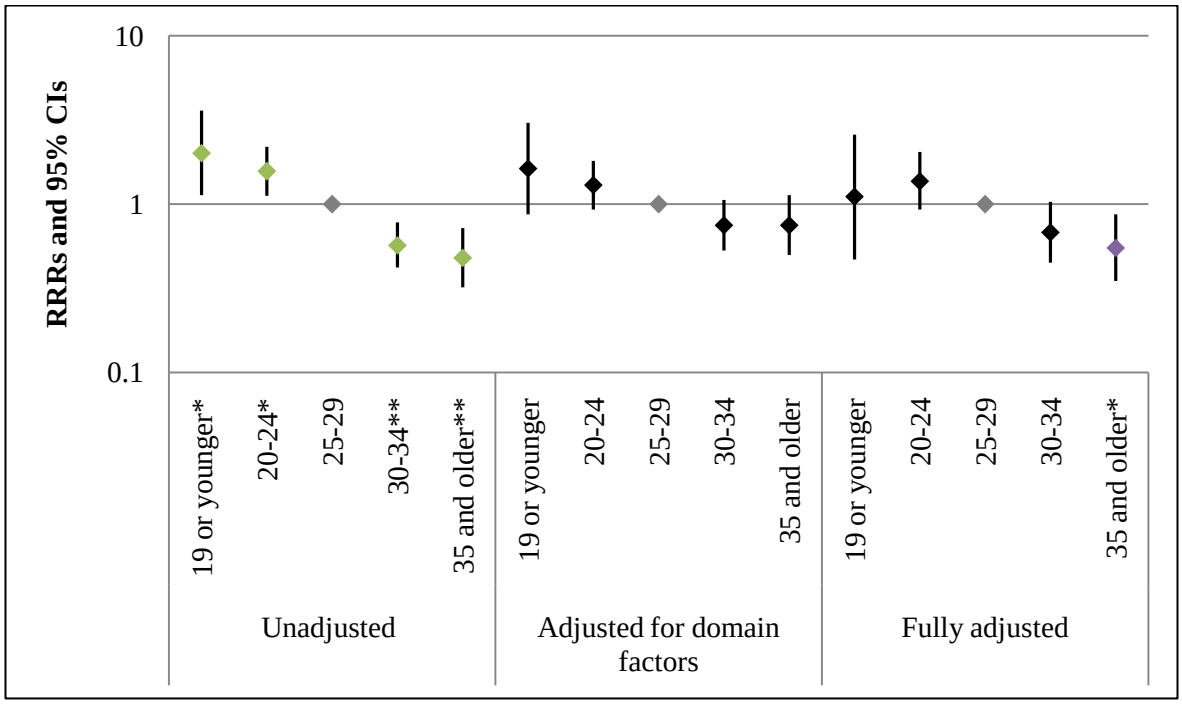
9.5.5 Multiparous women who did not receive antenatal care

Results from the multinomial logistic regression models are presented in Table A9.6. Women who received antenatal care but *did not* attend classes were the base comparator.

9.5.5.1 Maternal age

In the fully adjusted model, women who were 35 or older at the cohort birth were less likely to be non-attenders to antenatal care than women in their late twenties (RRR=0.55, p<0.05, see Figure 9.8). Age at first birth was not a significant predictor of multiparous women not receiving antenatal care, once other maternal factors were adjusted for.

Figure 9.8: The effect of maternal age on non-receipt of antenatal care for multiparous women

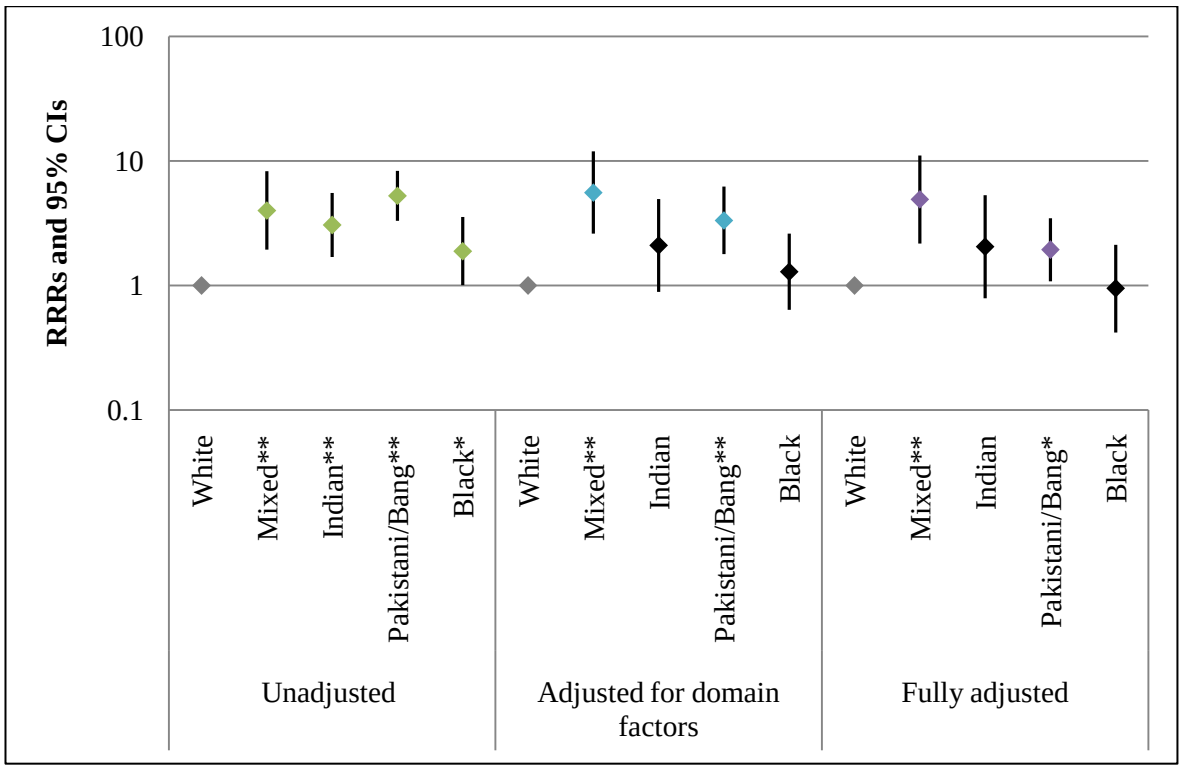


**p<0.001 *p<0.05

9.5.5.2 Ethnicity, language and migration

In unadjusted analyses, all non-White mothers appeared to be at higher risk of not receiving antenatal care; however, after adjustment for other maternal factors, only mothers of Mixed ethnicity and Pakistani/Bangladeshi women were at higher risk of not receiving care (fully adjusted RRR=4.92, p<0.05 for Mixed ethnicity and RRR=1.94, p<0.05 for Pakistani/Bangladeshi women, see Figure 9.9).

Figure 9.9: The effect of ethnicity on non-receipt of antenatal care for multiparous women



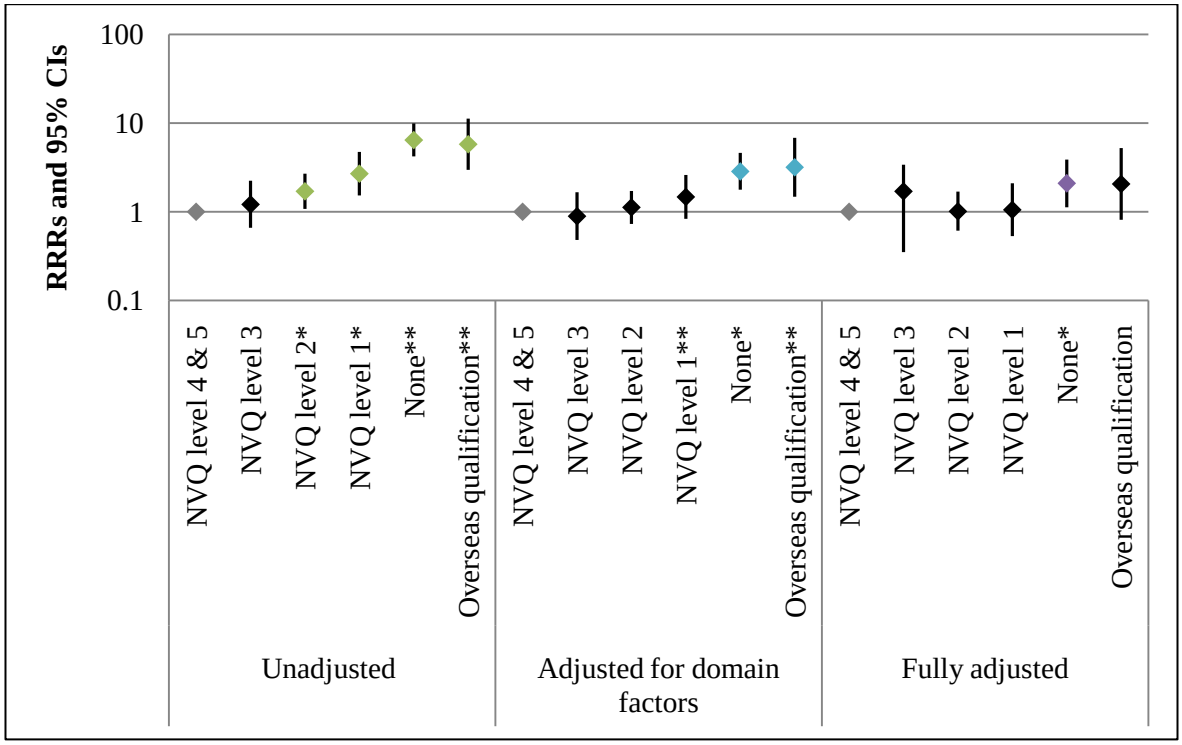
**p<0.001 *p<0.05

Language spoken at home was not related to the likelihood of receiving antenatal care when adjusted for other maternal factors, but mothers who had migrated to the UK over five years prior to interview were over twice as likely as a UK-born mother to have received no antenatal care (fully adjusted RRR=2.47, p<0.05).

9.5.5.3 Socio-economic status

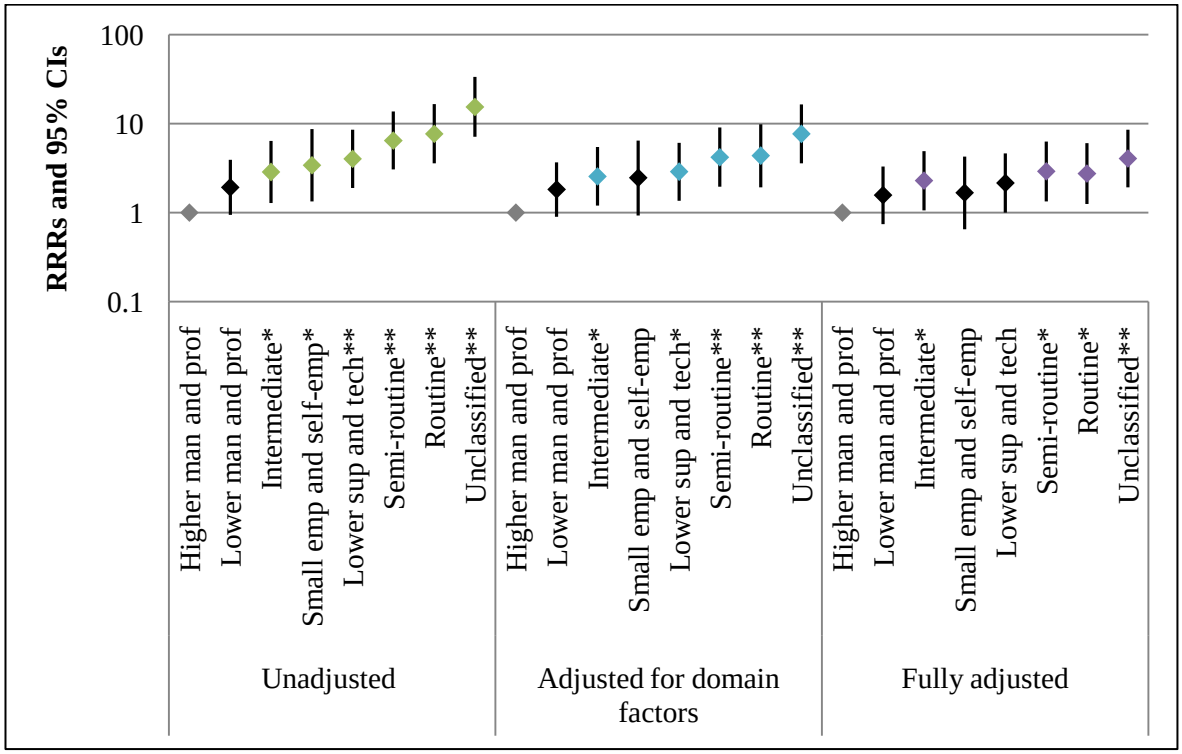
In unadjusted analyses, mothers with lower educational qualifications and of lower social class were more likely to have received no antenatal care. When fully adjusted for other maternal factors, social class remained a significant predictor of women receiving antenatal care (see Figure 9.11), with mothers in the lowest social class bands over twice as likely to have not received care and mothers who were unclassified being almost 4 times more likely (RRR=2.91, p<0.05 for semi-routine; RRR=2.75, p<0.05 for routine and RRR=4.07, p<0.05 for unclassified occupation compared to mothers from households where the highest occupation was higher managerial and professional). For educational level, mothers with no qualifications remained over twice as likely to have not received care (fully adjusted RRR=2.09, p<0.05, see Figure 9.10).

Figure 9.10: The effect of educational level on non-receipt of antenatal care for multiparous women



**p<0.001 *p<0.05

Figure 9.11: The effect of social class on non-receipt of antenatal care for multiparous women

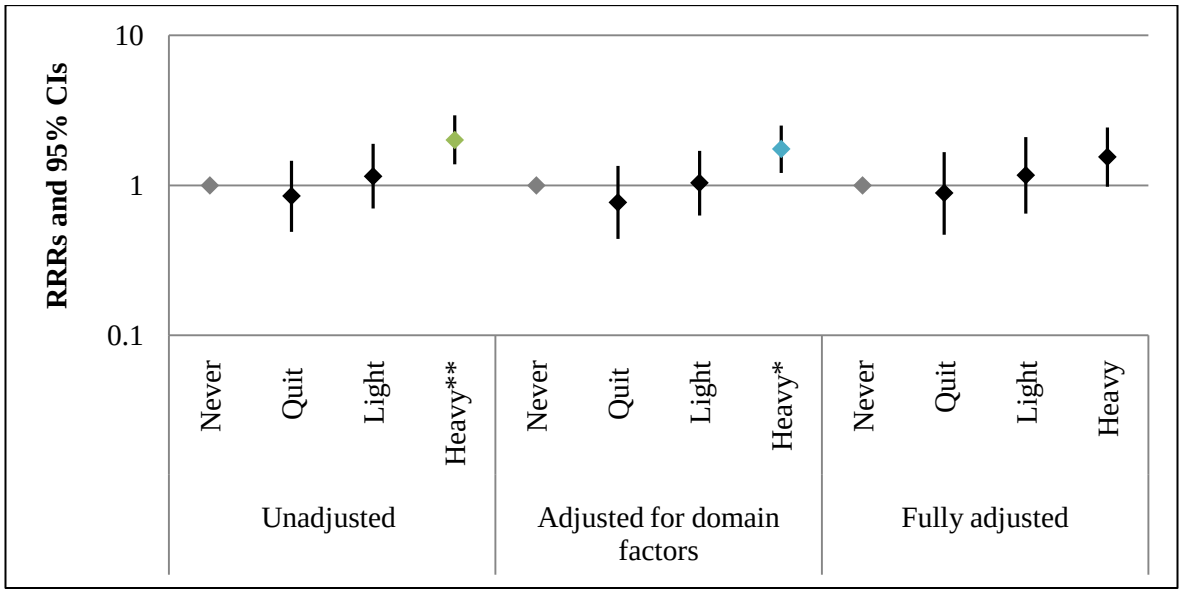


**p<0.001 *p<0.05

9.5.5.4 Smoking during pregnancy

In contrast to primiparous women, for whom there was a gradient of decreasing likelihood of having received antenatal care with increasing smoking, only multiparous women who smoked heavily during pregnancy were more likely to have received no antenatal care, and the result was of borderline significance (fully adjusted RRR=1.55, p=0.06, see Figure 9.12).

Figure 9.12: The effect of smoking during pregnancy on non-receipt of antenatal care for multiparous women



**p<0.001 *p<0.05

9.5.5.5 Other pregnancy factors

Women who experienced problems during pregnancy other than those that have been linked to caesarean section were more likely to have *received* antenatal care. Adjustment for maternal factors altered the reduced risk only slightly (unadjusted RRR 0.44, p<0.001 and fully adjusted RRR=0.43, p<0.001).

Mothers' feelings about pregnancy and whether the pregnancy had been planned were unrelated to the likelihood of receiving antenatal care for multiparous women.

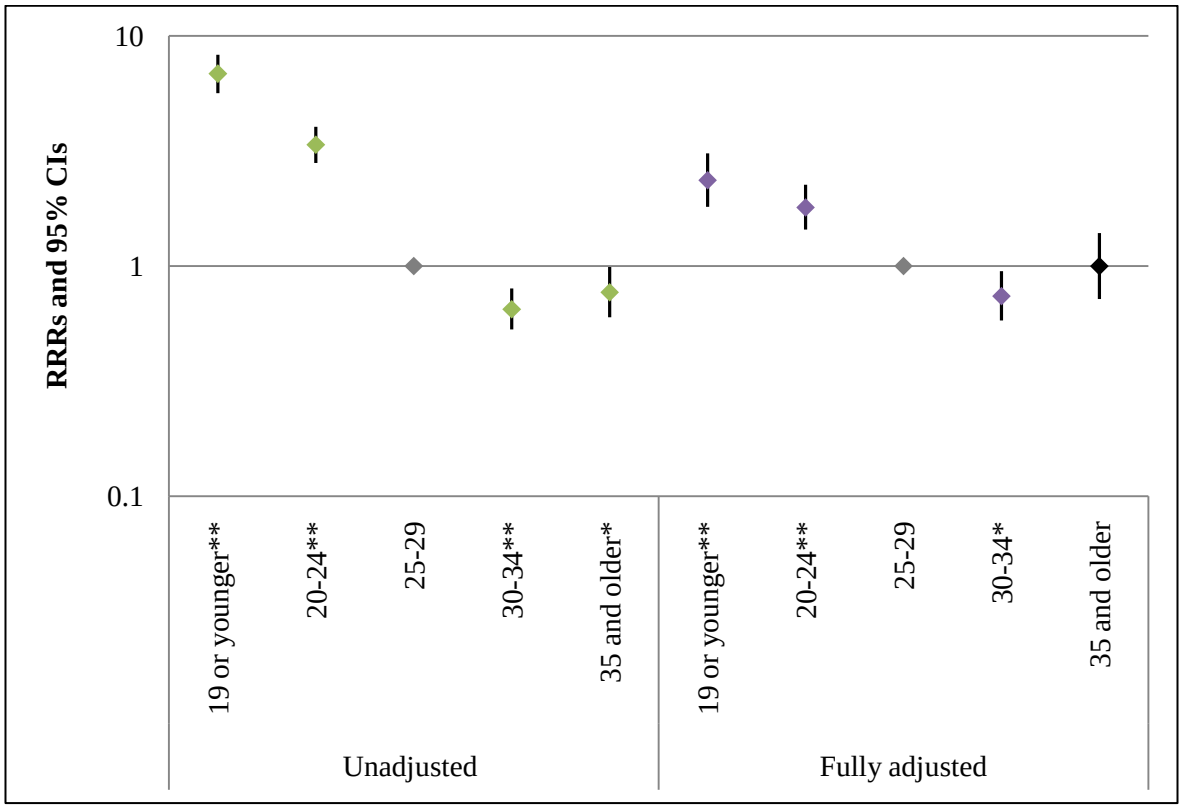
9.5.6 Primiparous women who received care but *did not* attend classes

Results from the multinomial logistic regression models are presented in Table A9.5. Women who received care and attended classes were the base comparator.

9.5.6.1 Maternal age

Figure 9.13 shows the effect of maternal age on attendance at classes among first-time mothers. The likelihood of women not attending classes increased with decreasing age. Although the risks were attenuated when fully adjusted, the decreased attendance with decreasing age remained. For example, teenage women were still over twice as likely to not attend compared to women in their late twenties (fully adjusted RRR=2.36, p<0.001).

Figure 9.13: The effect of maternal age on non-attendance at antenatal classes for primiparous women

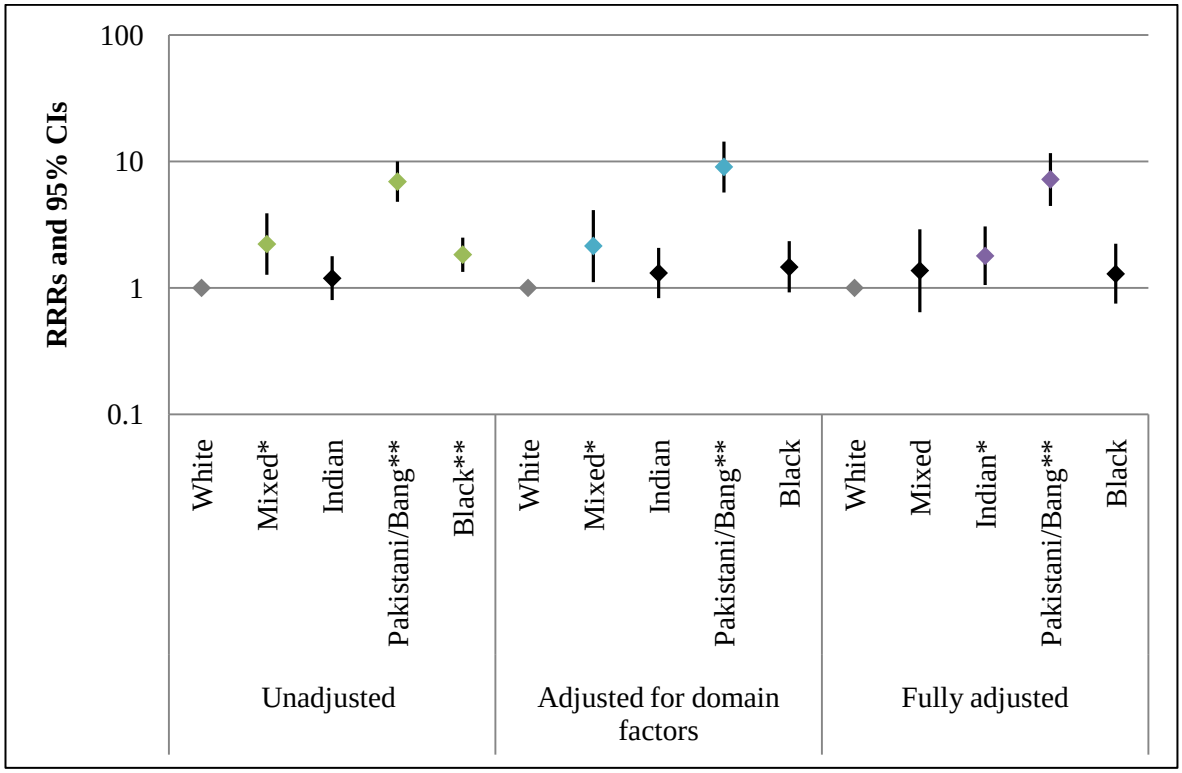


**p<0.001 *p<0.05

9.5.6.2 Ethnicity, language and migration

Figure 9.14 displays the effect of ethnicity on attendance at antenatal classes among primiparous women. Pakistani or Bangladeshi women were over 7 times more likely to be non-attenders at classes than White mothers and Indian mothers were also less likely to attend (fully adjusted RRR=7.20, p<0.001 for Pakistani/Bangladeshi women and 1.79, p<0.05 for Indian women).

Figure 9.14: The effect of ethnicity and religion on non-attendance at antenatal classes for primiparous women



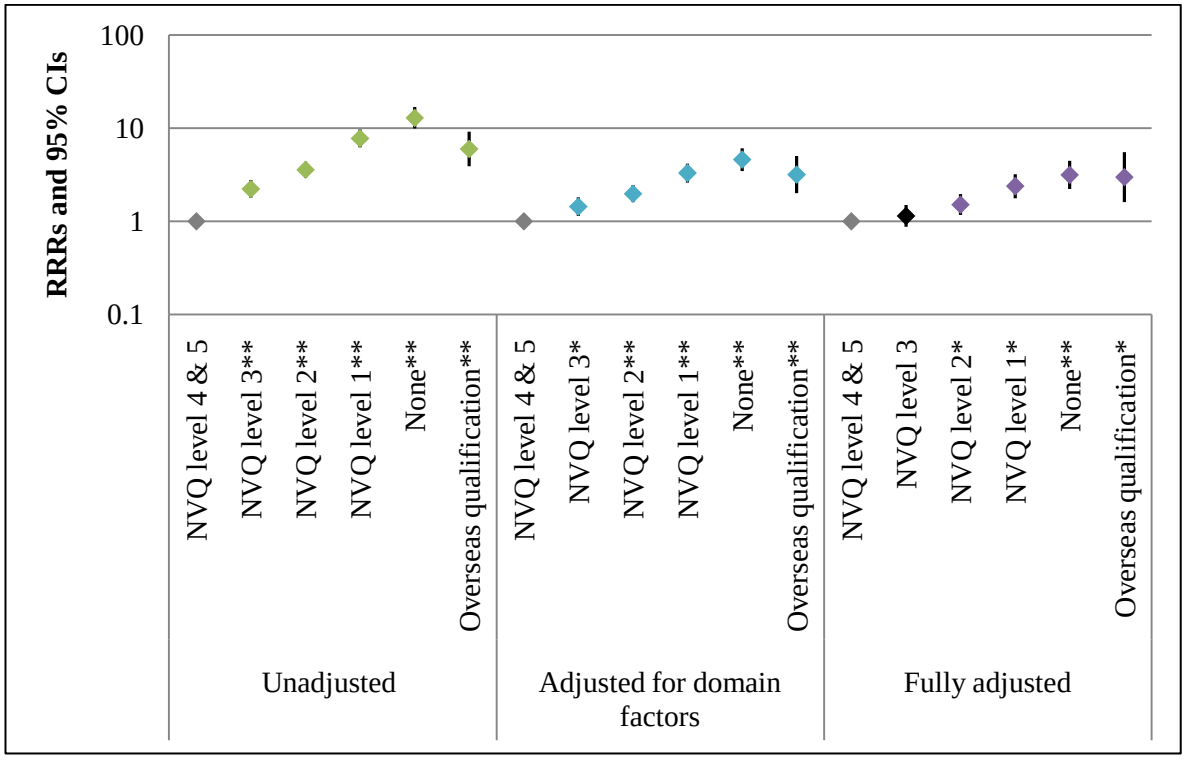
**p<0.001 *p<0.05

There was a higher risk of non-attendance at classes for women who spoke a language other than English at home in the unadjusted model and in the domain model (RRR=4.09, p<0.001 and RRR=2.00, p<0.05 respectively) compared to English speaking women; however, when fully adjusted in the final model, language was no longer significant (RRR=1.80, p=0.07). Similarly, migration status was not significantly related to class attendance when fully adjusted.

9.5.6.3 Socio-economic status

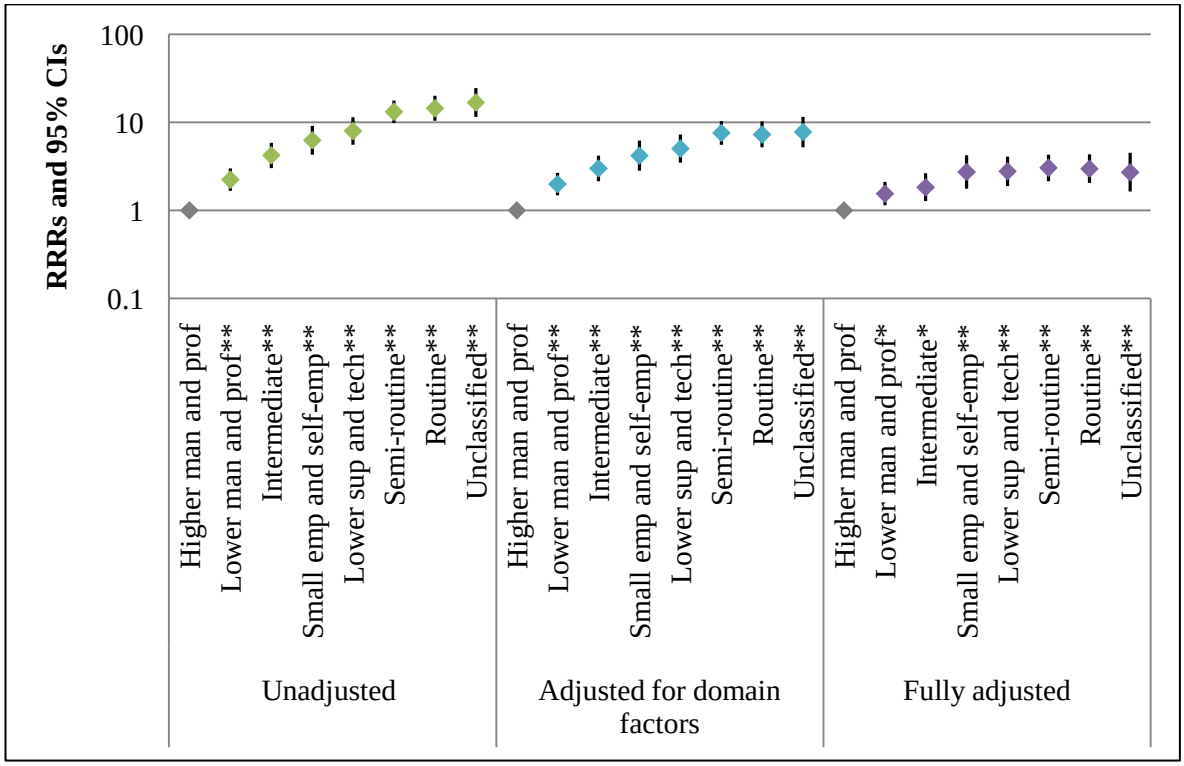
For primiparous women, non-attendance at classes was more likely for women of lower socio-economic status in terms of educational qualifications and social class (see Figure 9.15 and 9.16). In the unadjusted model, women who had no qualifications were 13 times more likely to not attend classes compared to women with degree level qualifications (RRR=12.92, p<0.001). In the final model, although the risk was reduced, mothers with no qualifications were still 3 times more likely not to attend than their more qualified counterparts (RRR=3.15, p<0.001).

Figure 9.15: The effect of educational level on non-attendance at antenatal classes for primiparous women



**p<0.001 *p<0.05

Figure 9.16: The effect of social class on non-attendance at antenatal classes for primiparous women

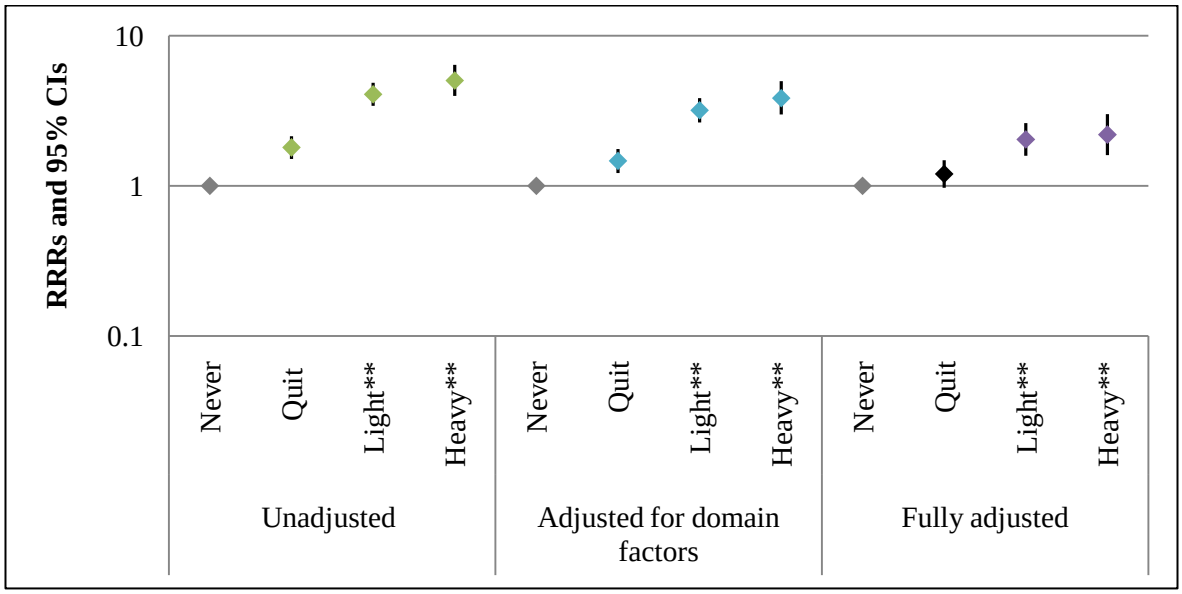


** p<0.001 *p<0.05

9.5.6.4 Smoking in pregnancy

Women who smoked during pregnancy were more likely to be non-attenders (fully adjusted RRR=2.04, p<0.001 for light smokers and RRR=2.19, p<0.001 for heavy smokers compared to non smokers, see Figure 9.17).

Figure 9.17: The effect of smoking during pregnancy on non-attendance at antenatal classes for primiparous women



**p<0.001 *p<0.05

9.5.6.5 Other pregnancy factors

When examining other pregnancy-related factors, primiparous women for whom the pregnancy was a surprise were more likely to be non-attenders (RRR=1.46, p<0.001 for women for whom the pregnancy was a surprise compared to women who planned the pregnancy).

Complications during pregnancy did not affect antenatal class attendance, and although women who were unhappy or not bothered about the pregnancy were at higher risk of not attending classes in the unadjusted model (RRR=2.45, p<0.001), after adjustment for other maternal factors feelings about pregnancy, was no longer a significant predictor of antenatal class attendance (RRR=1.04, p=0.77).

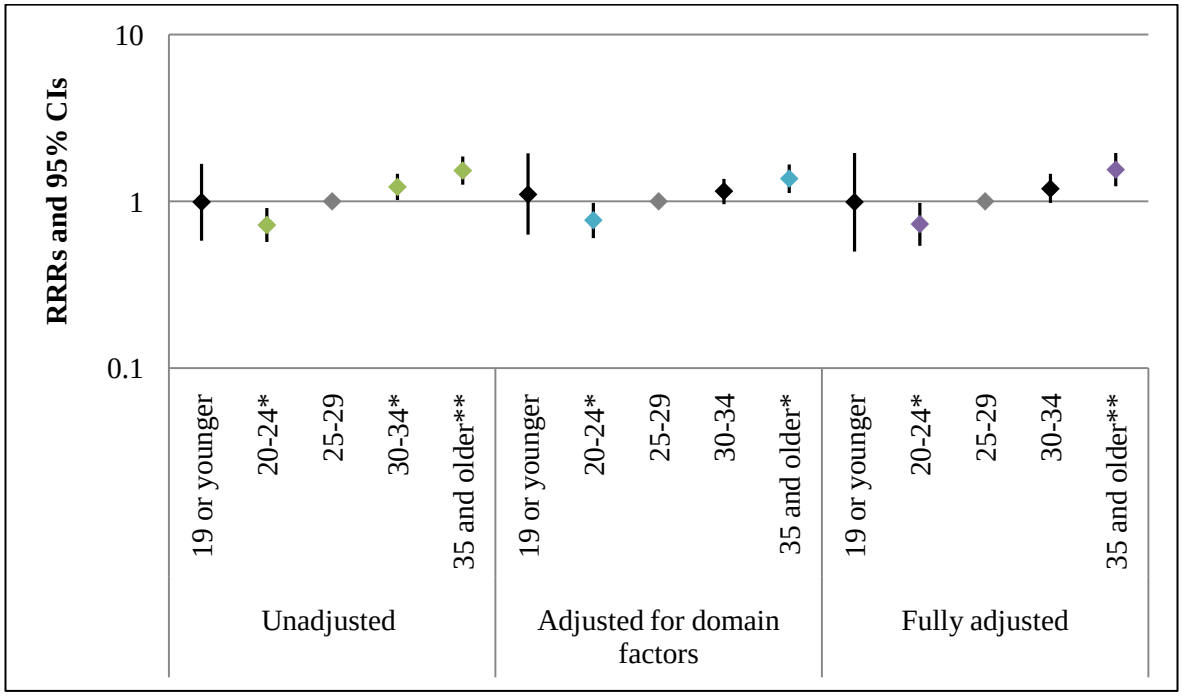
9.5.7 Multiparous women who received care and *attended* classes;

As discussed previously, few multiparous women in the MCS attended antenatal classes (14.5%). Results from the multinomial logistic regression models are presented in Table A9.7. Women who received care but *did not* attend classes were therefore the reference group.

9.5.7.1 Socio-demographic

Mothers who were over 35 at the index birth were more likely to attend classes than mothers aged 25-29, whereas mothers aged 20-24 were comparatively less likely (fully adjusted RRR=1.55, p<0.001 for 35 and older and RRR=0.73, p<0.05 for 20-24, see Figure 9.18). Age at first birth was unrelated to antenatal class attendance when adjusted for age at cohort member birth.

Figure 9.18: The effect of maternal age on *attendance* at antenatal classes for multiparous women*



**p<0.001 *p<0.05

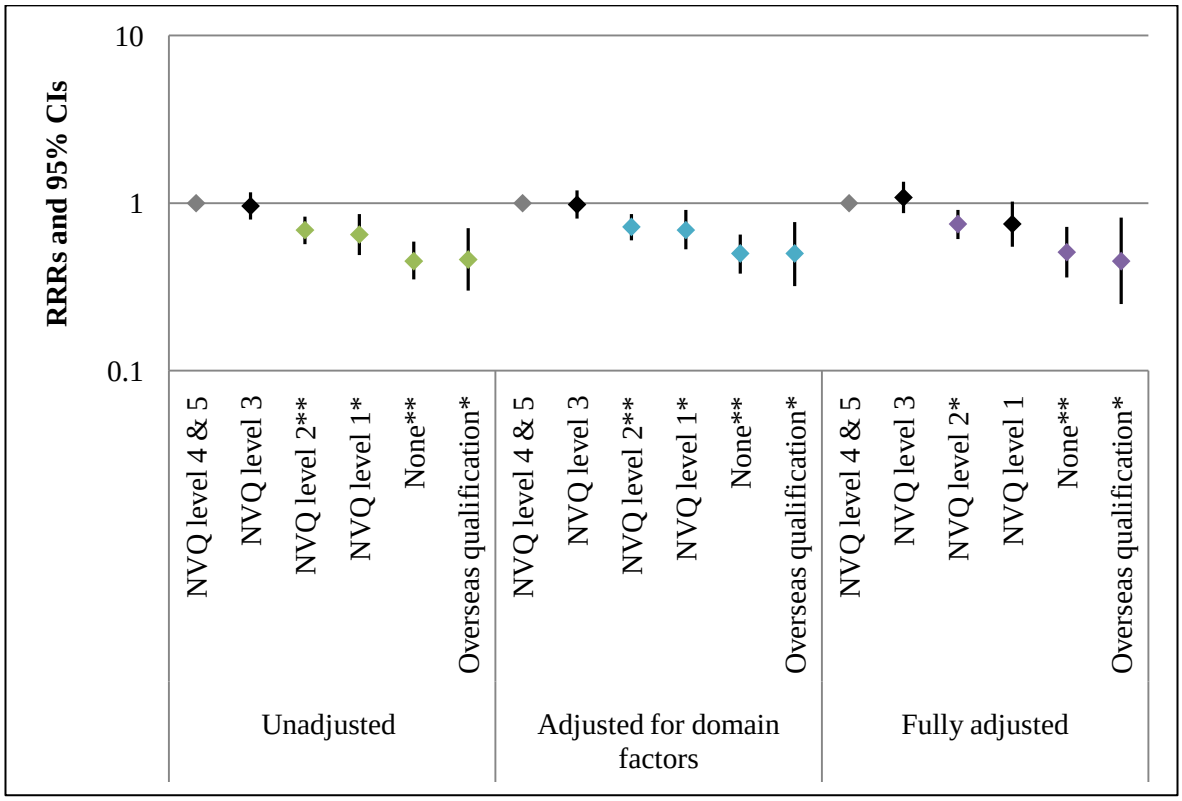
9.5.7.2 Ethnicity, language and migration

Although Pakistani or Bangladeshi women were less likely to attend classes in unadjusted analyses (RRR=0.65, p<0.05), when included in the fully adjusted model, this effect was no longer significant (RRR=0.66, p=0.09). First language at home and migration status were also unrelated to attendance at classes.

9.5.7.3 Socio-economic

In unadjusted analyses, multiparous women of lower socio-economic status as measured by educational level and social class were less likely to attend classes. When adjusted in the domain model, social class was no longer related to class attendance, whereas when fully adjusted the strength of the association between education and class attendance weakened only slightly (e.g. RRR=0.51, p<0.001 for no qualifications compared to women with degree level qualifications, see Figure 9.19).

Figure 9.19: The effect of educational level on *attendance* at antenatal classes for multiparous women

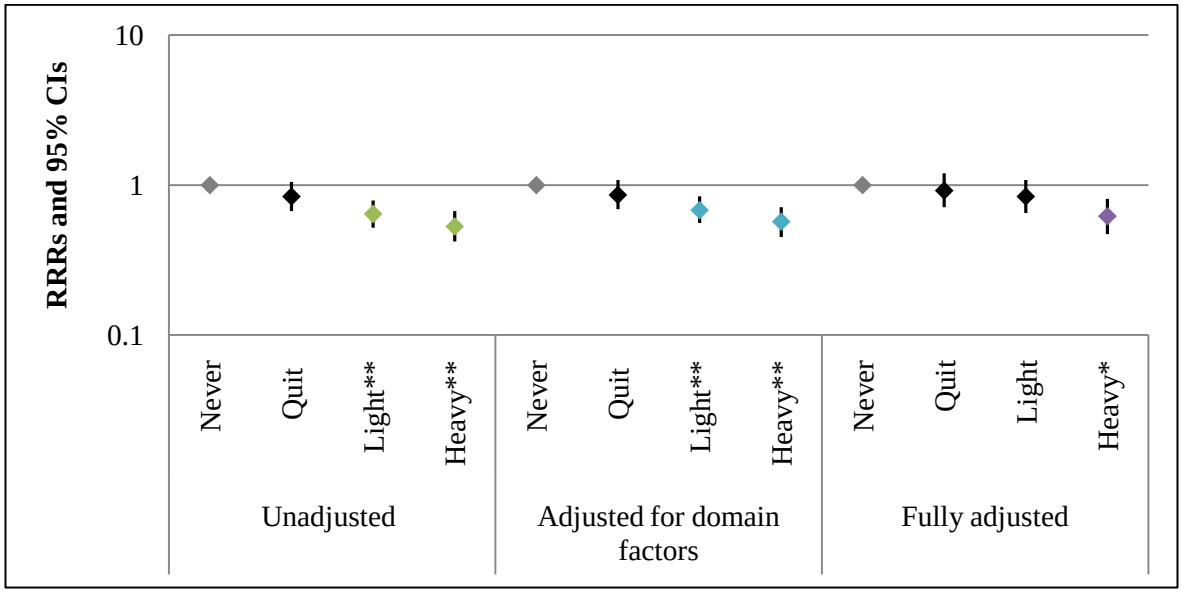


**p<0.001 *p<0.05

9.5.7.4 Smoking in pregnancy

Multiparous women who smoked heavily during pregnancy were significantly less likely to attend classes when compared to women who had never smoked (fully adjusted RRR=0.62, p<0.05, see Figure 9.20).

Figure 9.20: The effect of smoking during pregnancy on *attendance* at antenatal classes for multiparous women



**p<0.001 *p<0.05

9.5.7.5 Other pregnancy factors

Women for whom the pregnancy was a surprise were also less likely to attend classes (fully adjusted RRR=0.81, p<0.05). Complications during labour and mothers' feelings about pregnancy were unrelated to antenatal class attendance (although the result for complications during labour was of borderline significance).

9.5.8 Summary of the significant maternal predictors of antenatal care

Table 9.1 summarises the maternal characteristics which were significantly and independently related to antenatal care for both primiparous and multiparous women.

9.5.8.1 Antenatal care

Primiparous women who did not receive antenatal care were more likely to be younger, of Pakistani/Bangladeshi ethnicity, with lower levels of education and to have smoked in pregnancy. Being a migrant who had lived in the UK for more than five years was also a risk factor for having received no antenatal care. Women who had quit smoking in pregnancy were *more* likely to have attended antenatal care than women who had never smoked.

Among *multiparous* women being of Mixed and Pakistani/Bangladeshi ethnicity, being foreign-born but having resided in the UK for more than five years, having no educational qualifications,

being of lower social class and being a heavy smoker during pregnancy were all predictive of having received no antenatal care. Women who experienced problems or illness during pregnancy not normally associated with an increased risk of operative birth were more likely to have received antenatal care, as were women aged over 35.

9.5.8.2 Antenatal class attendance

Similar to women who did not attend care, *primiparous* women who did not attend classes were likely to be younger and of Pakistani/Bangladeshi descent and they were also more likely to be of Indian ethnicity. In terms of socio-economic status, there was an increased risk of not attending classes with decreased educational attainment and social class, as measured by occupational status. Women for whom the pregnancy had been unplanned and those who smoked during pregnancy were also less likely to attend classes.

For *multiparous* women many fewer characteristics were predictive of antenatal class attendance, probably as very few women having a subsequent child attend classes. However, multiparous women with lower educational qualifications or overseas qualifications, women for whom the pregnancy had been a surprise and women who smoked heavily during pregnancy were less likely to attend classes. Older women were more likely to attend classes.

Table 9.1: Summary of the significant (p<0.05) and independent predictors for antenatal care and classes*

Maternal characteristics#		Received no care		No classes	*Attended* classes
		Primiparous	**Multiparous**	**Primiparous**	**Multiparous**
Socio-demographic	**Age at cohort member birth**	Younger (<19=4.0)	35+ (0.6)	↓Age (<19=2.4)	↑Age (35+ =1.6)
	Age at first birth	N/A		N/A	
Ethnicity, language and migration	**Ethnicity**	Pakistani/Ban (6.3)	Pakistani/Ban (1.9) Mixed (4.9)	Pakistani/Ban (7.2) Indian (1.8)	
	First language at home				
	How long lived in the UK	>5 years (2.4)	>5 years (2.5)		
Socio-economic	**Educational level**	↓Education (none=8.0)	None (2.1)	↓Education (none=3.2)	↓Education (none=0.5)
	Social class		↓Social class (routine=2.8)	↓Social class (routine=3.0)	
Psychosocial	Feelings about pregnancy				
Pregnancy	**Smoking**	↑Smoking (heavy=3.0)	Heavy (1.6, p=0.06)	↑Smoking (heavy=2.2)	Heavy (0.6)
		Quit (0.5)			
	Planned pregnancy			Surprise (1.5)	Surprise (0.8)
	Complications: CS risk factor **Complications: Other**		Other comp (0.4)		

*Relative risk ratios (RRRs) given in brackets, ↓ = decreasing, ↑ = increasing, for factors with a gradient effect an example category RRR is given, pink indicates increased risk, blue indicates decreased risk.

Factors in **bold** significantly predictive of antenatal care or classes

9.6 Infant outcomes for women according to antenatal care

Table A9.8 and Figures 9.21 and 9.22 display infant birth weight and gestational age for women according to antenatal care received. Both primiparous and multiparous women who gave birth preterm were significantly less likely to have attended classes and were more likely to have received no antenatal care.

Among both primiparous and multiparous women, women who did not receive antenatal care had the highest rates of low birth weight, whereas women who received care and attended classes had the lowest rates.

Figure 9.21: Gestational age (weeks) according to antenatal care

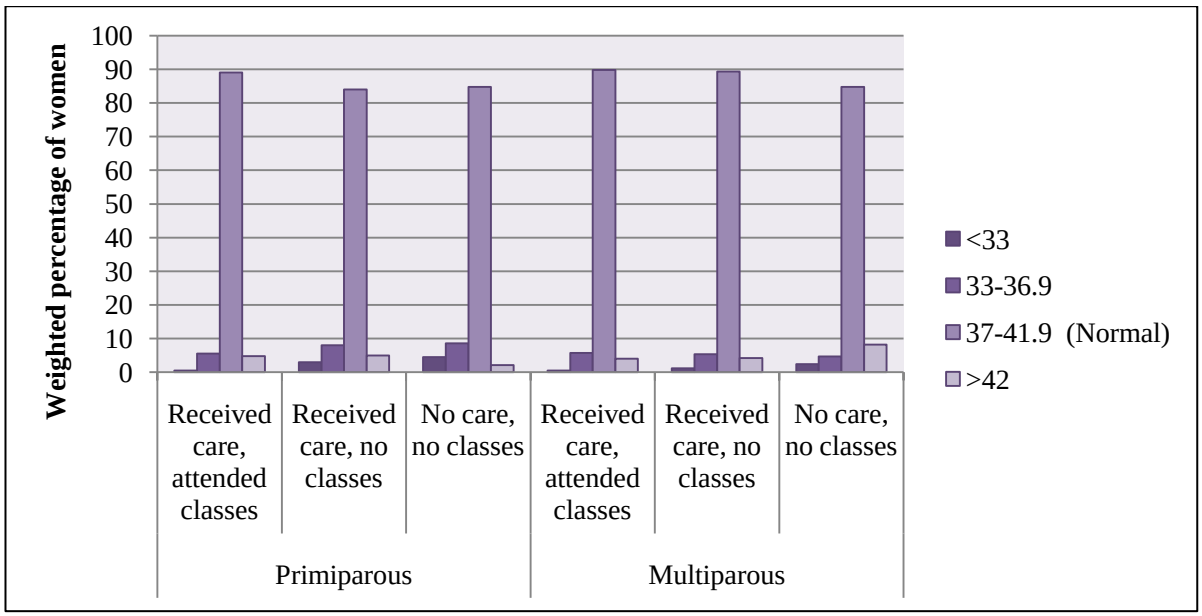
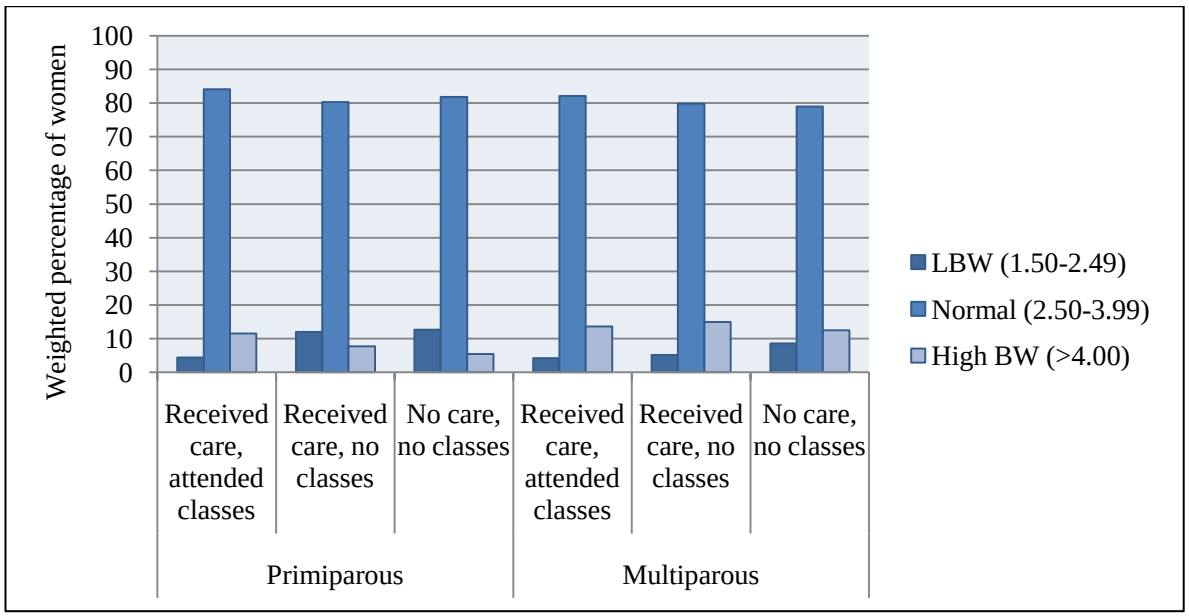


Figure 9.22: Birth weight according to antenatal care



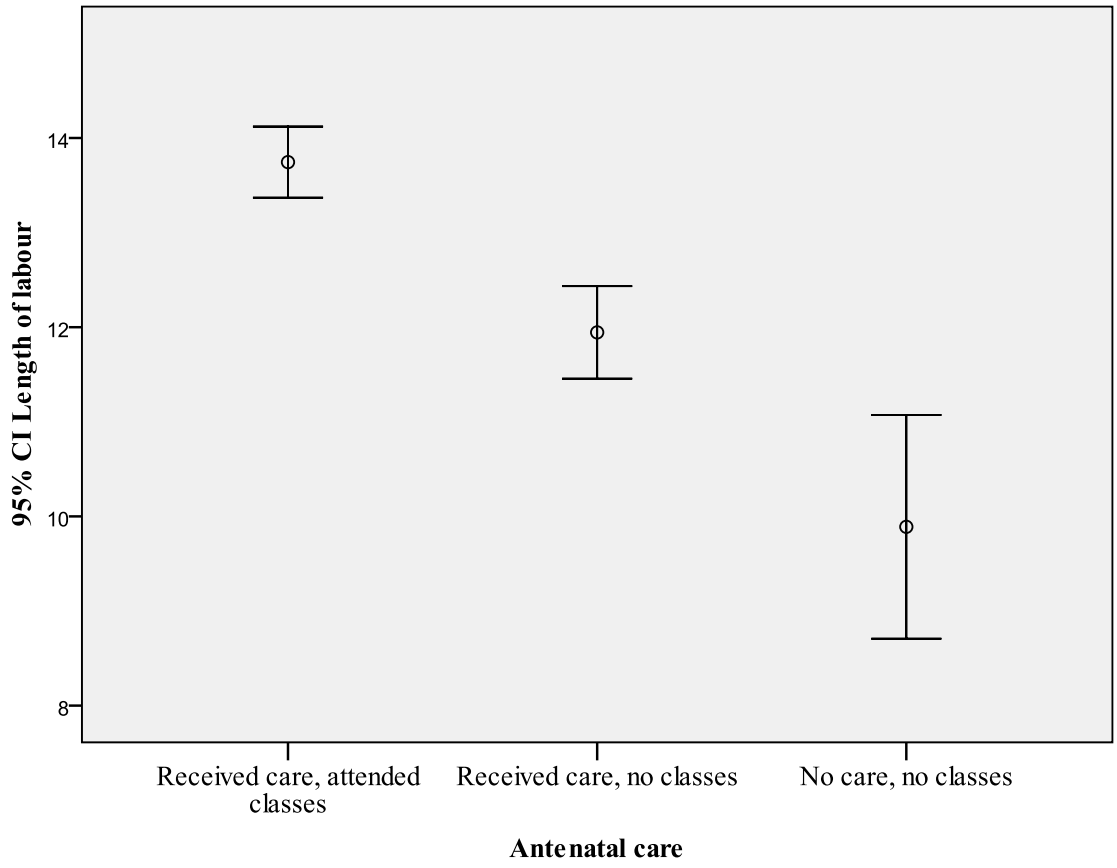
9.7 Labour outcomes for women according to antenatal care

Table A9.9 shows selected labour outcomes for women according to antenatal care. Induction of labour was not affected by antenatal care. Compared to *primiparous* women who received no antenatal care, 65% of whom experienced no complications during labour, only around half of the women who received care and attended classes experienced no problems. Compared to women who did not receive antenatal care, women who received care reported more fetal distress and 'other' complications during labour, and rates of these complications were higher again for women who attended classes. Among *multiparous* women a similar pattern of reduced labour complications for women who did not receive antenatal care arose. However, only fetal distress increased significantly with care.

Mean length of labour is shown in Table A9.9 and also in Figure 9.23 (for primiparae). Among primiparous women, those who received care and attended classes had the longest labours at an average of around 14 hours. Women who received care but did not attend classes had a length of labour around 2 hours shorter, and women who did not receive care had the shortest labours, at just over 10 hours on average. An unadjusted linear regression model showed that the differences in length of labour between the antenatal groups were significant (coefficient= -1.9 $p<0.001$ for women who did not attend classes and coefficient= -3.5 $p<0.001$ for women who did not attend care, compared to women who received care and attended classes). For multiparous mothers there was little difference in length of labour between the antenatal groups, which all averaged at around 6 hours. An unadjusted linear regression confirmed no significant differences between the groups (coefficient= -0.1 $p=0.72$ for women who did not attend classes and coefficient= -0.3 $p=0.46$ for

women who did not attend care, compared to women who received care and attended classes). Adjusting for all independent maternal characteristics which were predictive of antenatal care made very minimal adjustment to the regression coefficients (data not presented).

Figure 9.23: Error bars for length of labour for *primiparous* women by antenatal care



9.8 The relationship between antenatal care and mode of birth

Bivariate analyses discussed at the outset of this chapter and detailed in Chapter 4 indicated that rates of caesarean section and instrumental vaginal births were lower for mothers who did not attend classes and also for those who did not receive antenatal care. As mothers who attend classes or receive antenatal care are likely to be very different to those who do not, it was considered to be important to establish the significant differences between the women in the MCS who reported receiving different levels of antenatal care and then to statistically control for these factors when analysing the relationship between antenatal care and mode of birth.

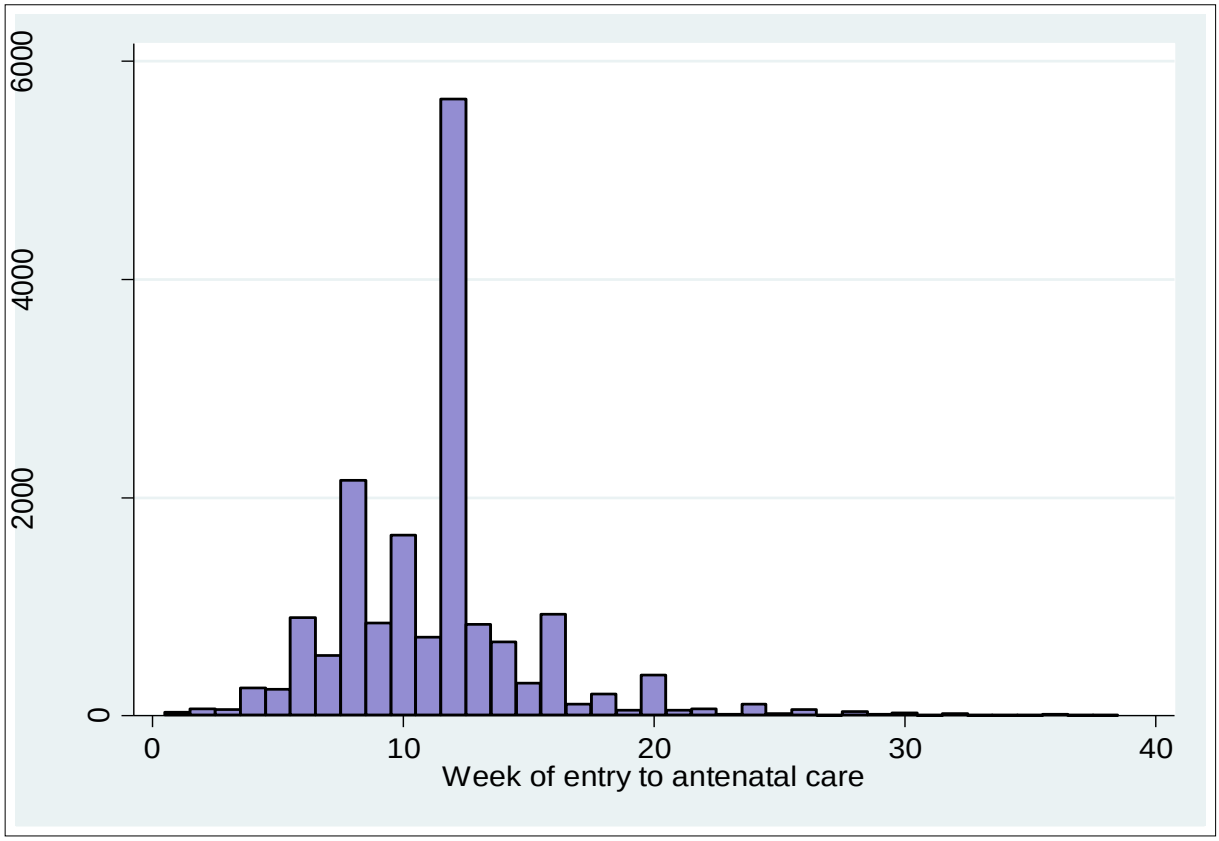
Table A9.10 displays multinomial logistic regression analyses exploring the relative risk ratios for modes of birth according to the level of antenatal care received in pregnancy. Three models are

presented; an 'unadjusted' model[4] (Model 1), a model adjusted for significant *maternal* factors found to be related to antenatal care (Model 2), a model which additionally adjusted for *infant* factors which differed in Table A9.8 (Model 3), and a final model (Model 4) which additionally adjusted for *labour* factors which were found to differ significantly by antenatal care in Table A9.9.

Interactions were explored between maternal factors and antenatal care on mode of birth. Any significant interactions were then included in Models 2, 3 and 4.

Women in the MCS who reported that they had received antenatal care were asked the following question: "*And, how many weeks pregnant were you when you had your first antenatal visit?"* To avoid bias arising from late attenders to care, all models controlled for the gestational week in which the antenatal care began. Figure 9.24 shows the distribution of entry to antenatal care by weeks of gestation. The majority of women began antenatal care in the first trimester, and particularly around week 12. However, around 21% of women began antenatal care in the second trimester and a minority (less than 1%) initiated care in the third trimester.

Figure 9.24: Week of entry to antenatal care



[4] Adjusted only for week of entry to antenatal care.

9.8.1 'Unadjusted' analyses

In unadjusted analyses, compared to mothers who had received care and attended classes, both *primiparous* mothers who did not attend classes and those who did not receive antenatal care were at a reduced risk of having an instrumental birth (RRR=0.53, $p<0.001$ for women who did not attend classes and RRR=0.36, $p<0.001$ for women who did not receive antenatal care) or an emergency caesarean section (RRR=0.73, $p<0.05$ for women who did not attend classes and RRR=0.39, $p<0.001$ for women who did not receive antenatal care). In addition, women who did not receive care were at a reduced risk of having a planned caesarean section (RRR=0.25, $p<0.05$).

For *multiparous* mothers antenatal care had no significant impact on rates of instrumental births. Similar to primiparae, multiparous women who did not receive care were less likely to have a planned caesarean (RRR=0.43, $p<0.05$). There was also a reduced risk of emergency caesarean section, but only for mothers who did not attend classes compared to those who did (RRR=0.72, $p<0.05$).

9.8.2 Analyses adjusted for factors found to be important predictors of antenatal care

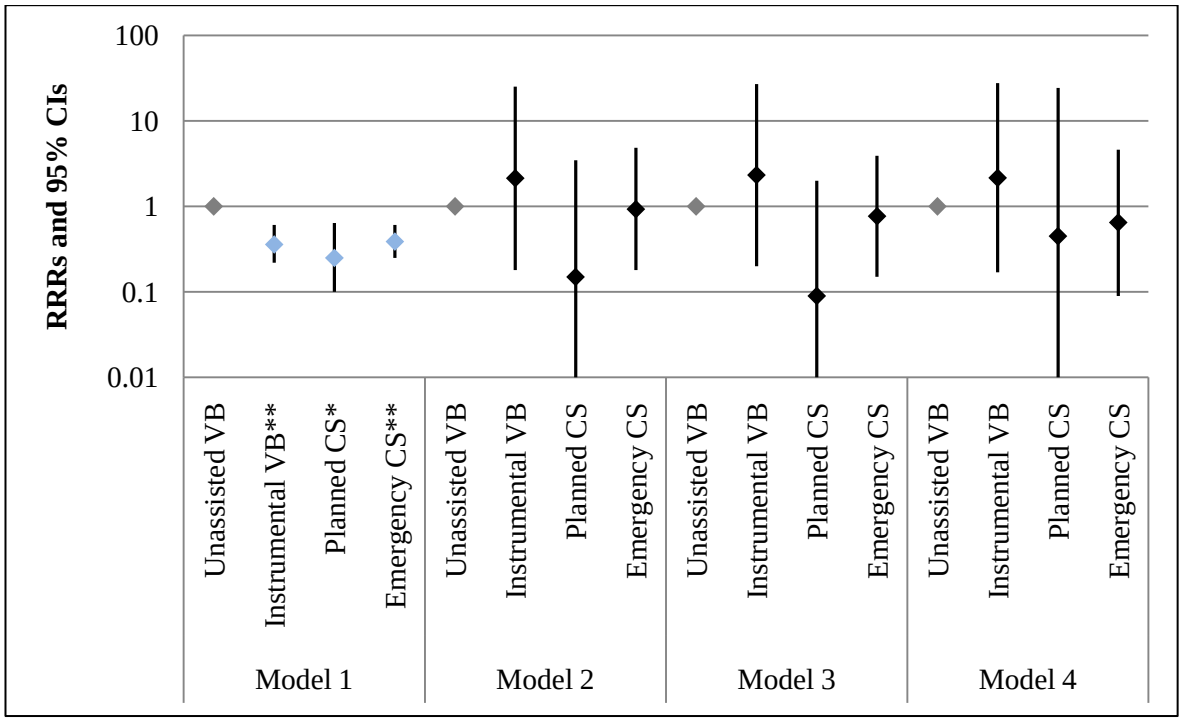
9.8.2.1 Primiparous women

Maternal factors which were found to be significantly related to antenatal care in the final models in Table A9.4 and Table A9.5 for primiparous women included; age at index birth, ethnicity, migration status, educational level, social class, unplanned pregnancy and smoking during pregnancy. In addition, birth weight and gestational age were found to differ significantly for women in different antenatal groups, as did complications in labour and length of labour. These factors were therefore adjusted for in multinomial logistic regression models predicting mode of birth.

Two multiplicative interaction terms were found to be significant in unadjusted analyses and were included in Models 2, 3, and 4; antenatal care and ethnicity (White vs. non-White) and antenatal care and social class (working class vs. not). When adjusted for all other factors in the models however, neither interaction remained significant.

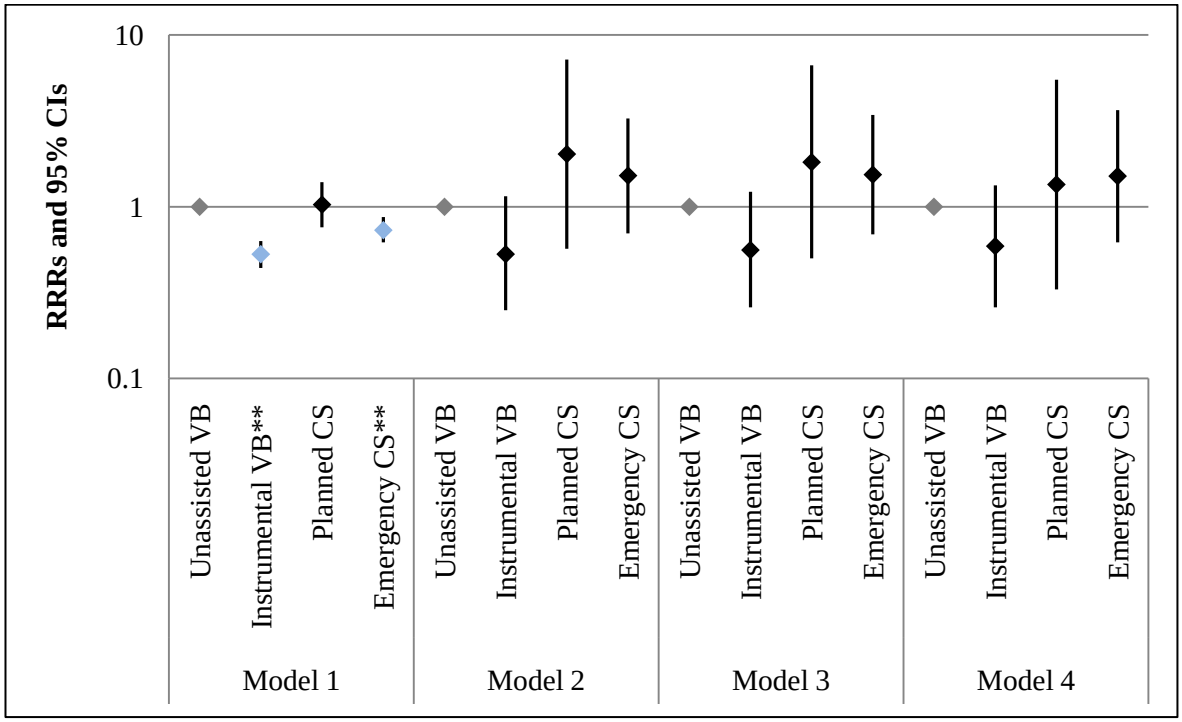
Figures 9.25 and 9.26 show graphically the results of the multinomial logistic regression models predicting mode of birth for primiparous women. After adjustment for maternal factors, antenatal care was no longer related to the likelihood of primiparous women having an operative birth.

Figure 9.25: The effect of non-receipt of antenatal care on mode of birth for *primiparous* women#



**p<0.001 *p<0.05 # Reference group = women who received care and attended classes

Figure 9.26: The effect of non-attendance to antenatal classes on mode of birth for *primiparous* women#



**p<0.001 # Reference group = women who received care and attended classes

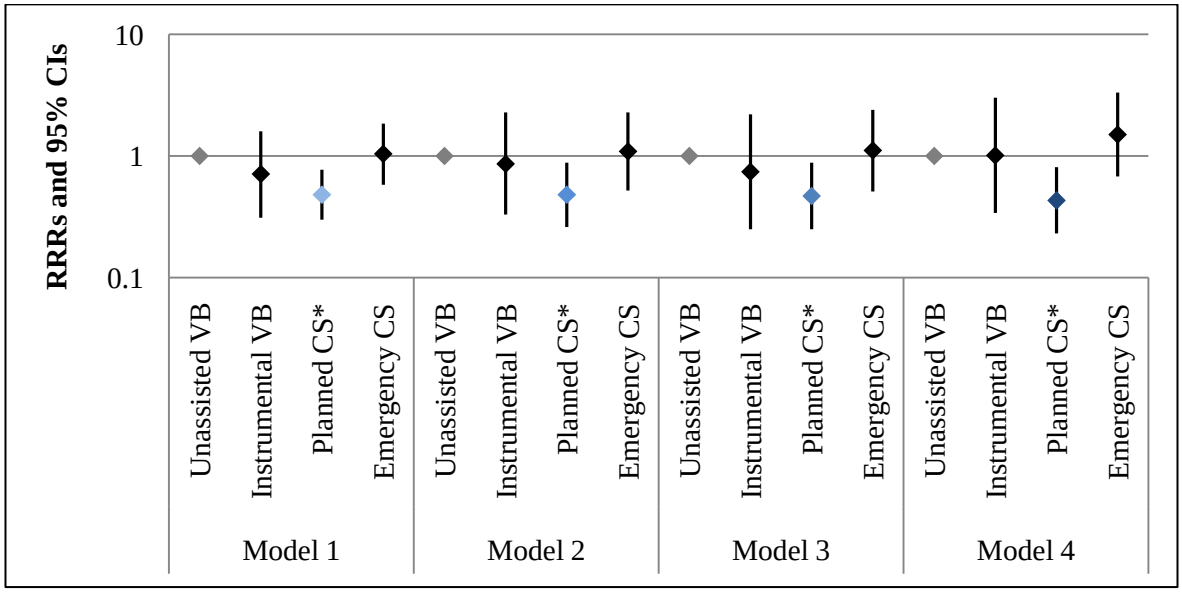
9.8.2.2 Multiparous women

For multiparous women, similar maternal characteristics were found to be significantly related to the likelihood of receiving antenatal care, or attending classes to those predictive for primiparous women. Maternal factors found to be significant in final models detailed in Table A9.6 and A9.7 were; age at index birth, ethnicity, migration status, educational level, social class, smoking during pregnancy and whether the pregnancy was planned. In addition, as with primiparous women, significant differences in gestational age and birth weight were found by antenatal care. Fetal distress during labour also differed significantly between groups.

Figures 9.27 and 9.28 show graphically the results of the multinomial logistic regression models for the effect of antenatal care on mode of birth for multiparous women. The reference group was women who received care, but did not attend classes. Adjustment for the above maternal, infant and labour factors made very little difference to the relative risk ratio indicating an increased risk of emergency caesarean section for mothers who attended classes, compared to those who did not. The 'unadjusted' RRR (Model 1) was 1.39 ($p<0.05$) and the adjusted RRR (Model 4) was also 1.39 ($p<0.05$).

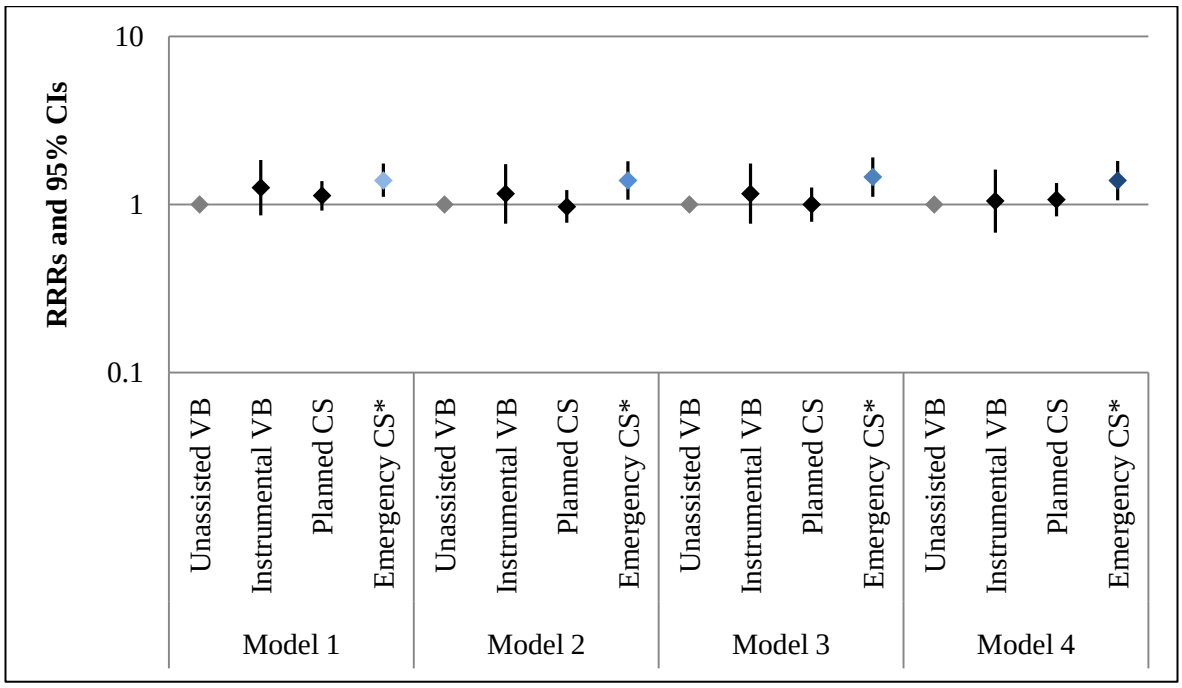
Multiparous women who received no care remained significantly less likely to have a planned caesarean section after adjustment for maternal, infant and labour factors. This result perhaps reflects the need for pre-labour caesarean sections to be arranged through consultations with health professionals during pregnancy.

Figure 9.27: The effect of non-receipt of antenatal care on mode of birth for *multiparous* women



*p<0.05

Figure 9.28: The effect of antenatal class attendance on mode of birth for *multiparous* women



*p<0.05

9.9 Discussion: Which women were less likely to receive antenatal care or to attend classes in the MCS?

9.9.1 Antenatal care

9.9.1.1 Lack of UK research

Antenatal care is important for identifying problems for women in pregnancy, and subsequently reducing adverse health outcomes for mothers and their infants. However, a minority of women do not access antenatal care. According to a review by Rowe and Garcia, updated in 2002, much of the literature regarding the demographics of women who receive fewer antenatal visits, or access care late in pregnancy was from Europe and the USA (Rowe and Garcia, 2003). The non-UK literature indicated that women were likely to be younger, of high parity, of non-White ethnic group, unmarried and of lower socio-economic status (Rowe and Garcia, 2003), and other non-UK studies have also shown similar patterns (Blondel and Marshall, 1998, Lia-Hoagberg et al., 1990).

Women from disadvantaged backgrounds, who may be less likely to receive optimal care in pregnancy, are also a group who are likely to be in the greatest need for antenatal care. This disparity of health service access according to social background is an example of the inverse care law (Tudor Hart, 1971), and is reflected in other areas of NHS care (Watt, 2002).

Antenatal care has previously been identified by the Department of Health as an area which could be targeted to reduce health inequalities (Department of Health, 2002). Recommendations were made to improve disadvantaged women's access to care and early booking to screening services (Department of Health, 2002). In the 2003 report on "Tackling Health Inequalities: A Programme for Action", improving the quality and accessibility of antenatal services in deprived areas was again emphasised (Department of Health, 2003).

Rowe and Garcia's systematic review conducted and published around the time of the reports by the Department of Health, highlighted the dearth of UK research into the socio-demographic characteristics of women who were less likely to access antenatal care (Rowe and Garcia, 2003). The review identified only nine UK studies which assessed the association between women's social class, or ethnicity, and antenatal care. Of the nine studies, the majority were based on data from the late 1970s or the 1980s, with the most recent from 1995. The studies were also hampered by small sample sizes, with 8 of 9 including less than 1,000 women, and only one study including adjustment for confounding factors (Rowe and Garcia, 2003).

Overall the findings from the review showed that UK women from lower social class bands were more likely to book late for antenatal care, or to attend fewer antenatal visits. In addition, all four studies which assessed ethnicity found that women of Asian background were more likely to book late for antenatal care (Rowe and Garcia, 2003). A more recent survey was conducted by Rowe and colleagues including around 800 women about their attendance for antenatal care (Rowe et al., 2008). Women who were born outside the UK and single women were more likely to initiate care late and Black women were more likely to have a late booking appointment. Although the study results were adjusted, small numbers in sub-groups may have hampered study analyses.

Although inequalities in access to antenatal care are referred to, evidence from the UK is limited to studies which are mainly outdated or restricted by small sample sizes. In addition, previous studies have focused on women who access care late, or attend few antenatal visits, rather than the women who, more worryingly, do not access care at all.

9.9.1.2 Antenatal care in the Millennium Cohort Study

Due to the retrospective nature of the questions about pregnancy, the Millennium Cohort study provides an opportunity to assess the characteristics of women who did not access antenatal care.

The proportion of mothers in the MCS who reported that they did not receive antenatal care generally reflects the numbers previously suggested in the literature. Less than 3% (weighted) of the sample did not receive any antenatal care during pregnancy. The Infant Feeding survey,

conducted in the UK around the time of the first wave of the MCS (Infant Feeding 2000), found that around 2% of the approximately 9,500 women had not received any antenatal check-ups during pregnancy (Hamlyn et al., 2002).

The MCS variable assessed whether women had received care, and whether they had attended classes. As mothers having a subsequent pregnancy were much less likely to attend classes, primiparous and multiparous women were examined separately. Overall, a similar proportion of primiparous and multiparous women reported receiving no antenatal care, including 258 (2.7%) primiparous women and 410 (2.9%) multiparous women.

In general, the findings from the MCS regarding the characteristics of women who reported that they had received no antenatal care reflected a deprived group of women, in agreement with much of the previous literature. Primiparous women who did not access antenatal care were more likely to be, younger, of Pakistani/Bangladeshi ethnicity, foreign-born but had resided in the UK for more than five years, to have low levels of education and to have smoked during pregnancy. Women who had quit smoking in pregnancy were *more* likely to have received care than women who had never smoked.

Similarly, multiparous women who did not receive care were more likely to be of Pakistani/Bangladeshi ethnicity, foreign-born but to have resided in the UK for more than five years and to have smoked during pregnancy (heavily). In addition, Mixed ethnicity women and those in the lowest social class band or with no educational qualifications were also less likely to have received care. Multiparous women aged over 35 were *more* likely to have received antenatal care.

Various UK and non-UK qualitative studies may help us to understand how the more disadvantaged characteristics of women may act as barriers to accessing antenatal care. For young women, barriers may relate to the unplanned nature of the pregnancy (Blondel and Marshall, 1998), or more practical issues such as attending school and travel (Howie and Carlisle, 2005). For disadvantaged women, financial uncertainty (Blondel and Marshall, 1998), childcare and other family issues, compounded by the stresses of day-to-day life (Lia-Hoagberg et al., 1990) have been reported as difficulties accessing antenatal care.

Pakistani and Bangladeshi women are among the most disadvantaged in the UK (Nazroo, 1997). However, previous research in the UK has suggested further barriers to antenatal care for these women relating to traditions, communication problems and the need for husbands to act as interpreters, and the requirement to maintain modesty in front of male doctors (Gatrad, 1994, Katbamna, 2000, Miller, 1995).

For smoking during pregnancy there is less evidence to explain the association with not receiving antenatal care. Women who smoke during pregnancy are more likely to be young and from a more disadvantaged background (Graham et al., 2010, Graham et al., 2006). However, after adjustment for maternal factors, including age and socio-economic factors, women who smoked during pregnancy remained more likely to have received no antenatal care than women who had never smoked. Smoking during pregnancy is widely recognised as a damaging health behaviour, which means women who smoke during pregnancy are often aware of the potential health risks. In the same sense, neglecting to attend antenatal care is generally recognised as a risky health behaviour, which could indicate attitudinal or psychological differences in these women. Previous research using the MCS has identified greater psychosocial problems among pregnancy smokers, including; interpersonal problems, adaptive functioning and health-related behaviour problems (Pickett et al., 2009).

In the fully adjusted model for primiparous women, those who quit smoking during pregnancy were *more* likely to have attended antenatal care than their non-smoking counterparts. Previous research in the MCS has also shown that women who quit had infants with better temperament at nine months (Pickett et al., 2008), and a reduced risk of behavioural problems at three years old compared to women who had never smoked (Hutchinson et al., 2010), which have been linked to adaptive maternal characteristics among quitting mothers (Pickett et al., 2008). The ability to quit smoking on behalf of the fetus reflects a positive attitude toward fetal wellbeing, which may also be reflected in the increased use of antenatal care amongst a group of women who are normally characterised by disadvantage.

9.9.2 Classes

Antenatal classes are available to the majority of primiparous women who receive antenatal care in the UK, either through the NHS, or for a fee from organisations like the National Childbirth Trust. The classes aim to prepare women for labour, childbirth and for becoming a parent. The majority of classes incorporate information about what happens during labour and birth, including information regarding pharmacological methods of pain relief available, as well as non-pharmacological methods e.g. breathing and relaxation (Escott et al., 2009).

The characteristics of women who do not attend classes are likely to be a reflection of the characteristics of women who did not receive care, as the invitation to attend NHS classes would come via antenatal care. However, compared to non-attenders to care, a much higher proportion of women, especially multiparous women do not attend classes, and non-attendance to classes is not perceived as a harmful health behaviour in the same way.

9.9.2.1 Classes in the Millennium Cohort Study

When compared with the MCS, a similar proportion of women attended classes in the Infant Feeding survey (Hamlyn et al., 2002); 64% of first-time mothers and 11% of multiparous mothers attended classes in the Infant Feeding Survey compared to 67.5% and 14.5% respectively in the MCS.

As with antenatal care, mothers in the MCS who were less likely to attend classes were from more disadvantaged backgrounds. Among primiparous women they were likely to be younger, of Pakistani or Bangladeshi ethnicity, with lower levels of education and from lower social class backgrounds, to have not planned the pregnancy and to have smoked during pregnancy.

Only around 1,500 multiparous women attended classes representing only 14.5% of the group. As classes are a form of preparation for the experience of childbirth and parenthood, it is understandable why a low proportion of women who have already had children attend. Also, issues with childcare as highlighted earlier as a barrier to antenatal care would also pertain. Consequently fewer characteristics of multiparous women were related to attendance; however, women with no education or an overseas qualification and women who smoked heavily during pregnancy were less likely to attend than mothers from more advantaged socio-economic backgrounds and those who had never smoked.

Although classes are a method of preparing for childbirth and parenthood, women have reported that classes were less important for preparation, but more important as a way to meet other women in comparable circumstances (Cliff and Deery, 1997, Muller and Newburn, 2009). Women who attend classes in the UK are frequently from more advantaged backgrounds (i.e. older, married or in a relationship, of higher social class and with higher educational attainments) (Cliff and Deery, 1997, Muller and Newburn, 2009). Therefore for younger, single and more disadvantaged women classes would be less of an opportunity to meet others similar to them. In addition, younger and more disadvantaged women have reported concerns about being stigmatized by the other women, or about the perceived school-like nature of the classes (Cliff and Deery, 1997, Howie and Carlisle, 2005).

Interviews with Bangladeshi and other Muslim women have revealed a lack of awareness about antenatal classes (Ali and Burchett, 2004, Katbamna, 2000). In Katbamna's study this contrasted with the Indian women who had in the majority attended the full course of classes. Bangladeshi women doubted the purpose and benefits of attending classes due to their view of childbirth a natural event, for which formal preparation was not necessary. In addition, embarrassment about

the discussion of childbirth, particularly in front of male partners, was a source of concern (Ali and Burchett, 2004, Katbamna, 2000).

9.9.3 Summary

In the UK there is little research regarding women who attend few antenatal visits and who access care late in pregnancy, and the research that has been conducted has generally included poor sample sizes (Rowe and Garcia, 2003). In particular however, there is very little evidence about the characteristics of women who do not access antenatal care, or classes. The Infant Feeding Survey from 2000 suggested that around 2% of mothers did not access care (Hamlyn et al., 2002). The retrospective nature of the question about pregnancy, asked to mothers when their infants were nine months old allowed non-attenders to be easily identified. In the MCS a comparable 2.8% of women reported not accessing antenatal care. The large sample size and the disproportionate sampling for disadvantaged women allowed for the exploration of the characteristics of non-attenders. In agreement with previous literature, women in the MCS who did not attend antenatal care or classes comprised a generally deprived group.

9.10 Discussion: The relationship between antenatal care, antenatal classes and mode of birth

Assessing whether antenatal care and classes are effective in improving outcomes for mothers and infants is of importance, especially in the NHS where there are resource implications elsewhere in the health system. In fact, financial issues are among a variety of reasons why the NHS has taken the decision to cut spending on classes (Nolan, 2010).

9.10.1 Issues with measuring outcomes relating to antenatal care

Clearly in the UK and across a variety of other countries women who attend antenatal care and antenatal classes are very different in terms of their socio-demographic background to those who do not access care. Therefore, assessing outcomes including mode of birth using observational designs undoubtedly introduces selection bias. For example, when considering just one demographic characteristic, age, it is clear that not controlling for age would most likely confound birth outcomes, as young women are considerably less likely to attend classes, and they are also significantly less likely to have an operative birth.

A number of randomised controlled trials have been conducted concerning antenatal care, or antenatal classes, and many have been summarised in two Cochrane systematic reviews; one regarding antenatal care (Villar et al., 2001) and another relating to antenatal classes (Gagnon and Sandall, 2007). Many of the randomised trials included in the reviews had poor designs, small

sample sizes, or a lack of statistical adjustment, and others with a more pragmatic design suffered from contamination (Gagnon and Sandall, 2007, Villar et al., 2001). However, a recent, larger and more superior quality study highlights the difficulties of conducting trials assessing antenatal care (Bergstrom et al., 2009). Although it is possible to randomise women to one class design or another, for example, it is not possible to control what other information women will seek. Preparing for childbirth is an important and often anxious time in a woman's life, meaning many women will be motivated to prepare for the experience. A wide variety of information is available to women through a range of media including childbirth books, and in more recent years an immeasurable quantity of information available on the internet and on television (Lagan et al., 2010, Morris and McInerney, 2010, Young, 2010). In the large RCT almost 40% of the women randomised to receive standard care (no psychoprophylactic training) sought private training (Bergstrom et al., 2009).

9.10.2 Previous literature from observational studies compared to the MCS findings

9.10.2.1 Antenatal care

Several observational studies assessed the relationship between antenatal care and mode of birth through the number of antenatal visits (Behague et al., 2002, Gissler and Hemminki, 1994, Gomes et al., 1999, Simoes et al., 2005, Petrou et al., 2003), or through the timing of the initiation of care (Braveman et al., 1995, Gissler and Hemminki, 1994). Similar to the MCS, one American study also assessed antenatal care by comparing women who received any antenatal care vs. none (Gareen et al., 2003). The overall finding from all studies was that women who received less antenatal care were less likely to have a caesarean section. Most studies were conducted in the 1980s and 1990s and all but one (Petrou et al., 2003) were non-UK based. However, in general the studies had large sample sizes and were well adjusted for maternal factors.

In the MCS, a strong association was found for women receiving no antenatal care and a reduced risk of unplanned operative birth in unadjusted analyses. After adjusting for independent predictors of antenatal care, antenatal care was not significantly related to unplanned operative birth. However, the majority of previous studies, including the only UK-based study, compared all caesarean sections (including planned and emergency) to vaginal birth. In my analyses, results are presented for instrumental birth, planned caesarean section and emergency caesarean section compared to unassisted vaginal birth. Because a minority of women did not receive care, this led to some small numbers which may have reduced statistical power.

9.10.2.2 Classes

In the MCS, maternal characteristics accounted for the variation in mode of birth by antenatal care group for primiparous women. However, for multiparous women a 40% increased risk of emergency caesarean section remained for women who attended antenatal classes (compared to those who did not) after adjustment for maternal, infant and labour characteristics.

Numerous observational studies have measured antenatal education in relation to mode of birth. Although when unadjusted, many studies found higher rates of operative births among women who attended more classes (Artieta-Pinedo et al., 2010, Fabian et al., 2005, Gunn et al., 1983, Patel et al., 2005, Sturrock and Johnson, 1990), among studies which adjusted for maternal factors, no residual effect remained after adjustment (Artieta-Pinedo et al., 2010, Fabian et al., 2005, Patel et al., 2005, Sturrock and Johnson, 1990). One study found no effect of classes on mode of birth in unadjusted or adjusted analyses (Gareen et al., 2003).

As with the studies assessing antenatal care, the majority of the studies considering antenatal education were from the 1980s and 1990s and were from non-UK countries. In addition, unlike the antenatal care studies, all previous antenatal class studies included smaller sample sizes than the MCS, meaning that it is questionable whether there was sufficient statistical power in order to detect differences between antenatal groups in mode of birth, after adjusting for other factors.

Artieta-Pinedo and colleagues conducted the most recent study regarding antenatal education and mode of birth (Artieta-Pinedo et al., 2010). Over 600 primiparous women were recruited during their 36-week antenatal visit to the study assessing outcomes for women according to antenatal class attendance in Spain. Women were categorised in three groups according to the number of classes they had attended; a) none, b) 1-4, or c) 5 or more. As with the MCS results, unadjusted rates of unassisted vaginal birth were highest for mothers who did not attend classes, with over three-quarters having an unassisted vaginal birth, whereas rates for mothers who attended 1-4 sessions and 5 or more sessions were substantially and significantly lower (60% and 56% respectively, chi squared $p<0.05$). However, after adjustment for age, nationality, social class, education, hospital and personality, antenatal class attendance was no longer significantly related to mode of birth.

There are possible explanations for why the Spanish study found no effect of antenatal classes on mode of birth when compared to the findings from the MCS. Firstly, there could genuinely be no effect and it must be highlighted that the different samples and different health care systems make the studies difficult to compare. However, secondly, the Spanish study recruited a comparatively small sample of mothers and there was little variation in the care they received, as 83% of the women attended more than five classes, 10% attended 1-4 classes and only 7% (45 women)

attended no classes. Thirdly, although similar confounding factors were adjusted for in both studies - importantly including age, education and social class - Artieta-Pinedo and colleagues also adjusted for hospital of birth and personality. Personality measurements were actually found not to be significantly different between the antenatal groups, so it is unlikely that this factor accounted for variance. Hospital of birth could have made a difference however if, for example, the women who attended no classes were more likely to attend hospitals with high rates of unassisted vaginal birth.

Interestingly, the only English study by Patel and colleagues also found no effect of antenatal education on mode of birth after adjustment for maternal factors (Patel et al., 2005). Almost 13,000 women were included in the sample from the ALSPAC cohort from Avon in England. Women were more likely to have a planned caesarean section if they did *not* attend classes (although this effect was only significant in unadjusted analyses); most probably reflecting the reduced need to prepare for childbirth among these women. As in the MCS, women were also more likely to have an emergency caesarean section if they attended classes, but, unlike the MCS, this effect disappeared after adjustment for similar maternal factors.

Although the study by Patel and colleagues is more similar to the MCS than the other studies, importantly it was conducted 10 years previously in 1990 and 1991. This raises questions about the comparability of the two studies. At the time of the ALSPAC study, according to hospital statistics from England (The Information Centre, 2009b), 12% of women were having a caesarean section, (7% emergency). At the time of the MCS this figure had almost doubled to 22% (13% emergency). So, not only were a smaller proportion of women having operative births in Patel's sample compared to the MCS, the content of classes in the UK may have been different a decade before the MCS. Also, there may have been differences in the number of women who did not attend classes in the early 1990s compared to 10 years later. The Infant Feeding survey from 2000 reported a drop in the number of first-time mothers attending antenatal classes in a five-year period, with 70% attending in 1995 compared to 64% in 2000 (Hamlyn et al., 2002).

In my study, unlike previous research using observational data, results were stratified by parity. This was felt to be especially important as attendance to antenatal classes is much lower for multiparous women. In the MCS, only 14.5% of multiparous women attended classes, compared to over 67% of primiparous women. Statistical adjustment for important maternal, infant and labour characteristics made no difference to the increased risk of emergency caesarean section. The minority of women who attend antenatal classes when they have already experienced childbirth may represent a group which differs from mothers who do not attend in other, unmeasured ways.

9.10.3 Speculative explanations for the increased risk of emergency caesarean section for multiparous women who attend antenatal classes

There are several possible explanations for why multiparous women in the MCS who attended antenatal classes, were at an increased risk of emergency caesarean section, compared to multiparous women who did not attend classes.

9.10.3.1 Selection bias: background characteristics not adequately controlled for

Much of this chapter has discussed the importance of adjusting for the backgrounds of women when considering outcomes relating to antenatal care, as the social situation of the women who do not receive antenatal care is vastly different from those that do. Although every step has been taken to ensure that all confounding background information was controlled for (by first establishing the independent predictors of antenatal care, and adjusting for these), there is a chance that there are unmeasured differences between the women, which account for the differences in mode of birth found between the groups.

Gissler (1994) suggested that unmeasured reasons for women seeking antenatal care could explain why women who attended many antenatal visits had higher rates of caesarean section than women who did not. In the MCS, women were asked if they had any illness or problem during pregnancy that required medical treatment, and if they did, they were asked about the nature of the problem. For the purposes of analyses for this project, complications during pregnancy were coded as none, problem known to be a risk factor for caesarean section (e.g. diabetes), and other. Non-receipt of antenatal care was higher among women who reported having no problems during pregnancy. Although this result could reflect women who experience problems during pregnancy seeking medical attention, women who receive antenatal care who are asymptomatic may have underlying problems identified through routine tests, which could confound the results. Complications during pregnancy were adjusted for in the models predicting mode of birth.

In addition to maternal and pregnancy factors which were independently related to receipt of antenatal care, labour and infant factors were also adjusted for, unlike most previous studies.

Previous studies have found higher rates of epidural among attenders to classes compared to non-attenders (Fabian et al., 2005, Gunn et al., 1983), and in one study this was significant after adjustment for other maternal factors (Fabian et al., 2005). Self-reported pain relief during labour in the MCS was not used for the purposes of this study as it was clear that some women were reporting the method of pain relief used *for* an operative birth (see further details in Appendix 3). Prior studies have also shown higher rates of induction among attenders to classes compared to non-attenders (Sturrock and Johnson, 1990), although not significant. A further study found that

mothers who attended many antenatal visits had significantly higher rates of induction than mothers who attended an average number of visits, after adjustment for maternal factors (Gissler and Hemminki, 1994). Findings from the MCS did not show a significant difference between the antenatal groups in the use of induction of labour.

Primiparous and multiparous women who did not receive antenatal care were much more likely to report experiencing no complications during labour compared to women who had received antenatal care, and especially compared to women who had attended classes. In addition, length of labour was shortest for primiparous women who received no antenatal care and was significantly longer for women who had received care, and longest for women who had also attended classes (even after adjustment for maternal characteristics), which could suggest some differential care. However, length of labour did not differ significantly with antenatal care for multiparous women.

Women who gave birth preterm were significantly less likely to have attended classes and were more likely to have received no antenatal care. Additionally, both primiparous and multiparous women who did not receive antenatal care had the highest rates of low birth weight, whereas women who received care and attended classes had the lowest rates. Low birth weight could be a marker for gestational age (as preterm infants are likely to be low birth weight). However, in a model predicting birth weight, antenatal care remained a significant predictor of birth weight after adjusting for gestational age (results not shown). As with preterm birth, low birth weight is a more common outcome for women from disadvantaged backgrounds, from which the women who do not attend classes or care are more likely to originate.

Infant birth weight, gestational age, complications during labour and length of labour were all adjusted for in my analyses. However, a significant effect of antenatal class attendance on emergency caesarean section rates remained for multiparous women after maternal, pregnancy, infant and labour outcomes were controlled for.

9.10.3.2 Multiparous women who attend antenatal classes have a different attitude

Antenatal classes represent an opportunity to prepare for childbirth. Despite this, 15% (almost 1,500) multiparous women attended antenatal classes, despite having previously experienced childbirth. These women were at a 40% increased risk of emergency caesarean section compared to women who did not attend classes. Although, as discussed previously, many background characteristics were adjusted for, the association remained, with no attenuation of risk.

In order to understand further why there is an increased risk for these women, it is necessary to consider the reasons why they are attending classes.

Firstly, women who attend classes for a subsequent birth may have had a previous operative birth, and are seeking further support and information for having an unassisted vaginal birth. We know from Chapter 2 that having a previous caesarean section increases the risk of further caesarean sections. However, in the MCS, we do not have information on previous mode of birth in order to adjust for this. This explanation may be the most likely and further research with information on obstetric history is needed to clarify if multiparous women who attend classes are more likely to have had a previous operative birth.

Secondly, women who attend antenatal care in a subsequent pregnancy could reflect women who want more medical input in their pregnancy, and this motivation could also reflect their choices in labour. A change in womens' attitudes towards obstetric interventions has been demonstrated. A survey of womens' expectations and experiences of UK maternity services conducted in 1987 was repeated in a similar fashion in 2000 (Green and Baston, 2007). Questions regarding womens' views of interventions were obtained during the latter stages of pregnancy. In the 2000 sample, there were significantly more positive attitudes towards obstetric intervention than in the survey conducted 13 years previously. Interestingly, willingness to accept interventions also increased significantly with maternal age. Furthermore, women who were highly positive towards interventions were twice as likely to have an operative birth, and were also more likely to have an epidural. In fact epidural appeared to be the mediating factor between willingness to accept interventions and operative birth, as when epidural anaesthesia was included in the model predicting operative birth, willingness to accept interventions was no longer significant.

Thirdly, multiparous women who choose to attend antenatal classes, despite having experienced childbirth previously, may potentially be more anxious about the upcoming birth. Some literature discussed in Chapter 2 has suggested that women who are more anxious during pregnancy, or who have a fear of childbirth, have higher operative birth rates than mothers who are not anxious or scared antenatally. The MCS does not have any direct measures of womens' psychological wellbeing in pregnancy to be able to compare women according to their antenatal care, or their mode of birth. Therefore, it is not possible to establish if anxiety is an explanatory factor for the increased operative birth rates for multiparous women who attended classes.

Finally, multiparous women who attended antenatal classes may have had a longer inter-pregnancy interval (the time between the end of one pregnancy and the beginning of another). A long gap between births has been associated with several unfavourable maternal and infant outcomes. For example, in a large longitudinal Swedish study, compared to women with an inter-pregnancy interval between 12 and 35 months, women with an interval of 72 months or longer were at a 50% increased risk of stillbirth, and a possible increased risk of early neonatal death (although this was of borderline significance) (Stephansson et al., 2003). Conde-Agudelo and colleagues (2006)

conducted a systematic review and meta-analyses of 67 population-based observational studies assessing the relationship between birth spacing and adverse infant outcomes. The pooled estimates indicated that, compared to women with an inter-pregnancy interval of 18-23 months, women with a gap of 59 months or more were at an increased risk of having infants born preterm, of low birth weight and small for gestational age. More recent work by the same authors has systematically reviewed the literature on the relationship between birth spacing and maternal health (Conde-Agudelo et al., 2007). Results from the 55 studies, which were mainly of good quality, indicated that a longer pregnancy interval was associated with preeclampsia, placental abruption, placenta praevia (in women with a previous caesarean section), and labour dystocia. However, longer spacing decreased the risk of uterine rupture for women attempting VBAC. The link between longer birth spacing and adverse outcomes is unclear, however, advanced age, subfertility, unplanned pregnancy, or declining growth supporting facilities, such as uterine blood flow may explain the association (Rousso et al., 2002). In addition these women may have experienced further complications such as miscarriage since their last birth (Love et al., 2010). Further research adjusting for birth interval, in addition to the confounding factors discussed here, could establish if longer birth interval partly or wholly explained the relationship between antenatal classes and emergency caesarean section among multiparous women.

9.10.4 Measure of antenatal care in the MCS

The question asked to women in the MCS regarding whether they received antenatal care is clear and includes the possibility of care with different health professionals.

Comparisons with the proportion of women who reported receiving no care in the MCS and the proportion in the Infant Feeding Survey from a similar time period indicate a similar proportion of non-attenders. Information about women who do not access care in the UK is limited. However, what is not clear from the MCS question is the amount of care that the women received who reported receiving care, or how many classes women attended. Potentially, for women who reported receiving care, this could indicate anything from one visit upwards. As has been suggested previously (Gunn et al., 1983), poor attenders to antenatal care e.g. women who attended few visits, or one class for example, could bias results when comparing women who attended no care or no classes vs. women who attended any. To avoid bias, my analyses were statistically adjusted for the week that women entered antenatal care.

In addition to a lack of detail about how much care women received, or how many classes they attended, there is also no information about the type of classes women attended. There may be huge variation in the type of classes women attend. For example, if a woman reported attending one

antenatal class, the class could have been focused on labour and birth preparation, but equally it could have been focused on caring for the newborn baby.

Finally, as the information about antenatal care and class attendance is self-reported, there could be an issue of response bias; as attendance at antenatal care is socially desirable, women who did not attend may have falsely reported that they did. However, due to the dearth of information about non-attendance at antenatal care in the UK, it is difficult to estimate to what extent response bias may be present in the MCS antenatal care questions.

9.10.5 Measure of mode of birth in the MCS

The measurement of mode of birth in the MCS will be discussed in further detail in the overall discussion of Chapter 11. However, the mode of birth women reported having, warrants discussion in the context of this chapter as a minority of women (44) who reported having no care antenatally also reported having a planned caesarean section.

To have a planned caesarean section i.e. a caesarean section planned during pregnancy due to contraindications to labour, repeat caesarean, or, in a minority of cases maternal request, a woman would need to have had at least some antenatal care. This apparent anomaly highlights the issues around the classification of caesarean section, not only by mothers, but by health professionals. Quigley and colleagues matched MCS data to hospital records for over 12,000 of the mothers and compared the reported mode of birth to the mode of birth on the hospital records (Quigley et al., 2007). Unsurprisingly for the vast majority of cases women knew what type of birth they had, with over 94% agreement comparing six modes of birth (normal, forceps, ventouse, assisted breech, planned CS and emergency CS). For caesarean section the most disagreement was on the type of caesarean. For women who reported having a planned caesarean section, there was 87% agreement. Twelve per cent of the remaining disagreement was due to the hospital records recording an emergency caesarean section. These discrepancies will be discussed further in Chapter 11.

9.10.6 Summary

Antenatal care allows for the health of a woman and her fetus to be monitored during pregnancy with the aim of identifying problems early. Women who do not access antenatal care, or access care late, have been found to be at a higher risk of perinatal mortality and morbidity including preterm birth and low birth weight (Lavender et al., 2007). However, some literature has suggested that operative birth rates are *lower* for women who do not attend care, or attended care late in pregnancy.

The future of antenatal education in the UK is uncertain. Although much of the focus of classes is to prepare women for childbirth, a recent review of the literature regarding antenatal education for the Department of Health summarised that there is limited evidence that classes reduce pain in labour and the use of epidurals, or increase vaginal births. However, the review did conclude that there was some evidence of higher satisfaction with the birth experience for women who attended classes (McMillan et al., 2009).

There are inherent difficulties with evaluating the outcomes for women who do or do not attend antenatal care or classes. Clinical trials, recognised as the gold standard in research terms, may not be the best method for appraising antenatal care. It would be viewed unethical to randomise women to receive no or few antenatal visits, and the same would be true of antenatal education. Trials have attempted to randomise women to receive different numbers of visits, but the differences between the groups were so small that there may not have been an intervention (Villar et al., 2001). Attempting to evaluate outcomes with observational data however, also raises problems. Firstly, to avoid selection bias, analyses must be adequately adjusted for maternal characteristics, due to the considerable differences between women who attend antenatal care and those who do not. Secondly, many factors dictate what happens to a women during labour and birth, including, maternal health and psychology, the hospital environment and the beliefs and actions of the health professionals (Nolan, 2009); therefore even if a relationship between antenatal care and birth outcomes is observed, establishing a causal relationship is challenging.

The majority of observational studies which have assessed antenatal care and mode of birth have found a *decreased* risk of unplanned operative birth for women who receive less antenatal care. Results from the MCS show a decreased risk of emergency caesarean sections for multiparous women who do not attend *classes* compared to those who attend, after substantial adjustment for maternal, infant and labour factors.

Further research is needed to investigate the relationship between antenatal care and mode of birth. Multiparous women who attend classes may often be women who have had a previous caesarean section, or who are more anxious. The type of multiparous women who attend antenatal classes may also be more compliant, and may therefore be more likely to comply with interventions during labour and birth such as epidural, which could not be adjusted for in this study. A mixed-methods approach could identify if, as suggested by Green and Baston (2007), women have become more accepting of medical technology, and if antenatal class attendance among multiparous women is a reflection of this.

9.11 Summary

What is already known on this subject?

- The Department of Health have suggested that improving access to antenatal care among disadvantaged women could help to reduce health inequalities. However, in the UK there is a dearth of research about the characteristics of women who are less likely to access antenatal care. In particular, no research has examined women who do not receive any antenatal care.
- Few studies have investigated the relationship between antenatal care (and/or classes) and birth outcomes, including mode of birth. However, the modest quantity of literature indicates that women who do not attend antenatal care are at a *decreased* risk of caesarean section. In addition, there is some evidence that women who receive more education antenatally are at a higher risk of caesarean section.

What does this study add?

- The retrospective nature of the MCS interviews allowed for the identification of women who reported receiving no antenatal care. In addition, there was information on which women attended antenatal classes.
- The 3% of women who did not receive antenatal care comprised a more disadvantaged group who were likely to be younger, of Pakistani or Bangladeshi origin, non-UK born, of low socio-economic status and to have smoked in pregnancy. Similar characteristics were also predictive of non-attendance at antenatal classes.
- In unadjusted analyses, non-receipt of antenatal care and non-attendance at classes was protective against operative birth.
- For primiparous women, when adjusted for maternal characteristics, antenatal care and class attendance were no longer related to mode of birth. However, for multiparous women who attended antenatal classes, there was an increased risk of emergency caesarean section (compared to women who did not attend classes).
- Further research is needed to investigate the relationship between antenatal care and mode of birth. Multiparous women who attend classes may be women who have had a previous caesarean section, who are more anxious, or who are seeking medical input in their pregnancy and their birth.

Section C:

The interplay of maternal, fetal and maternity service factors

CHAPTER 10: The Millennium Cohort Study: Fully adjusted models for the risk factors of operative birth

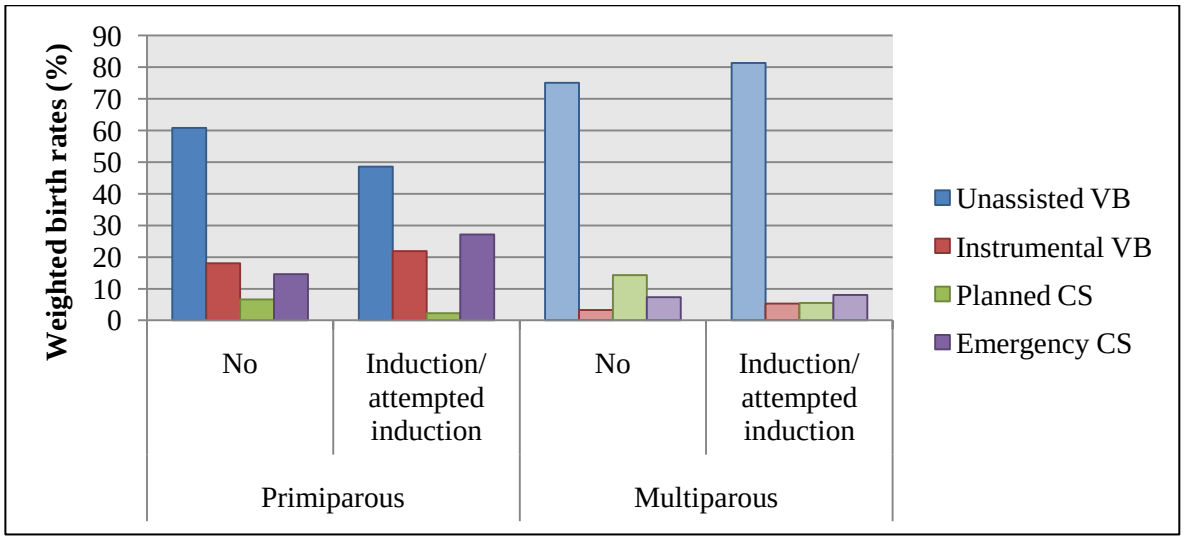
10.1 A note on MCS maternity service factors

Chapter 4 presented bivariate associations between maternal and infant factors and mode of birth. After reviewing relevant literature in Chapter 8, three maternity service-related variables were utilised from the MCS in this study; antenatal care (see details in Chapter 9), induction of labour and companionship during labour. The unadjusted relationships between induction of labour and companionship during labour will be described here (details of frequencies and weighted percentages are available in Table A4.2), and all three variables are included in the fully adjusted models presented in this chapter.

10.1.1 Induction of labour

Mothers who reported having induction, or attempted induction, had higher rates of emergency caesarean sections and instrumental vaginal births than mothers with a spontaneous onset of labour (see Figure 10.1).

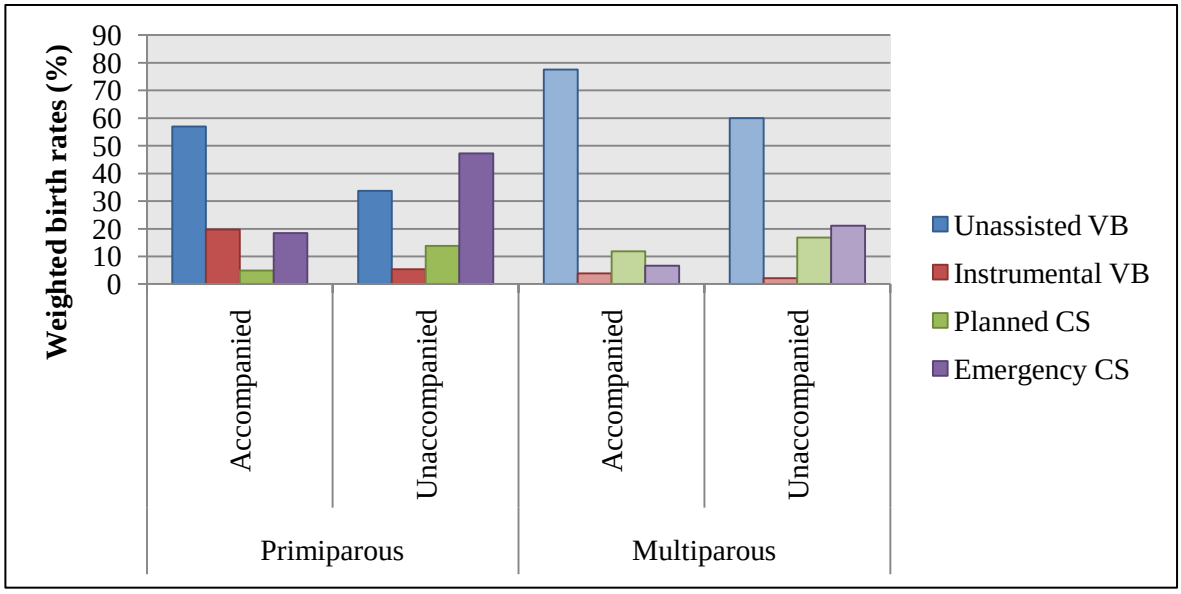
Figure 10.1: Mode of birth by induction of labour and parity



10.1.2 Companionship during labour

Women who were unaccompanied by a support partner during labour and birth had higher rates of emergency and planned caesarean sections, but lower rates of instrumental births.

Figure 10.2: Mode of birth by companionship during labour and parity



10.2 The need for multivariate analyses

In the analyses so far I have established the unadjusted relationships between maternal and fetal characteristics, and mode of birth (Chapter 4), and for some of these factors, I have conducted supplementary exploratory analyses in order to further understand these relationships. Chapters 5 through 7 and Chapter 9 focused on age and socio-economic status, ethnicity, fetal sex and antenatal care. The next step in my analyses was to model the socio-demographic, socio-economic, interpersonal, pregnancy, health, labour and fetal factors in multinomial logistic regression analyses, to establish which factors are *independently* related to mode of birth, whilst taking other important predictors into account.

Almost all maternal and fetal characteristics explored in Chapter 4 were modelled in this chapter, with three exceptions:

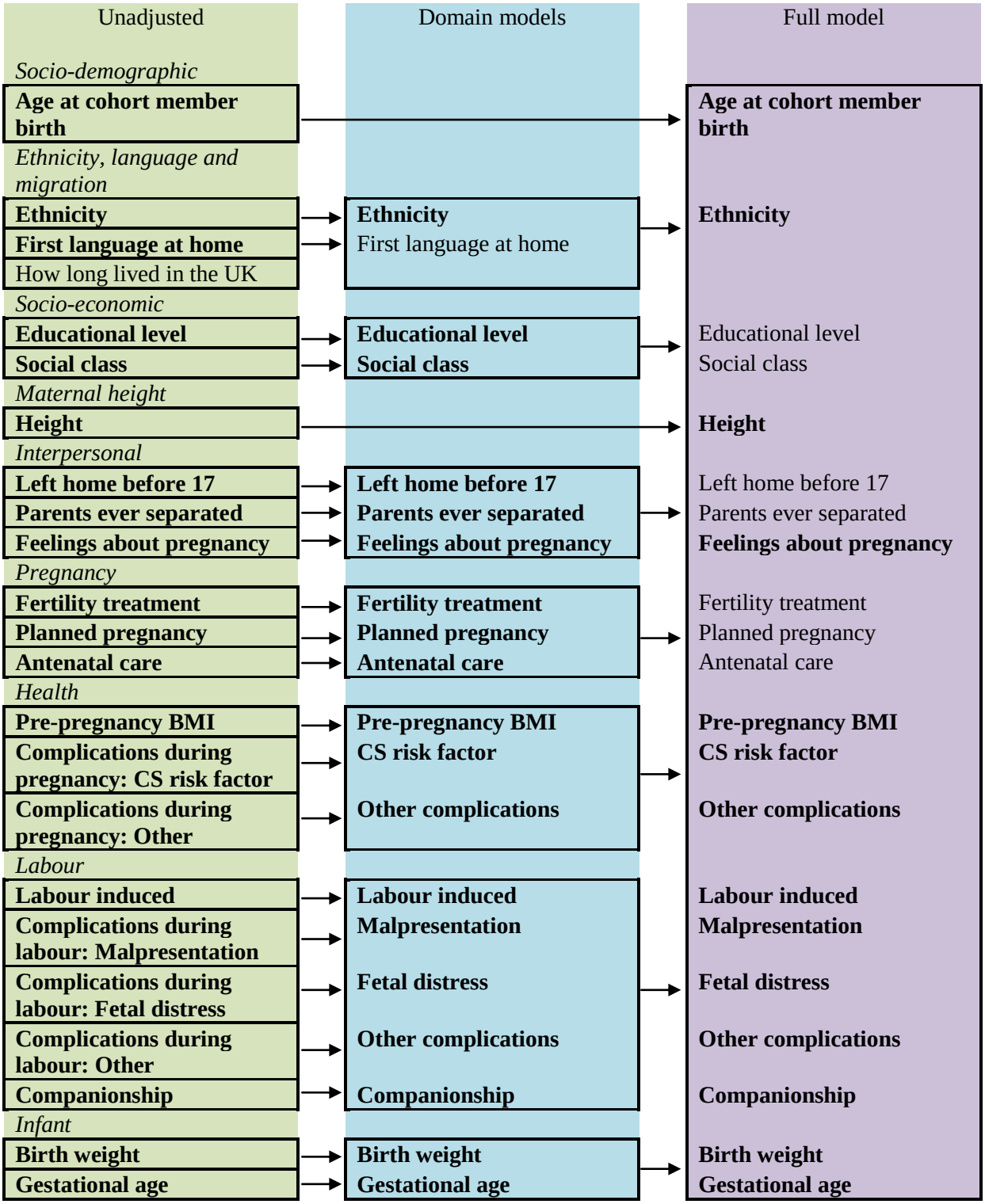
1) Paternal age was found to be unrelated to mode of birth, after adjustment for maternal age in Chapter 5.

2) Smoking during pregnancy was found to be a marker for social disadvantage in Chapter 5, and after adjustment for maternal age and socio-economic status, was no longer independently related to mode of birth.
3) The effect of fetal sex on mode of birth was explored in Chapter 7. Although found to be independently related to mode of birth after adjustment for birth weight and gestational age (as markers of fetal size), additional covariates included in the final models in this chapter were unlikely to confound the relationship between fetal sex and mode of birth.

Figures 10.3 and 10.4 summarise the method of modelling conducted to establish the independent predictors of mode of birth. Characteristics found to be significant (at the $p<0.05$ level) in unadjusted analyses were modelled together within each domain in multinomial logistic regression models. Domains with only one covariate, e.g. maternal height, were not modelled at this stage. Characteristics found to be significantly related to mode of birth from each domain were added into a final model.

To test for effect modification, interactions between the independent variables on the relationship with mode of birth were explored by adding multiplicative interaction terms to the fully adjusted models. Interactions found to be significant after adjustment were retained in the final models.

Figure 10.3: Summary of the characteristics of *primiparous* women examined in relation to mode of birth: the significant predictors and the models built for statistical adjustment



Factors in **bold** were significantly related to mode of birth

Figure 10.4: Summary of the characteristics of *multiparous* women examined in relation to mode of birth: the significant predictors and the models built for statistical adjustment

Unadjusted	Domain models	Full model
Socio-demographic		
Age at cohort member birth	**Age at cohort member birth**	**Age at cohort member birth**
Age at first birth	**Age at first birth**	**Age at first birth**
Ethnicity, language and migration		
Ethnicity	**Ethnicity**	**Ethnicity**
First language at home		
How long lived in the UK	**How long lived in the UK**	**How long lived in the UK**
Socio-economic		
Educational level	**Educational level**	**Educational level**
Social class	**Social class**	Social class
Maternal height		
Height		**Height**
Interpersonal		
Left home before 17	**Left home before 17**	**Left home before 17**
Parents ever separated	**Parents ever separated**	Parents ever separated
Feelings about pregnancy	Feelings about pregnancy	
Pregnancy		
Fertility treatment	**Fertility treatment**	**Fertility treatment**
Planned pregnancy	Planned pregnancy	
Antenatal care	**Antenatal care**	**Antenatal care**
Health		
Pre-pregnancy BMI	**Pre-pregnancy BMI**	**Pre-pregnancy BMI**
Complications during pregnancy: CS risk factor	**CS risk factor**	**CS risk factor**
Complications during pregnancy: Other	**Other complications**	**Other complications**
Labour		
Labour induced	**Labour induced**	**Labour induced**
Complications during labour: Malpresentation	**Malpresentation**	**Malpresentation**
Complications during labour: Fetal distress	**Fetal distress**	**Fetal distress**
Complications during labour: Other	**Other complications**	**Other complications**
Companionship	**Companionship**	**Companionship**
Infant		
Birth weight	**Birth weight**	**Birth weight**
Gestational age	**Gestational age**	**Gestational age**

Factors in **bold** were significantly related to mode of birth

10.3 Summary of the significant predictors of operative birth

Table 10.1 summarises the significant ($p<0.05$) predictors of operative birth from the fully adjusted models presented in Tables A10.2 through A10.7. A full description of the model results can be found in Appendix 4. The risks are also summarised in Figures 10.5 through 10.10, where red arrows indicate increased risk and blue arrows denote decreased risk. The thickness of the arrows relates to the effect size.

Table 10.1: Summary of the significant (p<0.05) and independent risk factors for operative birth*

Maternal characteristics#	Instrumental VB		Emergency CS		Planned CS	
	Primip	**Multip**	**Primip**	**Multip**	**Primip**	**Multip**
Socio-demographic						
Age at cohort member birth (reference=25-29)	↑Age (35+ = 2.1)		↑Age (35+ = 2.8)		↑Age (35+ = 3.3)	Older (30-34=1.3)
Age at first birth (reference=25-29)	N/A	Younger (<19=0.3)	N/A	Younger (<19=0.4)	N/A	Younger (<19=0.5)
Ethnicity, language and migration						
Ethnicity (reference=White)	Black (0.4)		Black (1.7)	Pak/Ban (0.5)	Black (0.5, p=0.06)	Pak/Ban (0.6, p=0.06)
First language at home						
How long lived in the UK (reference=UK born)		<5 years (3.7)		>5 years (1.9)		
Socio-economic						
Educational level (reference=degree level)		Overseas (2.8)	No education (1.5, p=0.06)			
Social class (reference=higher managerial)	Lower (semi-routine=1.4, p=0.06)				Lower (routine=2.1)	
Maternal height						
Height (reference=160-165cm)	Taller (0.8)		↓Height (<154cm=2.6)	↓Height (154-159cm=1.8)		↓Height (<154cm=1.5)
Interpersonal						
Left home before 17 (reference=no)		Yes (0.5)				
Parents ever separated						
Feelings about pregnancy (reference=happy)	Unhappy (0.8, p=0.05)		Unhappy (0.6)		Unhappy (0.5)	

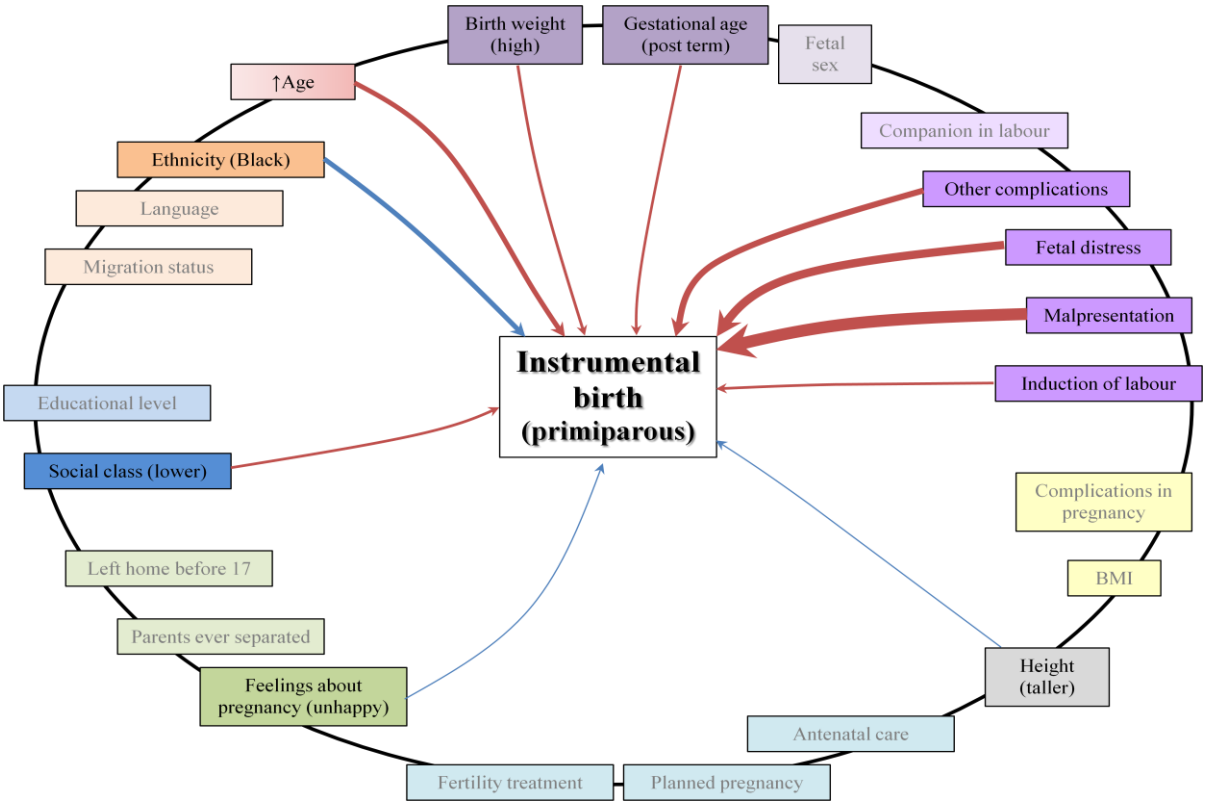
Pregnancy						
Fertility treatment (reference=none)						Treatment (2.7)
Planned pregnancy						
Antenatal care**				Classes (1.4)	No classes (1.4, p=0.06)	
Health						
Pre-pregnancy BMI (reference=ideal)			↑Obese (severely=2.5)	Severely obese (2.4)		↑Overweight (severely=2.1)
Complications: *'CS risk factor'*			CS risk (1.5)	CS risk (1.6)	CS risk (1.7)	CS risk (2.1)
Complications: *Other*			'Other' (0.7)		'Other' (1.5)	
Labour and birth						
Labour induced (reference=no)	Induced (1.5)		Induced (2.0)		Induced (0.5)	Induced (0.4)
Complications: *Malpresentation*	Malpres. (7.2)	Malpres. (12.3)	Malpres. (17.3)	Malpres. (16.4)	Malpres. (22.7)	Malpres. (8.1)
Complications: *Fetal distress*	Distress (4.7)	Distress (5.3)	Distress (6.9)	Distress (4.3)	Distress (0.2)	Distress (0.1)
Complications: *Other*	Other (3.5)	Other (3.5)	Other (5.2)	Other (4.6)		Other (0.4)
Companion (reference=accompanied)			No comp. (6.0)	No comp. (4.1)	No comp. (6.5)	No comp. (2.4)
Infant						
Birth weight (reference=normal)	High (1.4)		Low (1.9) High (3.3)	Low (4.3) High (1.8)		
Gestational age (reference=normal)	Post term (1.6)		Preterm (2.3) Post term (1.5)	Preterm (4.6)		

*Relative risk ratios (RRRs) given in brackets, ↓ = decreasing, ↑ = increasing, for factors with a gradient effect an example category RRR is given, pink indicates increased risk and blue indicates decreased risk.[#] Factors in **bold** significantly predictive of antenatal care or classes ** Reference for primiparous women=received care and attended classes, reference for multiparous women=received care but did not attend classes.

10.3.1 Instrumental vaginal birth

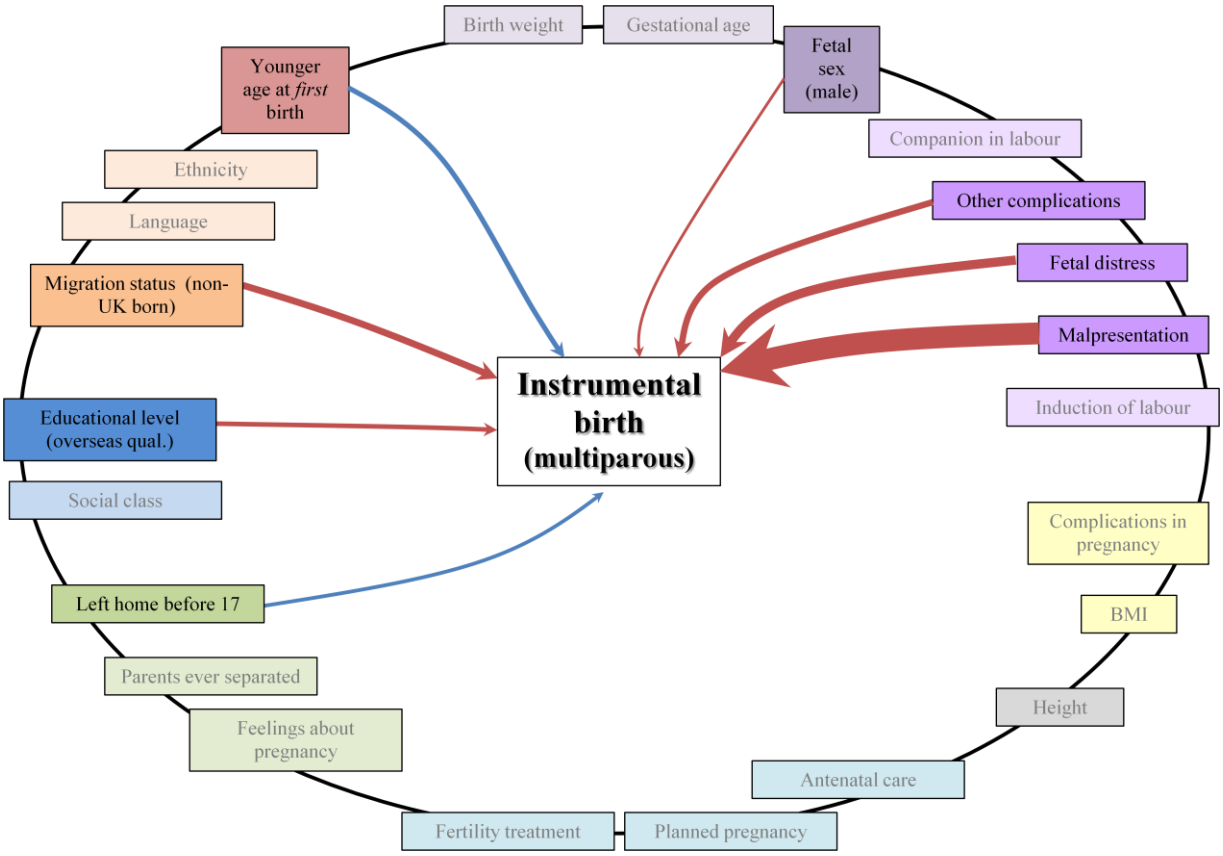
Among *primiparous* women, those who were older and of lower social class were more likely to have an instrumental vaginal birth, whereas Black women, women who were taller than average and women who were unhappy about the pregnancy were less likely. Women who had an induced labour and those who reported malpresentation, fetal distress or other complications in labour were more likely to have an instrumental birth, as were mothers who gave birth to either a high birth weight or post-term infant.

Figure 10.5: Predictors of instrumental birth for primiparous women



For *multiparous* women, those who reported malpresentation, fetal distress or other complications in labour were more likely to have an instrumental birth. In addition, mothers who had migrated to the UK less than five years previously and those with an overseas qualification were at an increased risk of an instrumental vaginal birth. Women who were younger at their first birth and those who left home before the age of 17 were at a reduced risk of instrumental birth.

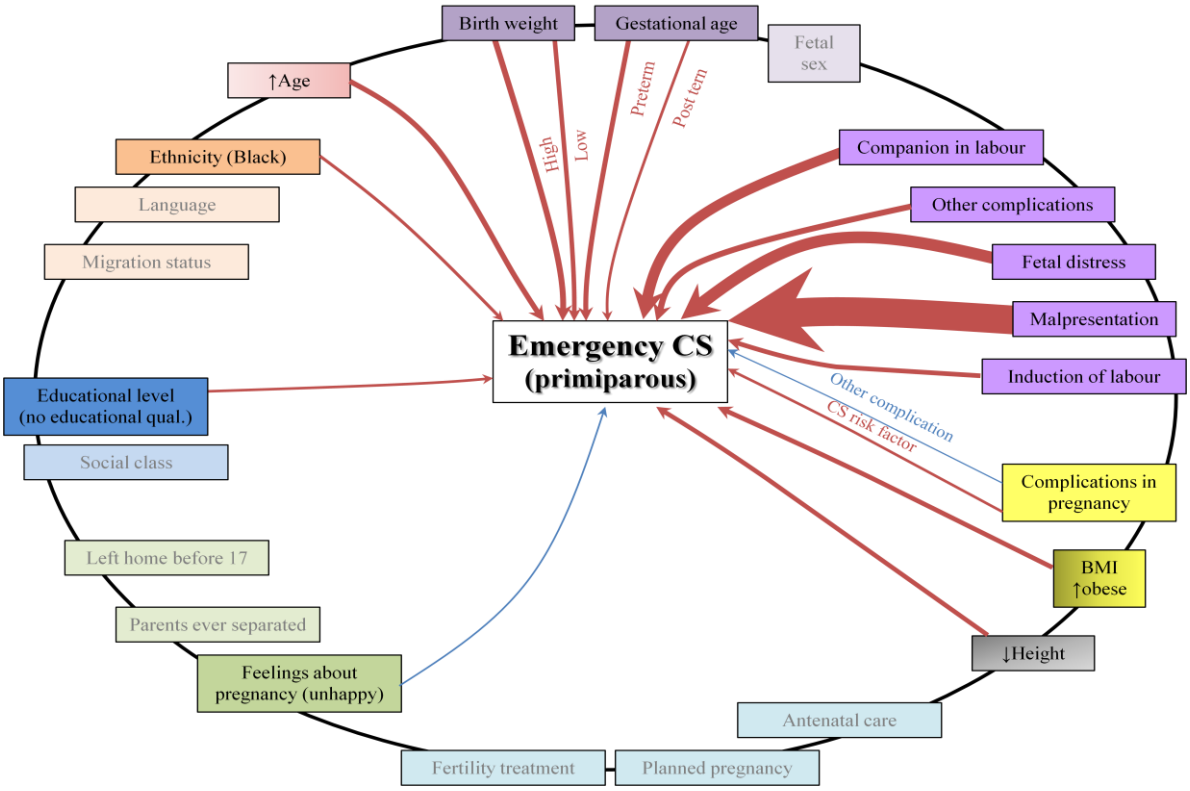
Figure 10.6: Predictors of instrumental birth for multiparous women



10.3.2 Emergency caesarean section

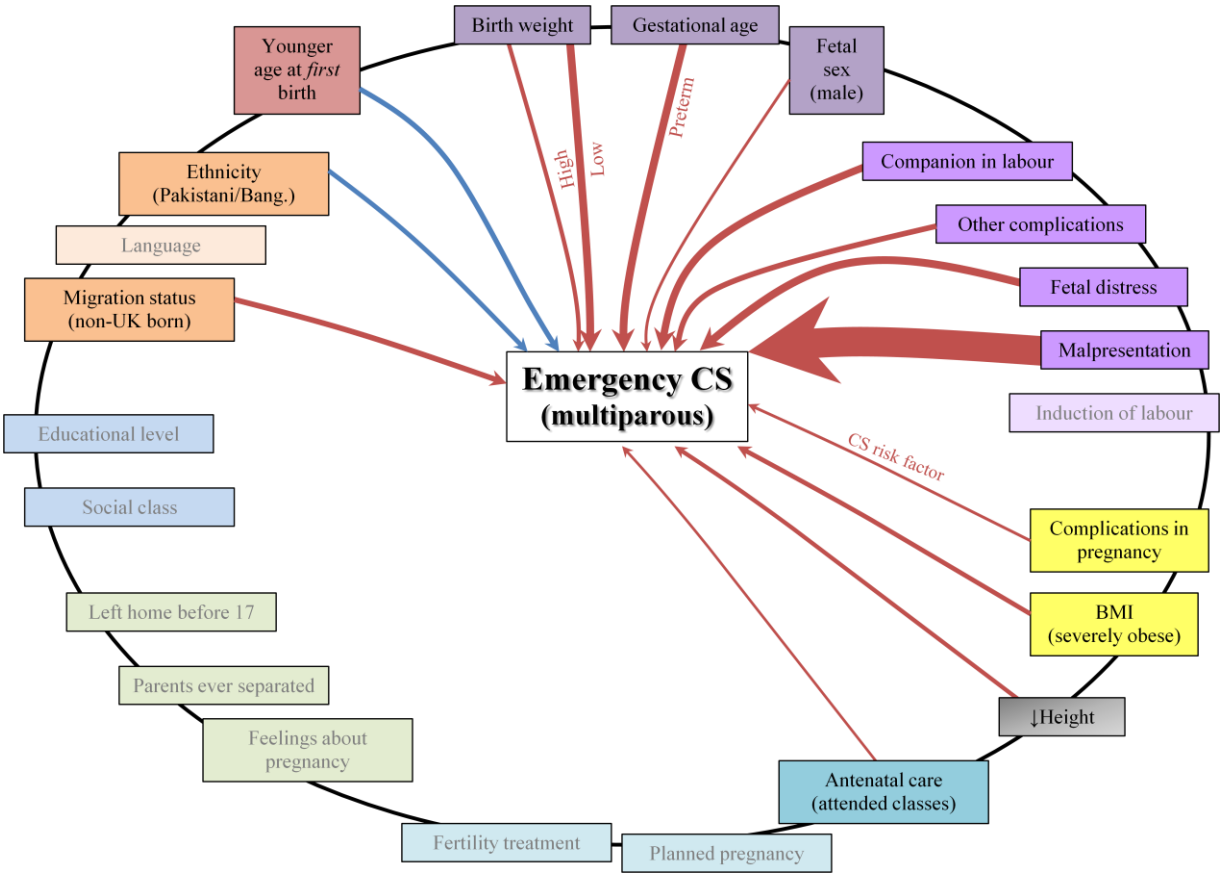
For *primiparous* women, those who were older, shorter, obese pre-pregnancy, and those who had a 'caesarean section risk factor' during pregnancy were more likely to have an emergency caesarean section. Women of Black ethnicity and those with no education were also more likely to have an emergency caesarean section. In terms of labour factors, women who were induced and who reported malpresentation, fetal distress or other complications in labour were more likely to have an emergency caesarean section, as were women who had no companion for the birth. Compared to women who gave birth to a normal weight infant and those who gave birth at term, women who gave birth to both low and high birth weight infants, and those who gave birth both pre and post-term were also more likely to have an emergency caesarean section. Mothers who were unhappy or not bothered when they discovered they were pregnant were at a decreased risk of emergency caesarean section, as were women with an 'other' problem during pregnancy.

Figure 10.7: Predictors of emergency caesarean section for primiparous women



Among *multiparous* women, those who had migrated to the UK more than five years previously were at an increased risk of emergency caesarean section, as were women who were of shorter stature, and those who attended antenatal classes (compared to women who did not attend). Similar health, labour and infant factors were predictive of emergency caesarean section to those observed for primiparous women. There was a higher risk of emergency caesarean section for mothers who were severely obese pre-pregnancy, for those who had a 'caesarean section risk factor' during pregnancy and for those who reported malpresentation, fetal distress or other complications in labour. Mothers who gave birth to low and high birth weight infants were at an increased risk of emergency caesarean section, as were mothers who gave birth preterm, but unlike primiparous women, multiparous women who gave birth post-term were not at an increased risk of emergency caesarean section. Multiparous women who were younger at their first birth and women of Pakistani/Bangladeshi ethnicity were at a reduced risk of having an emergency caesarean section.

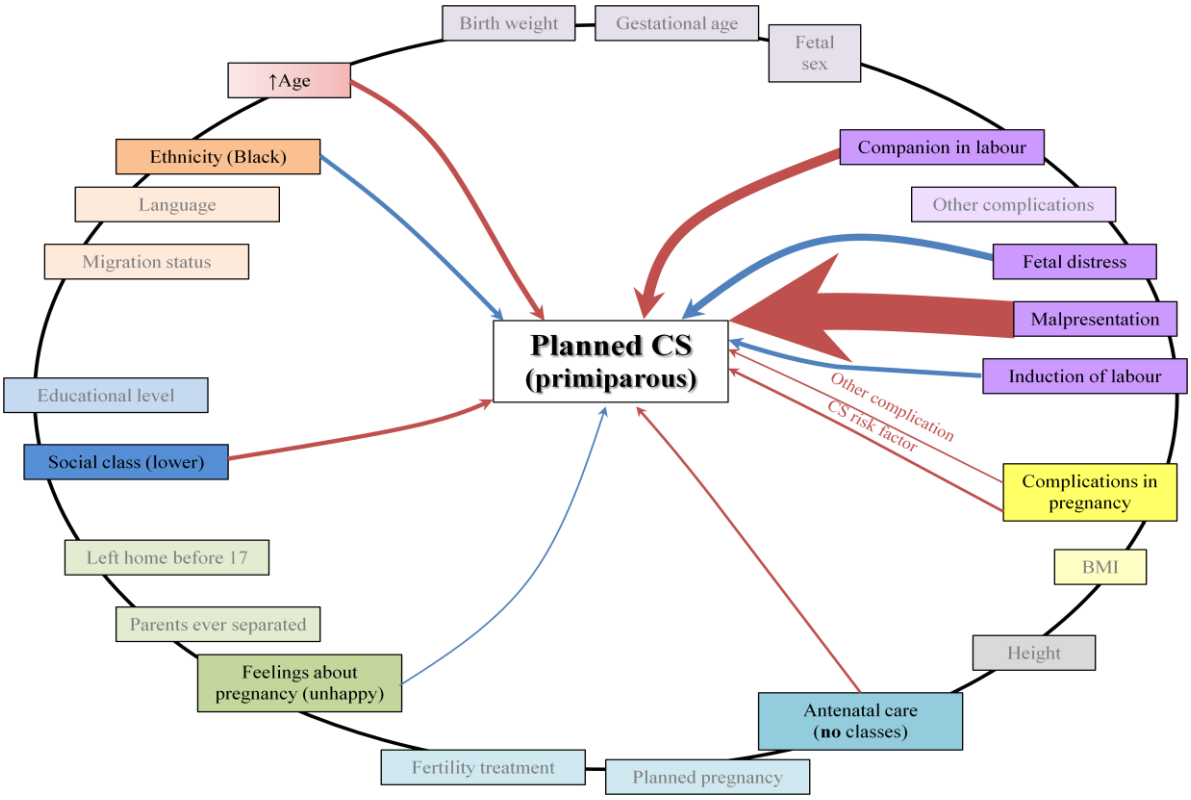
Figure 10.8: Predictors of emergency caesarean section for multiparous women



10.3.3 Planned caesarean section

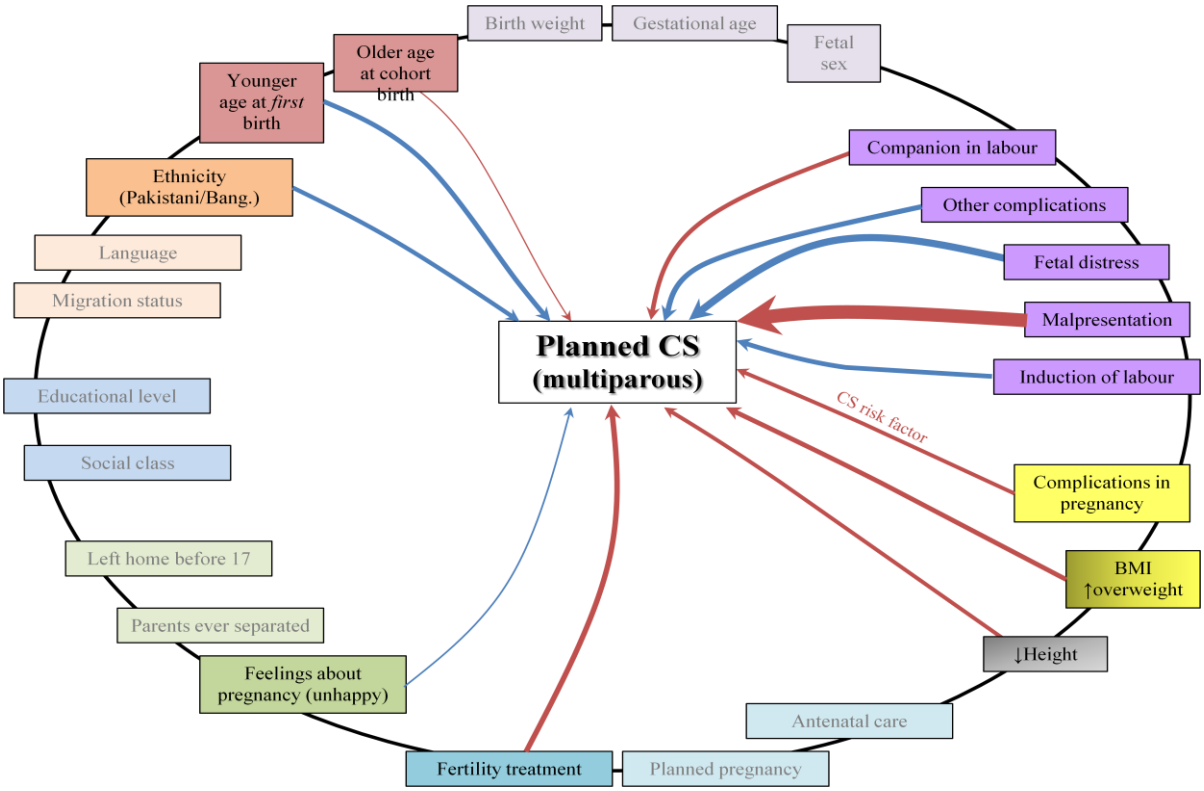
Among *primiparous* women, those who were older, those of lower social class, those who had not attended antenatal classes, women who experienced 'caesarean section risk factors' or 'other' problems during pregnancy, and those who reported malpresentation or no companion at birth were more likely to have a planned caesarean section. Mothers who were unhappy or not bothered when they discovered they were pregnant and women who reported fetal distress or being induced were less likely to have a planned caesarean section.

Figure 10.9: Predictors of planned caesarean section for primiparous women



For *multiparous* women those who were older at the cohort birth, of shorter stature, those who had received fertility treatment, who were overweight or obese pre-pregnancy and those who experienced a 'caesarean section risk factor' during pregnancy were more likely to have a planned caesarean section. In addition, women who reported malpresentation or having no companion at birth were also more likely to have a planned caesarean section, whereas women who were induced and those who reported fetal distress or other complications at the birth were less likely.

Figure 10.10: Predictors of planned caesarean section for multiparous women



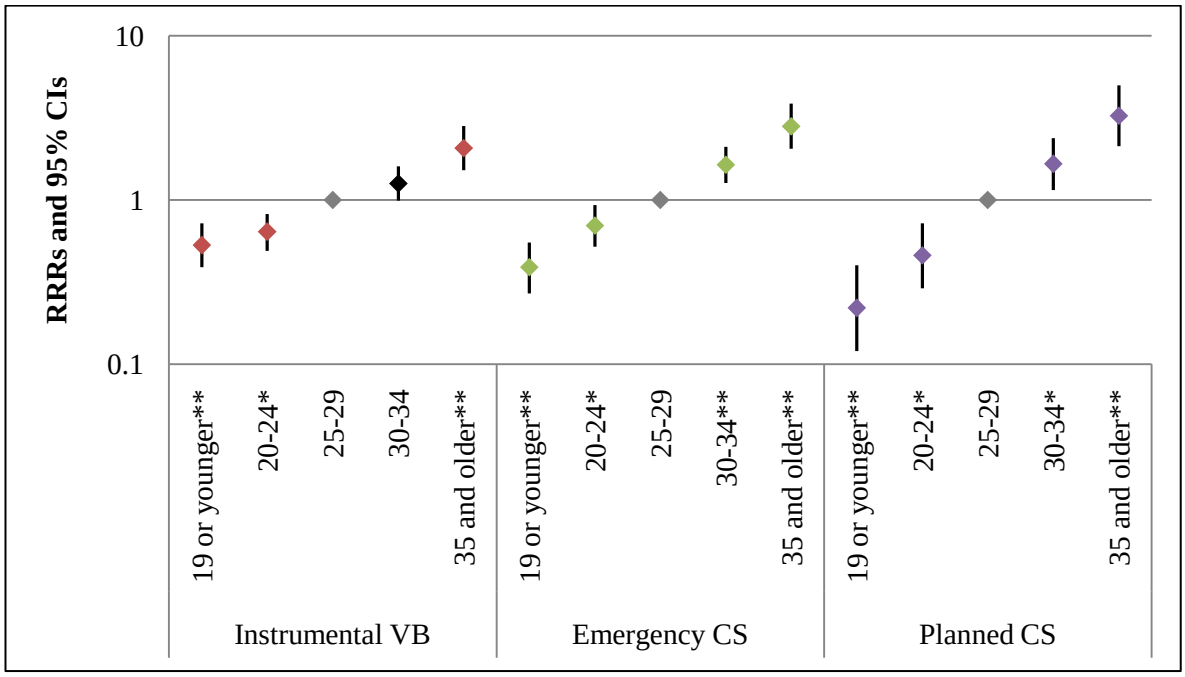
10.4 Discussion

10.4.1 Maternal age

There has been an interest in the association between 'advanced' maternal age and the risk of caesarean section. A recent systematic review included only studies which compared women aged over 35 to younger women (Bayrampour and Heaman, 2010). Substantial literature has found an increased risk of operative births for mothers of increasing maternal age (see Chapter 2), not just for those of 'advanced' childbearing age. For studies that distinguished between planned and emergency caesarean sections, a similar pattern emerged for both. For instrumental births the picture was less clear, with some studies finding an increased risk with increasing age, some finding an increased risk only for mothers over thirty, and some finding no effect of age on rates of instrumental births.

Findings from the MCS demonstrate the significant association between increasing maternal age and an elevated risk of operative birth for first-time mothers. After full adjustment, the effect of age was strongest for planned caesarean section, as can be seen in Figure 10.11. Notably, adjusting the results for maternal and fetal factors made little difference to the risks observed.

Figure 10.11: The effect of maternal age at birth on the risk of operative birth for primiparous women



**p<0.001, *p<0.05

The strong effect of maternal age at first birth not only affects the earliest birth, but also later births for women. As discussed in Chapter 3, age at first birth was estimated using information about the mother's other children. For multiparous women, younger age at first birth was protective of a later operative birth in the MCS. This effect could be explained by previous mode of birth, but obstetric history is not available in the MCS. There could also be a cohort effect. We know from the UK maternity statistics presented in Chapter 1 that caesarean section rates have been consistently rising. As the analyses in this study are adjusted for age at cohort member birth, we are effectively holding age constant (as if all women in the study were the same age at the cohort birth). Therefore a woman who had her first birth younger would also have given birth in an earlier year, when caesarean section rates were comparatively lower.

In Chapter 5 the association between pregnancy and labour factors and age at birth were examined. There was no evidence that women experienced poorer health during pregnancy with increasing age. Issues such as gestational diabetes, hypertension, and placenta praevia have previously been shown to increase with maternal age (Cleary-Goldman et al., 2005, Kirz et al., 1985, Luke and Brown, 2007, Martel et al., 1987). The self-reported measure of complications used in the MCS may have been too inclusive, diluting any effect of these particular issues. However, numbers of women with these problems were too small to be examined separately.

There was strong evidence of increasing labour and birth complications with increasing age, which could indicate poorer uterine activity with older age. In particular, malpresentation increased with increasing age, as has been previously observed (Ecker et al., 2001, Luke and Brown, 2007). However, malpresentation, fetal distress and other complications did not explain the increased risk of operative birth with increasing maternal age.

10.4.2 Ethnicity, migration status and language

10.4.2.1 Ethnicity

Some UK studies have documented differences in operative birth rates by ethnic background, but as discussed in Chapter 2, the measurement of ethnicity was broad or could have been inaccurate in some studies. In the MCS, women self-reported their ethnicity and this was categorised according to the census classification: White, Mixed, Indian, Pakistani/Bangladeshi, or Black (women of 'other' ethnic background were excluded due to the heterogeneous nature of the group).

Despite the oversampling of ethnic minority groups in the MCS, some groups included in these analyses were small and this was particularly a problem as the analyses were stratified first by

parity, and then by mode of birth. The sample sizes within groups as described in Table A4.2 should be considered in the interpretation of the results.

In the MCS, primiparous Black women were at 1.7 times the risk of emergency caesarean section compared to White women after full adjustment for significant maternal and fetal factors. The best quality and largest previous study by Paranjothy (2005) used information on over 150,000 women from all maternity units in England and Wales and was conducted at a similar time to the first wave of the MCS, in 2000. Due to the large sample, ethnicity was classified according to the more detailed census classification described at the outset of Chapter 6, but with Mixed ethnicity mothers presumably included in 'other'. As such there were three groups of Black women in Paranjothy's study; Black African, Black Caribbean and Black Other. Black African women were at the highest risk of emergency caesarean section at 2.3 times the risk of White women and Black Caribbean and Black Other women were around 1.7 times more likely. The results were adjusted for age, number of previous vaginal births, number of previous caesarean sections, gestation, mode of onset of labour, presentation and birth weight. The risk for Black mothers in the MCS was therefore similar and was adjusted for other factors known to differ by ethnicity such as BMI and socio-economic status.

Compared to White women, Black and Pakistani/Bangladeshi women were at a reduced risk of a planned caesarean section (although the results were of borderline statistical significance). These findings seem to support those of Paranjothy and colleagues (2005) who found that compared to White women, all other ethnic groups (including Black and Pakistani/Bangladeshi women) were at a reduced risk of a pre-labour caesarean section.

Primiparous Black women in the MCS were at a reduced risk of an instrumental birth compared to White women. This result supports those reported previously; for example, a study conducted in three London hospitals found that after adjustment for maternal and hospital factors, African and West Indian women were at half the risk of an instrumental birth compared to White women (Ibison, 2005). In addition, although unadjusted, the 2005-06 maternity statistics showed that 9% of White women with a spontaneous onset of labour went on to have an instrumental birth compared to 4% of Black mothers – the lowest rate (Richardson and Mmata, 2007).

Although the results in the MCS are comparable to those found in the few previous studies, it is unclear why women of different ethnicities have different risks of operative births. Bhopal has suggested that several social and biological forces generate ethnic health inequalities (Bhopal, 2009). Ibison (2005) suggested that maternal height, BMI and presence of a companion could have confounded their results, all of which were adjusted for in my study. In addition, unlike previous

studies, in my study, results were adjusted for health during pregnancy, complications during labour and socio-economic status, as well as migration status. The high BMI of Black women did explain some of their excess risk of emergency caesarean section (see Chapter 6). However, a residual effect of ethnicity on mode of birth remained after adjusting for all of these factors.

That Black women were at an increased risk of an emergency caesarean section compared to White women, but a reduced risk of instrumental birth is interesting. Instrumental births can only be conducted in the second stage of labour, when the woman is fully dilated. A higher risk of emergency caesarean section could therefore indicate increased complications in the early stages of labour, or a delay in reaching the second stage of labour.

Primiparous Pakistani/Bangladeshi women were at a reduced risk of having an unplanned operative birth in the unadjusted and the domain model. However, when fully adjusted, the relationship was no longer significant. This may be partly related to the younger average age at which Pakistani and Bangladeshi women began childbearing. In the MCS this was 23 years, much younger than White women (27). For multiparous women there was less variation in age by ethnic group.

Half of the Black women and two-thirds of Pakistani/Bangladeshi women in the sample were non-UK born. In the unadjusted analyses multiparous Black women were at almost twice the risk of emergency caesarean section compared to White women. However, adjusting for migration status explained the association. For multiparous Pakistani/Bangladeshi women, migration status appeared to be a negative confounder (Szklo and Nieto, 2007), as adjusting for migration status revealed a decreased risk of emergency caesarean section for these women which was previously non-significant.

10.4.2.2 Migration status

Multiparous women who were migrants were at a higher risk of having either an instrumental birth or an emergency caesarean section, compared to women who had been born in the UK. The link between migration and health is complex. Nazroo (1997) found evidence of a ‘healthy migrant effect’ when comparing the health of British and foreign-born ethnic minorities, with the health of the migrant population being better on average. This effect could be due to the better health needed in order to travel, and the different age and socio-economic profile of migrants compared to non-migrants in their home country (Nazroo, 1997). However, the experience of migration is likely to be stressful, and difficulties getting work, financial problems, as well as a lack of social support and different cultural beliefs could impact on the health of migrants (Im and Yang, 2006).

There is no information in the MCS about where the women had previously given birth. For a woman who had previously given birth in a foreign country there could be stark differences in the maternity system of their home country, and the UK. Katbamna (2000) conducted interviews with 15 Bangladeshi women, the majority of whom had lived in the UK for less than ten years. Many of the women reported delaying going to the hospital due to anxieties about the 'alien environment'.

Over time migrants can experience acculturation, by taking on the cultural values and customs of their new country (Im and Yang, 2006). This process of acculturation is even more likely to have occurred for second or third generation descendents of migrants, who have been born in the UK. In the UK a considerable proportion of minority ethnic groups are UK-born (Nazroo, 1997). Recent interviews with 34 UK-born ethnic minority mothers regarding their experiences of maternity care revealed that the women did not feel their ethnic background affected the care they received (Puthussery et al., 2010). The apparent equity of the care they received compared to White women was felt by the women to be due to their lack of language barriers and their UK-born status, and in addition they were more familiar with the UK maternity system. Language was not found to be a significant predictor of mode of birth in the MCS for multiparous women, and for primiparous women adjusting for ethnicity accounted for the variation in mode of birth by language. This surprising result has also been demonstrated previously by Ibison (2005), who found that the addition of 'language difficulties' to regression models did not change the odds of operative birth by ethnicity.

10.4.3 Socio-economic status

The highest occupation in the household ('social class') and educational level of the mother were used as measures of socio-economic status in this study. In the fully adjusted models for primiparous women, compared to women in the highest social class band and with degree level education, women of lower social class were at an increased risk of an instrumental birth and women with no educational qualifications were at an increased risk of an emergency caesarean section. In addition, multiparous women of lower social class were more likely to have a planned caesarean section.

Compared to the women in the highest social class band, first-time women in lower social class bands were around 1.4 times more likely to have an instrumental birth. To my knowledge, no previous UK research has assessed the link between socio-economic status and instrumental births. Furthermore, multiparous women of lower social class were more likely to have a planned caesarean section. These findings counter those found by Alves and Sheikh (2005), Barley and

colleagues (2004) and Fairley and colleagues (2011), who found that women in more deprived areas were *less* likely to have a planned caesarean section.

As discussed in Chapter 2, the area-based measures used in previous studies may not have accurately measured women's socio-economic position. Also, hospitals vary widely in their caesarean section rates (Paranjothy et al., 2005), using area-based measures could be more prone to bias if hospitals with high caesarean section rates were situated more frequently in affluent areas. Furthermore, both studies also adjusted for many fewer maternal and fetal characteristics than are adjusted for in this study.

The recently published large Scottish study used routinely collected data, with information on both area-level deprivation and social class (Fairley et al., 2011). The results from the most recent data included in the study, 1999-2000, suggest that women of low social class were at a *reduced* risk of a planned caesarean section, whereas the results from the MCS indicate the opposite. However, there are a number of important differences between the two studies that should be considered. Firstly, the MCS is a UK-wide study. Secondly, although the main analyses presented by Fairley and colleagues are for all women, they also present analyses stratified by previous caesarean section. When examining these stratified analyses, social class was only significantly related to planned caesarean section for women with a previous caesarean section, with the result for women with no history of caesarean section non-significant. My result was for primiparous women, and the MCS does not contain information to stratify by obstetric history. Finally, the MCS analyses were adjusted for numerous factors not accounted for by Fairley and colleagues, including educational level, ethnicity, migration, language, BMI, antenatal care, complications in pregnancy and labour and birth weight.

The reason for the higher risk of instrumental birth and planned caesarean section for women of lower social class is unclear. Disentangling the explanations for why socio-economic status is related to mode of birth is complicated. There are many linked factors such as younger age at first birth, higher likelihood of substance abuse and smoking in pregnancy, poorer eating habits, higher rates of obesity and more unintended pregnancies among disadvantaged women (Dowd, 2007, Nelson and Popenoe, 2001). In addition, women of lower social class are more likely to give birth preterm and to low birth weight infants (Macfarlane and Mugford, 2000). Nevertheless, a significant effect remained after adjustment for many of these factors.

Stress levels may also be higher for women of lower social class. The financial difficulties for pregnant women of lower socio-economic status have also been found to cause serious anxieties

(Blondel and Marshall, 1998), and these anxieties may be compounded by other problems such as depression and the hassles of daily living (Lia-Hoagberg et al., 1990).

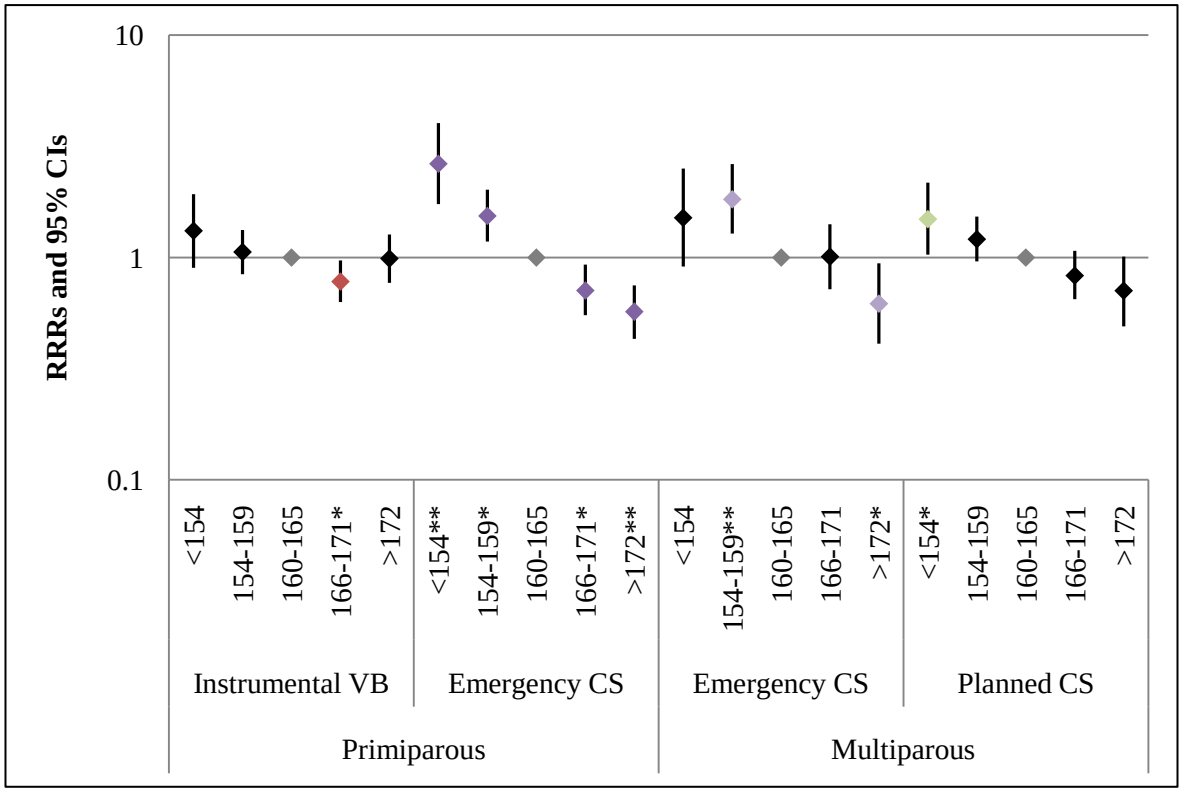
10.4.4 Maternal height

Maternal height is an indicator of both genetic and environmental factors, and shorter height has been linked to lower social class and a higher risk of health problems such as cardiovascular disease (independent of socio-economic position) (Elford and Ben-Shlomo, 2004, Lawlor et al., 2004). Short maternal height has also been linked to increased problems during labour. According to a paper published in 1968 on the epidemiology of human pregnancy (Barron, 1968), "the practicing obstetrician is well aware of the problems of pregnancy and labour in short women" (pg. 1203). Smaller pelvis size has been linked to shorter maternal height, increasing the risk of problems in labour through cephalopelvic disproportion (Barron, 1968, Dujardin et al., 1996, Mahmood et al., 1988).

Several studies have identified an increased risk of overall caesarean section, as well as emergency and elective caesarean section and instrumental births for shorter women (Cnattingius et al., 1998, Gareen et al., 2003, Mahmood et al., 1988, McGuinness and Trivedi, 1999, Read et al., 1994).

In the MCS, for both primiparous and multiparous women, the risk of emergency caesarean section increased with decreasing height. For example, compared to women of average height, women who were less than 154cm tall (around 5ft) were over twice as likely to have an emergency caesarean section if the birth was their first. Taller primiparous women were also at a decreased risk of instrumental birth. In addition, multiparous women of shorter stature were at a higher risk of a planned caesarean section, with women in the shortest category at around 1.5 times the risk. See Figure 10.12 for the fully adjusted risks.

Figure 10.12: The effect of maternal height on the risk of caesarean section



**p<0.001, *p<0.05

As there was no effect of maternal height on the risk of planned caesarean section for primiparous women, the risk of planned caesarean sections for multiparous women could represent repeat caesarean sections for women who had previously had an emergency caesarean section. The lack of information on obstetric history prohibits further exploration of this.

Birth weight declines with decreasing maternal height (Barron, 1968, Mahmood et al., 1988), and this was shown to be the case in the MCS in Chapter 8, with women in the tallest category having infants around 400g heavier than women in shortest category. However, adjusting the effect of maternal height on mode of birth for infant birth weight made little difference to the associated risks.

In Chapter 6, both maternal height and infant birth weight differed by ethnicity, as has been established previously (Kelly et al., 2009, Pickett et al., 2000b). Ethnicity has been found to modify the effect of maternal height on infant birth weight in an American sample (Pickett et al., 2000b). I tested the effect of maternal height on mode of birth (adjusted for infant birth weight) stratified by ethnicity. Stratification by each ethnic group was underpowered due to small numbers; however, for White women there was a strong effect of maternal height on mode of birth, whereas for non-White women there was no significant effect of maternal height on mode of birth.

Grouping together ethnic groups will have clouded differences between ethnic minority groups, which warrant further exploration in samples with larger numbers. However, it seems that being a short White woman is an important risk factor for unplanned caesarean section, which can increase the risk up to twice that of a tall White woman. Conversely, for some minority ethnic women, being of short stature does not lead to a higher risk of operative birth.

10.4.5 Interpersonal factors

Due to the timing of the interview (nine months after the birth), many questions regarding the psychosocial wellbeing of the mother that were included in the MCS could not be used for this study as predictors of mode of birth. I chose three questions as markers of psychosocial wellbeing. Two questions related to the mother's home life as a child; (1) whether the mother left home before the age of 17 (except to go to boarding school) and (2) whether her parents had ever permanently separated or divorced. The third psychosocial marker was feelings about the pregnancy; mothers were asked about how they had felt when they first discovered they were pregnant. For the purposes of the analyses mothers were coded as those who had been unhappy or 'not bothered either way', versus mothers who were happy.

Whether the mother's parents had ever separated was not predictive of mode of birth. However, multiparous mothers who left home before the age of 17 were less likely to have an instrumental birth. In addition primiparous women who were unhappy or not bothered when they discovered they were pregnant were at a reduced risk of having an operative birth.

When these results were apparent in unadjusted analyses, I expected that this could be related to the confounding effects of a more disadvantaged background, or young motherhood. However these factors were adjusted for in the full model and the effects remained, although somewhat attenuated.

Gareen and colleagues in a well adjusted American study including over 6,000 women found that women for whom the pregnancy had been 'unwanted' were 1.3 times *more* likely to have a caesarean section than mothers who had wanted the pregnancy (Gareen et al., 2003). Although unwanted pregnancy and being unhappy or not bothered about the pregnancy are slightly different measures, one would imagine that they would be correlated. Unplanned pregnancy was not found to independently predict mode of birth in the MCS, but a previous literature review has identified more risky health behaviours for mothers with unintended pregnancies and poorer birth and infant outcomes (Gipson et al., 2008). However, the quality of the studies is highly variable and for confounding effects may not have been adequately controlled for (Gipson et al., 2008).

The relationship between feelings about the pregnancy and mode of birth could indicate a different attitude among the women who reported being unhappy or not bothered towards their pregnancy, and these attitudes could extend to, and influence the labour process. From the analyses in Chapter 9 it is clear that women who were unhappy were much less likely to attend antenatal classes or antenatal care compared to women who were happy, although this was not independently related to antenatal care attendance in the final model.

Perhaps mothers who were happy about the pregnancy (who were at a higher risk of caesarean section) would be *more* anxious about their pregnancy and birth, and more likely to be accepting of technological intervention. Anxiety during pregnancy has been associated with decreased blood flow to the uterus (Teixeira et al., 1999), and an increased risk of operative birth (Crandon, 1979, Ryding et al., 1998). However, these studies used relatively small sample sizes and included poor or no adjustment for confounding factors.

Leaving home before the age of 17 was chosen as a marker of a more problematic upbringing. Leaving home at an early age may be for complex reasons; however, women who leave home early to assume independence, have similar social and economic problems to those experiencing early motherhood (Buck and Scott, 1993). However, in the MCS multiparous women who did leave home were *less* likely to have an instrumental birth. With no other studies to make comparisons to, it is difficult to draw conclusions from this finding. There could be behavioural effects of gaining early independence which translate to behaviours during labour, but further research is needed to establish this link.

10.4.6 Pregnancy factors

10.4.6.1 Fertility treatment

Multiparous mothers who reported having fertility treatment in order to become pregnant with the cohort baby were 2.7 times more likely to have a planned caesarean section than mothers who had not received fertility treatment. Adjustment for socio-demographic characteristics is important in studies assessing the relationship between fertility treatment and mode of birth as the women who receive treatment are likely to be older and of a higher socio-economic position to women who do not (Basso and Baird, 2003). The MCS analyses were well adjusted for factors which can predict higher rates of assisted conception, such as maternal age and socio-economic position, and analyses were only based on women with a singleton infant. However, a residual effect remained for planned caesarean section.

Earlier studies have used overall caesarean section rates which combine planned and emergency caesarean sections. The two previous studies which had separated the two found around a two-fold increased risk for emergency caesarean section, but not planned (Basso and Baird, 2003, Patel et al., 2005). As one previous study was Danish (Basso and Baird, 2003), making comparisons is more difficult due to the different health care systems. The English study using the ALSPAC study was conducted a decade earlier than the MCS. The differences observed could reflect changes in the management of women over the ten-year period. We know that between 1991 and 2001, caesarean section rates rose dramatically, from around 12% to around 22% (The Information Centre, 2009b). A higher risk of planned caesarean sections for women who had fertility treatment could therefore reflect a more 'conservative' approach to these pregnancies, especially considering the rise in defensive practice due to litigation as discussed in Chapter 1.

10.4.6.2 Antenatal care

After full adjustment, multiparous mothers who attended antenatal classes were at a 40% increased risk of having an emergency caesarean section compared to mothers who had not attended, and adjustment for full maternal and fetal factors made little difference to the increased risk. Primiparous women who did not attend classes were at an increased risk of a *planned* caesarean section.

The effect of increased risk of planned caesarean sections for mothers who did not attend antenatal classes no doubt reflects the decreased likelihood of attendance to childbirth classes among women who know that they will have a caesarean section. Speculative reasons for the increased risk of emergency caesarean section for multiparous women who attended classes are discussed in detail in Chapter 9, but in summary it is hypothesised that women who attend classes in a subsequent pregnancy may be different to those who do not, in ways unmeasured in this study; for example they may have had a previous caesarean section, they may be more anxious or more keen to have medical input in their pregnancy and their birth.

10.4.7 Health factors

10.4.7.1 Pre-pregnancy BMI

Womens' self-reported weight and height were used to calculate their pre-pregnancy body mass index (BMI). Compared to women in the normal BMI range, primiparous women whose pre-pregnancy BMI was obese were around twice as likely to have an emergency caesarean section. Multiparous women were at twice the risk of an emergency caesarean section if they were 'severely' obese pre-pregnancy. Multiparous women were also at an increased risk of a planned caesarean section if they were overweight or obese pre-pregnancy. Although women who were

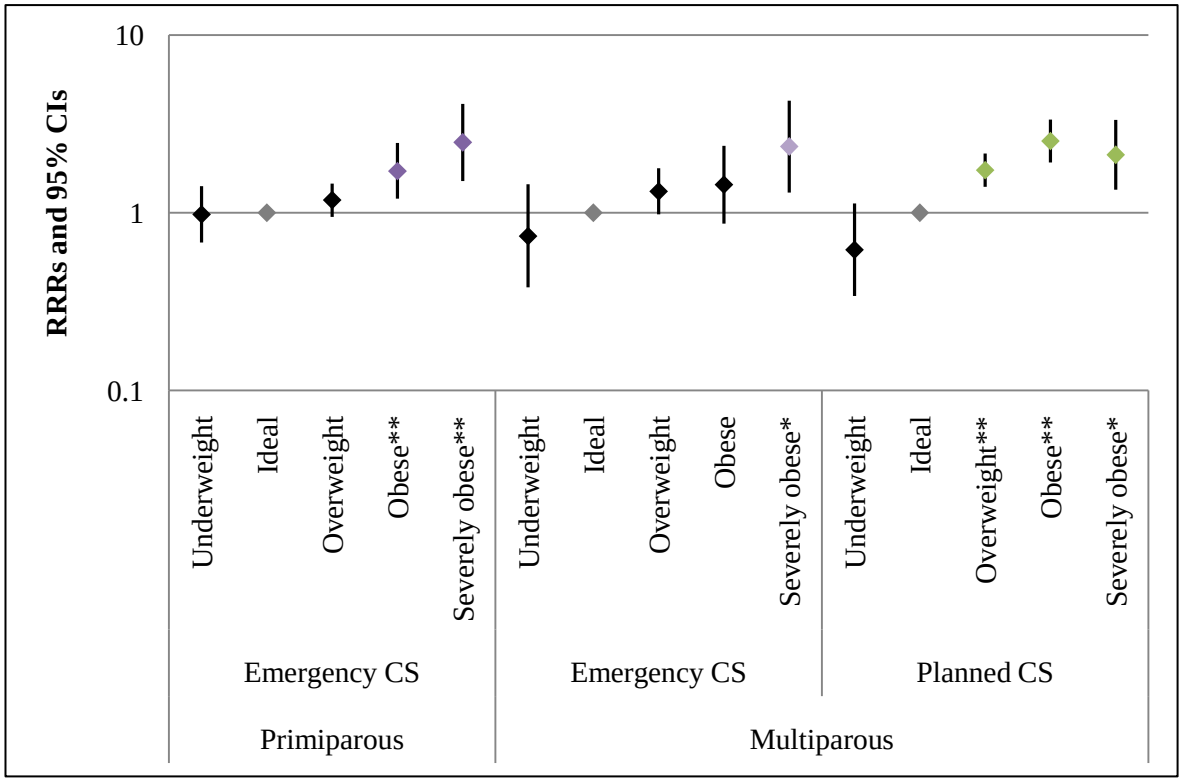
underweight were at a decreased risk of operative birth in unadjusted analyses, the effect disappeared after adjustment for other maternal and fetal factors (see Figure 10.13).

No effect was identified for instrumental births. Although one previous English study found an increased risk of instrumental birth for obese women, the results were adjusted only for birth weight (Naftalin and Paterson-Brown, 2008). In the only other study identified in the literature review to assess instrumental births, an increased risk of instrumental birth was only identified for morbidly obese women after adjustment for several maternal and infant factors (Weiss et al., 2004). Morbidly obese women have also been found to be at an increased risk of a planned caesarean section, whereas other overweight and obese women were not (Bhattacharya et al., 2007). Although over 400 women in the MCS were 'severely' obese (BMI >35), stratification by parity and mode of birth produced some small numbers (see Table A4.2), which may have reduced statistical power.

The lack of increased risk of planned caesarean section for overweight or obese first-time women, in addition to the previous finding of an increased risk only for morbidly obese women (Bhattacharya et al., 2007), may indicate that the increased risk of planned caesarean section among overweight and obese multiparous women may be a result of obstetric history. This finding may represent women who were overweight or obese when they had a previous birth and had an emergency caesarean section as a result, and did not lose the weight prior to the cohort pregnancy.

The use of self-reported weight has been used in many of the previous studies assessing the effect of weight on mode of birth, as direct measurement is not always possible. However, although women are likely to slightly under-report their weight, self-reported weight has been found to give a fairly accurate estimation of BMI (Brunner Huber, 2007), and as women will have gained weight during pregnancy, the proportion of women overweight at the time of birth is likely to have been underestimated in the MCS.

Figure 10.13: The effect of BMI on the risk of caesarean section*



**p<0.001, *p<0.05

10.4.7.2 Complications during pregnancy

Women who experience poorer health during pregnancy, particularly with problems like hypertension and diabetes, are at an increased risk of having an operative birth (see Chapter 2). We also know from earlier discussions that health during pregnancy may be modified by some of the socio-demographic characteristics explored in this thesis, such as age, socio-economic status and ethnicity.

In the MCS, women were asked; "*did you have any illnesses or other problems during your pregnancy that required medical attention or treatment?"*. Problems which could complicate or contraindicate labour such as diabetes, hypertension, fetal distress and placental problems, amongst others, were coded as 'caesarean section risk factors'. All other complications were coded as 'other'. Other problems reported by women during pregnancy were varied and included problems such as urinary infection, bleeding in early pregnancy, asthma, accident or injury and many more. Further details of coding are provided in Appendix 3.

Primiparous and multiparous women who reported receiving medical attention for a 'caesarean section risk factor' during pregnancy were more likely to have either an emergency or a planned caesarean section. The types of problems included in the caesarean section risk factor category did

not increase the likelihood of instrumental vaginal birth, therefore apparently accurately measuring risk factors for caesarean section.

The 'other' problems category is highly heterogeneous and includes any other problem which women reported seeking medical attention for during their pregnancy. Primiparous women who reported having an 'other' problem were also at an increased risk of having a planned caesarean section. However, primiparous women who reported having an 'other' problem were also significantly less likely to have an emergency caesarean section than women who did not report having 'other' problems.

Interpreting the effect of 'other' problems or illnesses during pregnancy is difficult, and the huge heterogeneity in the category makes disentangling the reasons behind the result impossible. In addition, despite the advice of a midwife (Baston, H, personal communication. 26 February 2008), the choice of whether some problems were risk factors for caesarean section remained somewhat subjective. This was because some categories were broad; e.g. 'gestational diabetes, raised blood sugar, abnormal glucose'. This category was included in 'other' as raised blood sugar and abnormal glucose levels can be stabilised and would cause no further problems. However, literature in Chapter 2 suggests that gestational diabetes can increase the risk of caesarean section.

Although the measure of problems during pregnancy is very heterogeneous in nature, adjusting for a measure of health during pregnancy was important due to the known differences by socio-demographic background. However, as discussed in Chapter 6, some women may have been less likely to seek medical attention for problems during pregnancy, and so a question with a focus on health-seeking behaviours may not accurately represent the health in pregnancy of all women.

10.4.8 Labour and birth factors

Women in the MCS were asked several questions about their experience of labour and birth. We know from research linking the MCS data with hospital data that women's reporting of their mode of birth was highly correlated with their mode of birth on the medical records (Quigley et al., 2007), as has been found in previous studies (Rice et al., 2007, Troude et al., 2008).
Although length of labour has been reported in previous chapters, the usefulness of such self-reported experiences for predicting mode of birth is questionable. The information relies on women's recall of a stressful experience more than 9 months previously, and their understanding of the medical procedures used during their birth.

Self-reported length of labour has been found to be poorly correlated with medical records, with women more likely to report longer duration (Rice et al., 2007, Tomeo et al., 1999). Furthermore, disagreement between maternal report and medical records has been reported to be higher for women of lower socio-economic status (Rice et al., 2007, Tomeo et al., 1999). The discrepancies may relate to when women believe their labour has begun, and when health professionals record the labour as beginning (Rice et al., 2007). These differences are understandable, as women in early labour (before 4cm cervical dilation) are encouraged to stay at home, and there is no simple definition for the start of labour, only a set of subjective symptoms (Janssen et al., 2009).

Although information on pain relief was available in the MCS, it was not used for the purposes of this study (see further details in Appendix 3). In addition, womens' recall of the type of pain relief they received has been reported to be poorer than their recall of other labour events such as mode of birth and induction of labour, when compared to hospital records (Githens et al., 1993).

The reasons for poor recall of some labour events may be multifactorial. Firstly childbirth is a stressful event. Secondly, recall relies on the women being accurately informed of labour events by health professionals, and on their understanding of the information given (Rice et al., 2007). In interviews with women soon after birth, discrepancies between maternal recall and hospital records have been shown to be greater when they relate to more technical knowledge of procedures (Joffe and Grisso, 1985). Thirdly, there is some evidence that anaesthesia may affect the accuracy of recall (Tomeo et al., 1999).

10.4.8.1 Induction of labour

Induction of labour was retained for the final models, as it has been found to be less prone to recall bias than other labour events, with good agreement compared with medical records (Githens et al., 1993, Troude et al., 2008). Women in the MCS were asked *"Was the labour induced or attempted to be induced?"*. Primiparous women who reported induction of labour (or attempted induction) were more likely to have either an instrumental birth or an emergency caesarean section. These findings are in agreement with the majority of literature from Chapter 8. The interpretation of the induction results should be treated with caution as firstly it is not clear for which women induction was successful; secondly we do not know why the women were induced, and thirdly there is no information on cervical status, which can modify the effect of induction on operative birth (Yeast et al., 1999).

As a result of the type of regression method chosen, 'labour' factors were also included when the outcome was a planned caesarean section. Women who have an unsuccessful induction, which

would be included as 'yes' according to the MCS question, may go on to have a 'planned' caesarean section. However, this was uncommon in the MCS (see Table A4.2), and therefore resulted in a 'reduced' risk of planned caesarean section for women who were induced.

10.4.8.2 Complications during labour and birth

The indications for the operative births in the MCS were not known. However, women were asked *"were there any complications during [baby's name] birth?".* Complications were coded as malpresentation, fetal distress or other complications. Further details of coding can be found in Chapter 3 and Appendix 3.

Reported complications had a strong effect on the likelihood of operative birth, with malpresentation having the largest effect on the risk. For example, women who reported malpresentation were over 17 times more likely to have an emergency caesarean section. Women who reported fetal distress were over four times more likely to report having an unplanned operative birth.

There was a 'reduced' risk for mothers who reported experiencing fetal distress and other complications during birth of having a planned caesarean section, compared to mothers who did not report these complications. However, as fetal distress and most of the 'other' complications reported were those that would occur during labour, e.g. maternal distress and raised blood pressure, it is unsurprising that only a small number of women who had a planned caesarean section reported these complications, which is interpreted in the models as a 'reduced' risk.

10.4.8.3 Being unaccompanied during the labour and birth

Companionship during labour has been shown to have numerous beneficial effects, including a reduced rate of operative births (Hodnett et al., 2007). In the MCS, mothers were asked *"Did you have someone with you during labour and delivery, other than health staff?"*. I have previously described the characteristics of the women who responded 'no' to this question, who were more likely to be single, multiparous, of Black or Pakistani ethnicity, from poor households, with low levels of education, and who did not attend antenatal classes (Essex and Pickett, 2008). This study has adjusted for these factors (where relevant) in addition to many more. Companionship during labour was not predictive of instrumental births. However, multiparous women who had no companion were twice as likely to have a planned caesarean section and four times as likely to have an emergency caesarean section, and primiparous women were six times as likely to have both types of caesarean section, compared to women who were accompanied.

As this question also asks whether someone was with them during the birth, to an extent these results may reflect women reporting that someone could not accompany them in the operating theatre. However, large numbers of women were accompanied for planned caesarean sections. In addition, my previous work suggests that this group of unaccompanied women differ significantly from women who were accompanied, comprising a more disadvantaged group. This suggests that the results are not merely reflecting whether their support partner could accompany them in theatre, but a disadvantaged group of women who do not have someone with them, for whatever reason, who are then at an increased risk of having an operative birth. In addition, although multiparous women were more likely to be unaccompanied (Essex and Pickett, 2008), the increased risk of caesarean section was greater for first-time mothers who were unaccompanied, as one might expect, due to the increased stress of having never experienced childbirth before.

10.4.9 'Fetal' factors

Gestational age and birth weight were used as markers of fetal characteristics directly prior to birth. Although these outcomes are highly correlated, both are needed in order to differentiate between preterm infants, and those that are small for gestational age (Thomas and Paranjothy, 2001). In addition, the reasons for a link between birth weight and mode of birth and gestational age and mode of birth may differ.

10.4.9.1 Birth weight

In accordance with previous literature (see Chapter 2), women who gave birth to low and high birth weight infants were at an increased risk of having an emergency caesarean section compared to women who gave birth to a normal weight infant, and women with a high birth weight infant were also more likely to have an instrumental birth. There was no association between birth weight and the risk of planned caesarean section.

An English study with a large sample size found an increased risk of planned caesarean section for mothers with high birth weight infants (Alves and Sheikh, 2005). However, in comparison to other previous UK studies (Paranjothy et al., 2005, Patel et al., 2005), and the MCS analyses, the adjustment for age, parity, gestation and deprivation was much less substantial. In particular there was no adjustment for health during pregnancy, and macrosomia is much higher for women with diabetes (Chauhan et al., 2005).

As discussed in Chapter 2, low birth weight can be a marker of underdevelopment, and low birth weight infants are more likely to experience adverse health outcomes in later life (Ashdown-

Lambert, 2005, Graham, 2007). However, some low birth weight infants are entirely healthy (Macfarlane and Mugford, 2000).

An interesting finding from the models predicting emergency caesarean section was an interaction between maternal height and infant birth weight for primiparous women (see Tables 10.2 and 10.3). As discussed earlier, mothers of shorter stature were at an increased risk of emergency caesarean section, and the same was true for mothers who had low birth weight infants. However, women of short height (<159cm) who had a low birth weight infant were at a *decreased* risk of emergency caesarean section compared to taller women. As birth weight decreases with decreasing maternal height, this finding may suggest that the 'low' birth weight infants for the short mothers were in fact normal for their height, and therefore more likely to be healthy.

In addition, among primiparous short women, those who had a high birth weight infant were 2.6 times more likely to have an instrumental birth than those with a normal weight infant. This risk was much higher than the increased risk for mothers with a high birth weight infant in the general MCS population, which was 1.4 times that of women with a normal weight baby. As height is a marker of pelvic size it is unsurprising that short mothers who gave birth to a large infant had a higher incidence of instrumental assistance for the birth.

10.4.9.2 Gestational age

In agreement with the previous literature, women who gave birth preterm were at an increased risk of having an emergency caesarean section. Primiparous women who gave birth post-term were at an increased risk of emergency caesarean section and also an instrumental birth.

It is not fully understood why women go into labour preterm; however, for preterm births with a spontaneous onset the causes are thought to be multifactorial, and include infection or inflammation, vascular disease and distention of the uterus (Goldenberg et al., 2008). Post-term births are more likely to be induced due to the risks of problems such as neonatal death and postpartum haemorrhage for women who naturally progress beyond term (Gulmezoglu et al., 2006), although induction of labour was adjusted for in the MCS.

Two previous English studies found a decrease in the odds of planned caesarean sections with increasing gestational weeks (Alves and Sheikh, 2005, Patel et al., 2005). However, because gestation was broken down into weeks, these findings most likely reflect a tendency for caesarean sections to be performed at term, with a decreasing likelihood of the operation being arranged for when women were approaching post-term.

10.5 Summary

What does this study add?

- A variety of socio-demographic, socio-economic, interpersonal, pregnancy, health, labour, and infant factors are independently predictive of mode of birth. In particular:
- All types of operative birth increased with increasing maternal age at birth, from teen years onwards, rather than an effect only for mothers over the age of 35. In addition, younger age at first birth was protective of a later operative birth for multiparous women.
- Primiparous Black women were at a significantly higher risk of emergency caesarean section compared to White women, but they were less likely to have an instrumental or a planned caesarean section.
- Non-UK born multiparous women were more than twice as likely to have an unplanned operative birth than their UK-born counterparts.
- In contrast to previous literature suggesting that some women may be 'too posh to push', women of lower socio-economic status were at an increased risk of having an operative birth.
- Malpresentation was the most influential risk factor measured in the MCS, increasing women's risk of an operative birth between 7 and 23 times compared to women who did not report malpresentation.

CHAPTER 11: Discussion

11.1 Introduction

This study has explored the relationship between many maternal, pregnancy, labour and fetal factors and mode of birth in a large UK sample. I began by exploring the literature to gain an understanding about what is known about the predictors of mode of birth. There was a scarcity of literature for many predictors, particularly in the UK, where little research of this nature has been conducted. I chose variables from the first (and one from the second) wave of the Millennium Cohort Study which had been highlighted as important in the literature, or which had not been previously researched, but were plausibly related. The relationship between the variables and mode of birth were explored in a series of analyses in Chapters 5, 6, 7 and 9, which culminated in final 'fully adjusted' multivariate models in Chapter 10.

The discussion is divided into four main sections; a summary comparison with previous key UK studies, a critique of the methods used, interpretation of the study findings and the implications of the study findings.

11.2 Comparison with previous UK studies

As discussed in Chapter 2, few of the studies identified in the literature review were UK-based. Of those that were, many were focused on particular risk factors such as deprivation (Alves and Sheikh, 2005, Barley et al., 2004), fear of childbirth (Johnson and Slade, 2002), diabetes (Hawthorne et al., 1997) and antenatal care (Petrou et al., 2003). With fragmented research conducted at different times in different populations, it is more difficult to establish to what extent the results are generalisable.

Three previous UK-based studies included large sample sizes and utilised multivariate techniques to investigate how a variety of factors in their populations relate to mode of birth. The first utilised data taken from the Avon Longitudinal Study of Parents and Children (ALSPAC), conducted in the early 1990s (Golding et al., 2001, Patel et al., 2005). The second was based upon the results of the National Sentinel Caesarean Section Audit Report (NSCSA) conducted in a three-month period in 2000 and 2001 (Paranjothy et al., 2005, Thomas and Paranjothy, 2001). The third recently published study used hospital episode statistic (HES) data from English NHS trusts in 2008 (Bragg et al., 2010). Table 11.1 shows a comparison of the variables explored in the ALSPAC and NSCSA and the HES study, compared to those explored in this thesis within the MCS. Factors highlighted

in bold are explored in the MCS and the ones in purple were not examined in any of the other three studies.

Table 11.1: A comparison of factors examined in the MCS, ALSPAC the NSCSA and HES data

Predictors of mode of birth explored		**MCS** n=18,239	**ALSPAC** n=12,944	**NSCSA** n=147,087	**HES data** n=620,604
Socio - demographic	**Age**	✓	✓	✓	✓
	Age at first birth	✓			
	Parity	✓	✓	✓	✓
	Age of partner	✓			
	Marital status		✓		
Ethnicity	**Ethnicity**	✓	✓	✓	✓
	Language	✓			
	Migration status	✓			
Socio-economic	**Educational level**	✓			
	Social class	✓	✓		
	Home ownership		✓		
	Area-level deprivation				✓
Height	**Height**	✓			
Interpersonal	**Left home before 17**	✓			
	Parents ever separated	✓			
	Feelings about pregnancy	✓			
Pregnancy	**Fertility treatment**	✓	✓		
	Planned pregnancy	✓			
	Antenatal care	✓	✓		
Health	**Smoking during pregnancy**	✓	✓		
	Pre-pregnancy BMI	✓			
	Problems in pregnancy	✓	✓		✓
	Physical exertion		✓		
	Diet		✓		
Obstetric history	Previous CS		✓	✓	✓
	Previous vaginal delivery			✓	
	Miscarriages		✓		
	Previous stillbirth		✓		
Labour	**Labour induced**	✓		✓	
	Epidural		✓		
	Complications	✓			✓
	Presentation	✓	✓	✓	✓
	Support during labour	✓	✓		
	Position in labour		✓		
	Lost control of behaviour		✓		
Infant	**Birth weight**	✓	✓	✓	
	Length		✓		
	Head circumference		✓		
	Gestational age	✓	✓		✓
	Fetal sex	✓			

The MCS analyses confirmed a relationship between the following factors and mode of birth: maternal age, parity, ethnicity, complications in pregnancy, induction of labour, complications in labour (the HES data showed an increased risk of caesarean section with fetal distress and dystocia), malpresentation, birth weight and gestational age. Additionally, as had previously been found in the ALSPAC data, smoking during pregnancy was not independently related to mode of birth.

Some factors were found to be independently related to mode of birth in the MCS, which were unrelated in previous studies, namely; social class, fertility treatment, antenatal care and companionship during labour (in the ALSPAC data these were unrelated in the fully adjusted models).

Finally, several factors were examined in the MCS that were not in any of the three previous large UK studies: age at first birth, migration status, educational level, height, interpersonal factors, pre-pregnancy BMI and fetal sex. These factors were all found to be significant and independent predictors of mode of birth. In addition, age of partner, language spoken at home and planned pregnancy were also novel in the MCS, but were not found to be significantly related to mode of birth, after adjustment for other maternal and fetal factors.

11.2.1 Comparing study quality for the core comparative studies

The validity of results from primary studies depends largely on study quality. For non-randomised studies many quality assessment tools have been developed, but no one tool is accepted as superior. In 2003 a Health Technology Assessment (HTA) Programme Report reviewed the literature to identify and evaluate quality assessment tools for non-randomised studies (Deeks et al., 2003). The review identified 193 separate tools, of which 14 were deemed to be the ‘best’, and 6 of those were reported to be suitable for use in a systematic review. The quality assessment tool used for this study was chosen from one of those six tools. The ‘Quality Assessment Tool for Quantitative Studies’ assesses the methodological quality of studies (Thomas, 1998), importantly assessing elements of selection bias, confounders and data collection. The tool has been tested for construct validity and test-retest reliability, with adequate results (Thomas et al., 2004).

For the purposes of this study some sections of the tool were not used as they were redundant, for example, blinding and withdrawals. Table A11.3 provides an overview and score for each of the four core comparative studies based on selection bias, confounders and data collection. Selection bias included two parts; whether the individuals were likely to be representative of the target population, and what percentage of selected individuals agreed to participate. For confounders, the

tool asks for the percentage of relevant confounders controlled for. Due to the huge number of potential confounders, each with different potential importance, studies were assessed based on how many of the 10 groups shown in Table 11.1 were adjusted for (e.g. socio-economic factors = 1 group). If the study had adjusted for at least one factor from the group, it was counted. For data collection, due to the variety of data collected, the question was adapted to focus on the validity of the data collection for mode of birth. Each study was given a score out of 7, the composition of which is explained in footnotes attached to Table A11.3.

The MCS scored 6 out of a possible 7, losing 1 point for selection bias. Although the individuals selected for the study were 'very likely' to be representative of the target population due to the eligibility of children living in a weighted random sample of almost 400 electoral wards, the 72% of individuals who agreed to participate fell below the highest 80-100% category in the checklist. Nevertheless, 72% remains a good recruitment rate, considering the oversampling of wards with large populations of disadvantaged and ethnic minority families. The study was assessed to be strong in terms of the confounders controlled for, and was felt to have a validated mode of birth outcome due to the previous linkage study with hospital-level data (Quigley et al., 2007).

The ALSPAC study scored full marks, gaining the extra point compared to the MCS as 85% of eligible women agreed to take part in the study. However, it should be noted that study quality tools focus on internal rather than external validity (Deeks et al., 2003). Results from ALSPAC are based on one relatively affluent area in England, and may therefore not be generalisable to the rest of England, or the UK. The study was well adjusted and mode of birth was determined from computerised records from the hospitals involved, which was felt to be a valid measure of mode of birth.

The NSCSA scored 5/7, gaining top marks for selection bias, as 99% of all registered births in a three month period in England and Wales were included, and data were collected at hospital-level, rather than from women, making recruitment rates not applicable. However, in terms of covariates, the study was assessed to be weak as five of ten categories were not controlled for, including socio-economic, height, pregnancy, health and interpersonal factors. Data collection for mode of birth was the main strength of the NSCSA as data were collected for the study using comprehensive specialised data collection tools, which were also validated by local facilitators and the RCOG.

The HES study also scored 5, with full marks for selection bias as over 600,000 births were included in England for 2008, with data from hospital level. Although it is not clear if any HES records had no information on mode of birth, this is probably unlikely as details were taken from procedure fields primarily, and only from maternity tail data, which is known to have patchy

coverage, if procedure field data were not available. The study had a moderate score for confounders, with 7 of 10 categories controlled for, however, height, pregnancy and interpersonal factors were not included. The data collection section was labelled 'can't tell' as the authors report that no study has validated the HES coding of caesarean section against hospital records in the UK.

The Millennium Cohort Study compares favourably with the three previous UK studies, scoring 6 out of a possible 7 on the adapted quality assessment tool, compared to 7 for ALSPAC, and 5 for both the NSCSA and the HES study. The ALSPAC study scored higher due to the high recruitment rate, however, compared to the MCS their findings are much less generalisable to the UK population as a whole. Although the NSCSA and the HES study have huge sample sizes, the comparisons made in Table 11.1 were also borne out in the quality assessment, with both studies scoring worse than the MCS in terms of confounding factors controlled for.

11.3 A critique of the methods used

11.3.1 Strengths of using the Millennium Cohort Study

11.3.1.1 The sample

The data for this thesis came from the first wave of the MCS, a large population-based cohort study containing over 18,000 families sampled from almost 400 electoral wards from all four countries in the United Kingdom. The first wave was conducted between 2000 and 2002, when the cohort infants were around nine months old.

Ethnic minority groups and disadvantaged women are frequently underrepresented in research. To combat this, areas with high numbers of ethnic minority groups and high levels of child poverty were over-sampled in the MCS. The resulting sample was large and (once weighted using survey weights) was representative of the UK.

A strength of the data was the large number of characteristics that could be explored in relation to mode of birth, and the ability to use multivariate techniques to establish the independent effects of individual risk factors due to the large sample size. Table 11.1 details the factors explored in the MCS, compared to those included in the ALSPAC cohort study (Patel et al., 2005), the NSCSA study (Paranjothy et al., 2005) and the HES data study (Bragg et al., 2010). The direct comparison highlights the wealth of information available in the MCS which had not been explored previously in relation to mode of birth in large UK samples. In particular, age at first birth, migration status, height, interpersonal factors, BMI and fetal sex were significantly and independently predictive of mode of birth, and had not been included in the previous research. Furthermore, the large data set

allowed some more rare events to be explored; for example, the less than 3% of women who received no antenatal care as discussed in detail in Chapter 9.

The measurement of some factors was better than in previous research. For example, the information on individual level socio-economic status allowed the question of whether women are 'too posh to push' to be explored. Although the ALSPAC study included information at an individual level, social class was based on maternal occupation (Patel et al., 2005), and was measured in a sample of women concentrated in an area more affluent than the general population in the early 1990s (University of Bristol, 2008). The most recent study by Bragg and colleagues (2010) used HES data, but the authors comment on the incompleteness and inaccuracy of some HES information.

11.3.1.2 Categorisation of mode of birth

As described in Chapter 2, one of the main issues with much of the previous literature regarding the risk factors for mode of birth is the categorisation of mode of birth. In many studies, especially those conducted in America, the focus has been on the total caesarean rate. Although in the majority of UK studies the distinction between planned and emergency caesarean sections has been made, this was not true in all cases (Hawthorne et al., 1997, Petrou et al., 2003, Redshaw et al., 2007). Moreover, instrumental births have been largely ignored except in a minority of UK studies (Bhattacharya et al., 2008, Naftalin and Paterson-Brown, 2008, Redshaw et al., 2007, Richardson and Mmata, 2007). To my knowledge this study is the first to assess the independent predictors of instrumental births using multivariate techniques.

The categorisation of mode of birth in the MCS, although self-reported, is likely to accurately represent the actual mode of birth that women experienced. Previous studies comparing self-reported mode of birth and medical records have found high levels of agreement (Rice et al., 2007, Troude et al., 2008). Quigley and colleagues linked records from over 12,000 MCS interviews to hospital medical records (Quigley et al., 2007). There was 98% agreement between the self-reported mode of birth and hospital records using three categories (normal, assisted and caesarean section) and 94% agreement when using six groups (normal, forceps, ventouse, assisted breech, planned caesarean section and emergency caesarean section). The disagreement when using the six groups was mainly related to the distinction between planned and emergency caesarean sections, as has been previously noted (Rice et al., 2007). Of 7,140 English women with matched records, 82 of 836 (9.5%) of women who reported having a planned caesarean section had an emergency caesarean section according to the medical records, and a further 73 cases of 603 (12%) were in the opposite direction (Quigley et al., 2007).

It should also be noted that medical records are not always accurate and are also likely to deviate somewhat from the actual events (Hewson and Bennett, 1987). As discussed in Chapter 1, the traditional classification planned (or elective) and emergency caesarean sections is broad as 'emergency' caesarean sections can include those conducted in minutes to save the life of a mother or her child, or a situation where an early birth is desirable but there is no maternal or fetal compromise (Lucas et al., 2000). The example below describes a possible situation whereby a woman requires a caesarean section for failure to progress, but there is no maternal or fetal compromise. The caesarean section would not be an 'emergency', and could be 'planned' for later that day. It would seem most likely that it is in these less urgent cases that the biggest discrepancies between self-report and medical records would occur, for example:

A woman has been in labour for several hours; although there are no signs of maternal or fetal complications, the labour is not progressing well. A decision is made by the attending staff that a caesarean section should be performed. However, the theatre is in use and a slot is booked for later that day.

In further support of the representativeness of the sample, Table 11.2 shows a comparison between the weighted MCS mode of birth rates for the analytic sample, and the rates according to the hospital episode statistics (HES) in England from the most similar period (The Information Centre, 2009b). The rates in the MCS were very similar to the rates reported in the HES data, suggesting a representative sample.

Table 11.2: A comparison of mode of birth rates: MCS and hospital episode statistics

Mode of birth	**Hospital episode statistics* 2000-2001**	**MCS** (Sep 2000 - Jan 2002)**
Unassisted vaginal birth	66.6%	68.1%
Instrumental birth	10.9%	10.4%
Emergency caesarean section	8.8%	9.1%
Planned caesarean section	12.7%	12.4%

* Figures add up to 99% but are correct according to the HES tables, **Weighted rates

11.3.1.3 Few sample restrictions

It is common for studies to restrict their sample to primiparous women, or to examine low risk or 'standard' primiparous women (Cleary et al., 1996). Although women with multiple births (who represented only 256 MCS births) were excluded, no other restrictions were imposed. All analyses were stratified by parity which allowed comparisons to be made between primiparous and multiparous women.

11.3.2 Limitations of using the Millennium Cohort Study

11.3.2.1 Using one data source

The first limitation to acknowledge is that the MCS was used in isolation. Despite the many strengths of the MCS, there were limitations to using an omnibus survey which will be discussed in detail below. Using further data sources would have allowed comparisons to be drawn and further variables not available in the MCS to be explored, adding to the understanding of predictors of mode of birth. However, this was beyond the scope of this thesis.

11.3.2.2 Secondary data limitations

Despite the many strengths of using a large cohort study, there were also limitations imposed through the use of a secondary data source. A lack of information regarding obstetric history (most importantly regarding previous mode of birth) greatly restricted the interpretation of findings for multiparous women. In the NSCSA, repeat caesarean sections accounted for 14% of the overall caesarean section rate. Multiparous women who had previously experienced a vaginal birth had a caesarean section rate of 10%, whereas those with at least one previous caesarean section had a rate of 67% (Thomas and Paranjothy, 2001). There was also little detailed information about events during labour and birth, with pain relief the most significant omission. Although women were asked about their use of pain relief during pregnancy in the MCS, we do not know whether women were reporting pain relief during labour, or that used for the birth itself. For epidural, which has the most significant impact on mode of birth (see Chapter 8), there was also no detail about the timing or type of epidural. Details of events during labour would help to unpick the mode of birth differences observed between women in the MCS.

Parity and age at first birth had to be estimated through the use of other available information (see Chapter 4), and for some women may have been inaccurate. However, the available information on the number of siblings in the household, the number of other children not living in the household, and whether the mother had ever had a stillborn baby on which parity was estimated, imply a likely accuracy of parity information for the vast majority of women. The retrospective nature of the questions relating to pregnancy (or pre-pregnancy) and childbirth asked at nine months postpartum could be subject to recall error, nevertheless, recall of childbirth events is likely to be accurate in most cases. Furthermore, some information (e.g. family income and marital status) could not be utilised due to their measurement at nine months after the birth.

The self-reported nature of the information may also have had a bearing on the quality of the data. For example, complications during pregnancy and labour were open questions which resulted in extremely heterogeneous responses, many of which would not be considered to be complications by medical professionals. As a result many complications were categorised as ‘other’ making the

results more difficult to interpret. In addition, there is some suggestion that women may have answered differently by background. For example, Pakistani/Bangladeshi women reported low rates of complications in pregnancy, despite much research to suggest that they are among the most health deprived ethnic minority groups in the UK (Sproston and Mindell, 2006, Nazroo, 1997). However, information from qualitative research indicates that these women may under-report pregnancy complications (Katbamna, 2000) (see further discussion in Chapter 6).

Information gaps could be addressed in future waves of the MCS by asking women for further information. However, despite evidence that recall and impact of birth events can be vivid even many years after the event (Simkin, 1991), the likelihood of recall error would be significantly increased.

11.3.2.3 Analytical limitations

The first limitation of the analytical methods used in this thesis is that of multiple testing. A p-value of 0.05 was used throughout. Therefore we would expect significant results in one in twenty of the tests may have occurred by chance. The more tests conducted, the more likely it is that a significant result will be identified when actually the null hypothesis is true, and there was no real difference (Bland, 2000).

Another issue with testing for statistical significance is the need to consider the size of the effect, and whether it has any real world meaning (Bland, 2000). Throughout my tables, due to the volume of results presented, I have highlighted the statistically significant findings. These significant findings are likely to be real, but it does not mean they are important clinically. Conversely, real differences may be non-significant. Despite the large data-set, as all analyses were stratified by mode of birth and parity, some small numbers may have underpowered analyses to detect a difference between groups. This was true particularly for analyses by ethnicity, e.g. only 9 primiparous Black women had a planned caesarean section and a reduced likelihood of planned caesarean section for these women was of borderline significance.

A further consideration with the data is that association does not necessarily signify causation (Gordis, 2004). A good example of this was the finding from Chapter 9 that women who attended no antenatal classes were at an increased risk of having a planned caesarean section. This could be interpreted as a negative effect of not attending childbirth classes. However, it is unlikely that a lack of attendance is causing a higher risk of planned caesarean sections. The more likely reason for the association is that women who know they are going to have a planned caesarean section do not feel the need to attend childbirth classes.

11.3.2.4 Hospital data

We know from detailed discussion in Chapter 8 that maternity units vary greatly across the NHS in terms of the organisation and delivery of care, the birth environment, the philosophy of care, the staff involved in the birth, and the various interventions used during labour. The huge inter-unit variation in caesarean section rates has sparked concern (Boseley, 2009). Although a proportion of the caesarean variation is likely to be attributable to population differences in the women served by the hospitals (see further discussion in section 11.5.3), variation will also relate significantly to the organisation and process of care within maternity units, which was not captured by this study.

Records of women from the MCS can, in some cases, be linked to their hospital records (Quigley et al., 2007). While the use of multilevel analytical methods would have provided adjustment for the likely hospital-level effect on mode of birth, by identifying which women attended the same maternity unit, maternity data were poor and was not available for all women (see further details in Appendix 2).

11.4 Interpretation of the findings

The findings of this study demonstrate that the characteristics of women and their infants, as well as their experiences during pregnancy and labour, are associated with mode of birth. In the UK, only three large studies have attempted to understand how the characteristics of women are associated with mode of birth using multivariate techniques (Bragg et al., 2010, Paranjothy et al., 2005, Patel et al., 2005). This study provides further evidence to support the differences found in those studies, and also explores a wide range of other factors (see Table 11.1), in addition to investigating the predictors of instrumental births.

The evidence from this study indicates substantial differences in the mode of birth women experience. These differences relate not only to the medical and health characteristics of women, but more importantly to their social background; including their age, ethnicity, migration status and social class. What is not clear is to what extent these associations reflect deeper health differences among these women, and true differences in medical need for an operative birth, or whether they are partly a result of differential attitudes and behaviours of women, or differential care from health professionals during labour.

11.4.1 Context

The first consideration when interpreting the findings from this study is the social construction of childbirth, and the environment in which women experience childbirth in the 21st century.

Childbirth is complex. Literature regarding obstetric ethics outlines the difficulties for clinicians to make sound clinical judgements whilst also respecting the values and wishes of women. In addition, a unique feature of obstetric ethics is the fetus, which can be regarded as an individual patient (Chervenak and McCullough, 1992).

Added to the complexity of the clinician-woman (and fetus) relationship is the social reality of childbirth. Sociologists and anthropologists have argued that birth is a social rather than a purely biological reality. This is evidenced by the stark differences in the management of birth by different societies (Davis-Floyd and Sargent, 1997, De Vries et al., 2001a). As discussed in Chapter 8, modern UK maternity care is characterised by a variety of routine medical interventions. Therefore a medicalised model of care shapes childbirth for most UK women, and women who give birth in a hospital will have restrictions placed on their ability to control the birth experience (De Vries, 1981). Kitzinger describes the hospital as a high-tech birth culture; a social system that regulates a woman's behaviour through 'ritual' acts such as continuous fetal monitoring (Kitzinger, 2006).

Despite arguments from various social movements for the de-medicalisation of maternity care, caesarean sections and other medical interventions in childbirth continue to rise. De Vries talks about how medicine responds to and accommodates changing social and cultural conditions; for example, by making cosmetic changes to hospitals to make them more homely, whilst actively encouraging women to use new pain medication (De Vries et al., 2001b). In a society with a high cultural valuation of technology (Wendland, 2007), it is unsurprising that health professionals, and women themselves, may have lost confidence in women's ability to labour without the assistance of technology (Cherniak and Fisher, 2008, Tew, 1990).

11.4.2 Speculative explanations for differences in mode of birth by background

11.4.2.1 Parity

The large sample size of the MCS allowed for all analyses to be stratified by parity, which to my knowledge has not been done previously in a UK sample. Stratifying by parity was beneficial in two ways. Firstly it allowed the predictors of mode of birth to be examined for these two very different groups of women. Secondly, simply adjusting for parity would have resulted in more complicated models, with numerous interaction effects.

The findings demonstrate that predictors of mode of birth differ by parity; in particular, many more characteristics are predictive of mode of birth for primiparous than for multiparous women. This result is in some ways unsurprising. Primiparous women and multiparous women differ enormously, both in their physical and psychological responses to childbirth. Importantly however,

midwives will also view women differently dependent on their parity, and will have different expectations about how a woman's labour will progress.

Many previous studies have focused on primiparous women only, or have adjusted for parity in their analyses. These latter studies have shown between a 1.5 and a 9-fold increase in caesarean sections for primiparous women compared to multiparous (UK studies only) (Alves and Sheikh, 2005, Green and Baston, 2007, Johnson and Slade, 2002, Patel et al., 2005).

It seems for multiparous women the significant impact of the previous birth (see Chapter 2) may override the importance of other characteristics, whereas for primiparous women, who are at a much greater risk of having an operative birth, many more factors can influence mode of birth.

Some differential predictors by parity may also relate to other characteristics of women which were unmeasured in the MCS. For example, that being a migrant is predictive of an unplanned operative birth for multiparous women but not for primiparous women may relate to where the previous birth had taken place, which is unknown in the MCS. For primiparous women, regardless of country of birth, giving birth in the UK maternity system will be a new and unfamiliar experience. UK-born multiparous women will have experienced the maternity system before, whereas for women who have previously given birth in a foreign country, the UK maternity system may be an entirely different and alien experience.

In the next section of the discussion I will focus on three speculative explanations for the differences in operative birth rates according to maternal background; health variation, the attitudes and behaviour of women and the attitudes and behaviour of health professionals. These explanations are not intended to be exclusive, and it is likely that due to the complex nature of childbirth as discussed previously, a combination of these factors may apply.

11.4.2.2 Health variation by socio-demographic background

The independently significant socio-demographic characteristics of women at the highest risk of an operative birth were; older maternal age, low socio-economic status, Black ethnicity and being non-UK born. Each of these characteristics has been associated with poorer reproductive or general health outcomes (see examples below and previous chapters for further discussion).

The increased risk of operative birth with increasing maternal age may be a physiological effect. Firstly, in the MCS there was a strong dose-response effect of increasing risk of all types of operative birth with increasing age (from teenage years upwards), rather than an effect only for the

'older' mothers (over the age of 35), who have been the focus of much previous research. Secondly, previous studies outlined in Chapter 5 have evidenced poorer uterine function with increasing age, and in the MCS malpresentation and other complications did increase with increasing age.

The adverse effects of lower socio-economic status on health are well known (e.g. Wilkinson and Marmot, 2003). Relating specifically to pregnancy, women of lower socio-economic status are more likely to have a poor diet and higher rates of obesity, and to engage in risky health behaviours such as smoking (Dowd, 2007, Nelson and Popenoe, 2001). They may also be more likely to be anxious or depressed during pregnancy (Blondel and Marshall, 1998, Lia-Hoagberg et al., 1990), and they have a higher risk of poor infant outcomes such as low birth weight and preterm birth (Macfarlane and Mugford, 2000). The increased risk of operative birth for women of lower socio-economic status may reflect poorer health among these women.

Although some information was available in the MCS regarding the health of women during pregnancy, and on labour complications, the information was based on self-report and was collected retrospectively, around nine months after the birth. The information may not therefore have captured accurately the health of women during their pregnancy.

While for some factors, a higher incidence of operative births may be a reflection of poorer overall health, or a poorer physiological response to pregnancy and labour, it would seem doubtful that the risk of operative birth is determined principally by the health of women. For example, women of Pakistani/Bangladeshi ethnicity, who are amongst the most deprived in terms of socio-economic position and health in the UK, were at a *reduced* risk of caesarean section compared to White women in the MCS.

11.4.2.3 The attitudes and behaviours of women

Changing Childbirth suggested that care should be woman-centred, advocating choice for women regarding their maternity care (Department of Health, 1993). Recommendations for care in labour in the report summarised that "every reasonable effort should be made to accommodate the wishes of the woman..." (p. 31).

Women in labour have different motivations and wishes; some will be aiming for a more 'natural' birth with minimal intervention, some will be desiring a medicalised birth, with the assistance of technology (for example to control pain), and some women will not have strong beliefs about the

course their labour should take. A woman's choices and behaviour during labour are likely to be modified by a variety of factors.

In some qualitative American studies, attitudes towards pregnancy and childbirth have been shown to differ by social class. Higher-class women have been found to want to exert control over their birth; either through wanting a more natural birth, or desiring a more medicalised birth (Davis-Floyd, 1994, Lazarus, 1997).

Davis-Floyd (1994) interviewed 70 affluent middle-class White American women about their pregnancy and birth experiences. Despite the similar backgrounds of the women, their attitudes towards childbirth varied dramatically and represented extremes in response to their desire for control. Some women were adamant that they wanted a natural home birth and sought to control their environment, and the people that were involved in their birth, in order to embrace the natural birth experience. Sandra reflects on her decision to have a home birth:

> *My friends think I'm crazy. But I think they are. I mean really, they are – they're the ones that have missed the whole birth experience, not me* (**Sandra, in Davis-Floyd 1994, p. 1133**).

Other women felt alienated from their bodies during pregnancy and sought control through technology; controlling their pain with epidural anaesthesia and demanding a caesarean section:

> *I [asked] for an epidural at one point, but they said they didn't have time to do it...that just drove me wild. I didn't like that at all – I wanted to have it the way I wanted to have it* (**Kay, in Davis-Floyd 1994, p. 1132**).

> *Ultimately the decision to have a Cesarean while I was in labor was mine. I told my doctor I'd had enough of this labour business and I'd like to have a Cesarean and get it over with. So he whisked me off to the delivery room and we did it* (**Elaine, in Davis-Floyd 1994, p. 1132**).

Conversely, lower-class women have been found to be much less assertive (Lazarus, 1997). Lazarus (1997) conducted two separate qualitative studies in the 1980s in America. The first was an observational study at a large public clinic which followed the care of 53 poor women, 18 of whom were aged between 16 and 19 (the average age at first birth for women in the sample was 19). When asked about what mode of birth they would prefer some women said that they did not know, whereas others said "natural, I guess" (p. 141). In the later study 45 women who attended

private clinics were interviewed. The women were mainly college graduates, with an average age at first birth of 30. Nineteen women in the 'middle-class' group were health professionals themselves, or were married to health professionals. Lazarus summarises; "Some [middle-class women] had definite views about technical interventions such as whether to have epidural anesthesia or an episiotomy. Some women asked doctors for their cesarean section rates..." (p. 143).

In another qualitative study in the USA, Nelson (1983) interviewed over 200 women and summarised "they [working-class women] don't become interested in the birth process because they don't think that they can determine what is going to happen to them" (p. 294).

Lazarus (1997) attributed the less assertive behaviour of the poor women in her study to their lack of access to, and desire for knowledge about the pregnancy and childbirth process. In a UK qualitative study lower-class White women were also found to be more restricted in terms of their knowledge and choices regarding their care (Bowes and Domokos, 2003). In the MCS, women of lower socio-economic status were much less likely to attend antenatal classes or receive antenatal care compared to their more advantaged counterparts.

Green and Baston (2007) surveyed over 900 women from 8 English maternity units during their third trimester in 2000. Several questions related to willingness to accept interventions were included and were aggregated into an overall score. Women with no education had significantly higher average scores (indicating a greater willingness to accept intervention) than the more educated women in the sample. Recent interviews with UK maternity care staff have echoed these findings, with staff reporting that women of lower social class in their care were more likely to prefer a medicalised birth (Puthussery et al., 2008):

> *I think if they're lower socioeconomic groups they probably actually want to have an epidural and want to have very medicalised care...* (**White British female midwife, in Puthussery et al 2008, p. 199**).

In the MCS, information on pain relief during labour could not be used as there was insufficient information about the circumstances surrounding the use of pain medications. However, there was no evidence that induction rates differed by socio-economic status (data not given). In a survey of over 700 women who gave birth in English hospitals in the late 1980s, well-educated women were more aware of the side effects of different types of pain relief and were significantly less likely to use Pethidine and more likely to adopt alternative methods of pain relief in labour; however, there was no association between educational level and use of epidural anaesthesia (Green et al., 1998b). Further research with information on epidural use by socio-economic status could identify if

epidural use is the link between lower socio-economic status and operative births (see Chapter 8 for details of the research on epidural anaesthesia and mode of birth).

Interviews with UK Bangladeshi and Gujarati Indian women have revealed divergent attitudes towards both pregnancy and birth (Katbamna, 2000), which could impact on their behaviour during labour. For example Bangladeshi women in the study more often continued with their normal activities until the late stages of labour. In Bangladesh, home birth assisted by a female relative is traditional; Bangladeshi women were therefore anxious about the alien hospital environment:

> *I did not want to go to the hospital too soon...I do not know many people here who could look after my children. I am also afraid to go to the hospital without my husband because I do not understand English* (**Bangladeshi mother, fifth pregnancy, in Katbamna 2000, p. 76**).

Some Bangladeshi women also feared caesarean sections and held beliefs that they may be sterilised during the procedure, as this quote from a Bangladeshi hospital interpreter demonstrates:

> *Some of these women have heard stories from other women that if they arrive too early in labour then they would have a Caesarean section. In my experience, I found that quite a few didn't come into hospital until they were in full labour. Some people also believe, especially some husbands, that the doctor may carry out a sterilization while a woman is having a Caesarean* (**Bangladeshi hospital interpreter, in Katbamna 2000, p. 77**).

Conversely, Gujarati women were anxious to arrive at the hospital early and viewed the hospital as a safe place. In addition, there was evidence that Gujarati women were more knowledgeable about pain medications, and could more easily ask for pain relief (Katbamna, 2000). Interviews with Pakistani women in the UK have demonstrated a limited access to knowledge and choices regarding their care (Bowes and Domokos, 2003). For example, one Pakistani woman who had not been able to travel to antenatal classes described her experiences of pain relief:

> *[At the classes] they teach you how to breathe and how to use the gas and everything, and I never... I had no clue...So it was very difficult for me to deliver the baby. I was screaming my head off* (**Pakistani woman 107, in Bowes and Domokos 2003, p. 92**).

Interviews with health professionals caring for migrant women in English maternity units have revealed views that migrant women were more submissive and much less assertive than their UK-born counterparts:

> *The second-generation Black Caribbean will question, definitely... they wouldn't be so accepting. They would want to know more, they would question... yeah, they would challenge us more* (**Irish female midwife, in Puthussery et al 2008, p. 198**).

These mainly qualitative findings provide some evidence that some women may have less perceived control and less prior knowledge about their birth experience dependent on their socio-economic status, their ethnicity and whether they were born in the UK. Nelson (1983) suggested that working-class women were "more inhibited by the context in which birth occurs" (p. 294). Reduced knowledge and perceived control over the birth experience could make women of lower social class and some ethnic backgrounds more restricted by 'environmental constraints' during childbirth. However, women's core attitudes to childbirth may also differ by socio-economic background and ethnicity.

Further UK research is needed to explore the attitudes of women of different backgrounds towards pregnancy and childbirth, and to establish if these attitudes impact on behaviour during labour. Much of the research described here, particularly relating to socio-economic status is American and was conducted in the 1980s. As health care in America is not publically funded, the care women receive is more likely to be influenced by their socio-economic status. Furthermore, in some studies there was no comparator group (Davis-Floyd, 1994), or there was a completely different comparator group from a different setting and time frame (Lazarus, 1997). Conducting research to include disadvantaged groups is notoriously difficult. Bowes and Domokos (1996) discuss the difficulties of raising the 'muted' voices of Pakistani women regarding their maternity care, especially considering the 'social positioning' of the researchers, and discuss ways in which these difficulties can be addressed.

11.4.2.4 The attitudes and behaviours of health professionals

The relationship between health professionals and women

The relationship between health professionals and patients has long been of interest to researchers. Paternalism is the traditional model of the doctor-patient relationship, where the doctor is the expert and the patient's role is to comply (Britten and Weiss, 2004). Milgram's psychological

experiments showed the power and authority of medicine, and how humans will obey an authority figure (Cassell, 2005).

Woman-centred care is more aligned with the model of concordance, the core principals of which are understanding and respect for the patient's view (Britten and Weiss, 2004). However, in the qualitative literature regarding maternity care there is some evidence of medical hegemony (the power exerted by a dominant group over other groups), with women of lower social class being more influenced by the authoritative knowledge of health professionals (Bowes and Domokos, 2003, Lazarus, 1997, Puthussery et al., 2008, Nelson, 1983). In Nelson's interviews with over 200 American women, compared to working-class women, middle-class women desired a more cooperative rather than an instructional relationship with their doctor (Nelson, 1983). Puthussery and colleagues (2008) in their recent interview study with health professionals involved in UK maternity care, identified a theme that the women of lower social class in their care were more likely to "see the doctor as the important person" (pg 199).

Literature has suggested that ethnic minority groups have less involvement in decision making, whilst other research has demonstrated that patients are more actively involved in decision making if their health care provider is of the same ethnicity (Green et al., 2003). Health professionals caring for minority ethnic groups have described how problems with communication and a lack of cultural knowledge cause uncertainty and a barrier to professional care which is disempowering (Kai et al., 2007). Puthussery and colleagues (2008) conducted interviews with 30 health professionals from 8 English maternity units. The health professionals reported that it was easier to provide care for women who were UK-born, compared to migrant women. The ease of caring for UK-born women seemed to stem predominantly from fewer language and cultural barriers (Puthussery et al., 2008):

> *...It's much easier if they have been born in the country and brought up here, but if they are new to the country and we can't communicate with them, language is a big problem* (**White British female midwife, in Puthussery et al 2008, p. 197**).
>
> *Women with perhaps lower expectations or who are less articulate and less able to make demands are disadvantaged because they don't know how to ask* (**White British female midwife, in Puthussery et al 2008, p. 198**).

An Irish interview study with health professionals caring for ethnic minority women echoed difficulties with communication:

> *I mean if you can't speak their language, you know... you can't establish any rapport* (**Unnamed service provider, in Lyons et al 2008, p.265**).

Language may play a key role in the development of the relationship between a health professional and the woman they are caring for. For women for whom English is not their first language, interviews with both staff and women have demonstrated how language can be a barrier (Bowes and Domokos, 2003, Bowler, 1993, Katbamna, 2000, Lyons et al., 2008, Puthussery et al., 2008). However, communication difficulties may not only apply to situations where both parties speak different first languages. Roter and Hall discuss how the negative stereotypes of disadvantaged groups held by doctors can affect the way they interact with patients (Roter and Hall, 2006). According to Waitzkin (1985) increased communication problems between doctors and patients of lower social class relate to the 'competence gap' between patients and doctors. Although in modern UK maternity care there may be less 'social distance' between a woman and midwives caring for her, technical terminology, which is also highlighted by Waitzkin, may be more of an issue for women of lower socio-economic status, especially as we know that these women may be less likely to have a desire for or access to prior knowledge about childbirth.

Interestingly, as has been found previously (Ibison, 2005), language was not an independent predictor of mode of birth in this sample. This finding was surprising considering that language is frequently reported as a barrier in the relationship between midwives and women. However, this finding does not exclude the importance of communication problems in the maternity care setting. In the MCS 710 women did not speak English at home. Although around a quarter of these women were UK-born, the inclusion of both migration and ethnicity may have captured the communication difficulties in the sample. In addition, around 2,000 women spoke English and other languages. As these women reported speaking English they were grouped with the women who spoke English only at home. However, we do not know how good their English was, and their inclusion in the comparison group may have diluted effect sizes.

Stereotyping

"Conscious and unconscious beliefs by professionals can influence clinical decision-making and contribute to ethnic disparities" (Puthussery et al., 2008 , p.199).

An ethnographic observational study conducted over a three-month period in a British hospital in the late 1980s, and complemented by interviews with 25 midwives, revealed very stereotypical views of the health professionals about the South Asian women in their care (Bowler, 1993). Four main stereotypical themes emerged from Bowler's study: (1) difficulties communicating, (2) lack of compliance and over-use of services, (3) attention-seeking behaviour and low pain thresholds,

and (4) a lack of maternal instinct. Communication was found to be a significant problem in the study. The South Asian women who could not speak any English were perceived to be rude and unintelligent, and if the women did speak some English their broken English was often viewed as bossy.

> *Some Asian women are like blocks of wood, you know, thick [banging her head]. Mind you others are delightful. It's impossible to understand whether they have understood or not* (**Unnamed midwife, in Bowler 1993, p.161**).

> *Well, these Asian women you are interested in have very low pain thresholds. It can make it very difficult to care for them* (**Unnamed midwife, in Bowler 1993, p.167**).

Bowler's study was conducted more than 20 years ago. However, ethnic inequalities in maternity services persist, and the way in which staff provide these services contributes to inequity (Bharj and Salway, 2008). More recent qualitative studies have echoed the stereotypes suggested by Bowler, such as some minority groups being louder or more aggressive during labour (Lyons et al., 2008, Puthussery et al., 2008), and others having low pain thresholds (Puthussery et al., 2008):

> *Indian women, without a doubt have a lower pain threshold, without a doubt* (**White British female midwife, in Puthussery et al 2008, p. 198**).

Stereotyping relates not only to ethnicity, but to other demographic characteristics of women. In a US study, women who were disadvantaged in terms of their household income or insurance status were significantly more likely to report feeling like they had been treated differently by health professionals during their maternity care because of their social position than women with a high household income, or with employer-sponsored health insurance (De Marco et al., 2008). Green and colleagues (1990) discuss two common stereotypes in UK maternity care: the 'well-educated middle-class NCT type' and the 'uneducated working-class woman' and showed with survey data that the attitudes of these women did not reflect those expected from these negative stereotypes.

Midwives, especially on a busy labour ward, may use stereotypes as a tool in order to react to situations as they arise (Green et al., 1990). However, these stereotypes may not always apply to the individual women in their care (Bowler, 1993). When stereotypical knowledge does not apply to an individual patient professional uncertainty can arise (Kai et al., 2007).

Is 'cultural competence' training the answer?

There is no accepted definition of 'cultural competency' (Kai et al., 2007, Kleinman and Benson, 2006), which may explain why there is little evidence of the effectiveness of cultural competence training (Kai et al., 2007). According to Lo and Stacey (2008 p. 741) "the concept of culture remains unclear when applied to racially and ethnically diverse patients". The grouping of people dependent on their ethnic background ignores the variations within groups; however, an idiosyncratic view of culture makes the implementation of standardised guidelines virtually impossible (Lo and Stacey, 2008). Reducing cultural competency to a set of technical knowledge and skills may actually increase uncertainty for health professionals (Kai et al., 2007).

Both Kleinman and Benson (2006) and Kai and colleagues (2007) suggest the need for a greater focus on patients as individuals. Green and colleagues discuss how stereotyping can more easily occur if midwives have not had the chance to get to know the woman first (Green et al., 1990). Perhaps the key to reducing staff behaviours based on stereotypical preconceptions of women is increased continuity of carer, which could also improve communication between staff and women.

Women reflect more favourably on experiences of childbirth when they have an established relationship with a midwife (Bowers, 2002), and additional carers during labour may increase the risk of caesarean section (Gagnon et al., 2007). Furthermore, interviews with ethnic minority women receiving both caseload midwifery care and conventional care have revealed that greater continuity of carer may be even more important for minority groups, who are likely to feel alienated from service providers (McCourt and Pearce, 2000). Women who had a greater continuity of carer felt that they could communicate better with their midwife, and that they were more supported.

11.5 Implications of the research

Over the past two decades, caesarean section rates have risen significantly in the UK, but little is known about what is causing the high rates. In addition, instrumental births have not decreased over the period. Both main types of operative birth represent an increased risk to the physical and psychological health of women, as well as a risk to their infants, and a substantial cost to the NHS. My thesis describes the significant and independent predictors of mode of birth in a large UK sample. What is not clear is to what extent these differences are the result of health differences, or differences in the behaviour of women or their health professionals.

11.5.1 Instrumental births

Fewer maternal and fetal characteristics were predictive of instrumental births compared to caesarean sections. However, as with caesarean sections, instrumental births also increased with increasing age, and women who began childbearing earlier were protected against having an instrumental birth in later pregnancies. In addition, women of lower social class and those who were not born in the UK were at a greater risk.

Much previous research, particularly in the UK, has focused on the predictors of caesarean sections, and the predictors of instrumental births have been largely omitted. However, as discussed in Chapter 1, women who have an instrumental birth can also experience serious negative physical and emotional consequences, such as morbidity of the pelvic floor, low satisfaction with the birth experience and even post-traumatic stress disorder. Instrumental birth rates do differ by maternal and fetal characteristics, and as will be discussed in the next section, modifying the behaviour of women or health professionals could potentially help to prevent some of these procedures.

11.5.2 Modifiable factors

As discussed by Patel and colleagues (2005), many factors described in this thesis are not amenable to change. It should be noted that labelling women as high risk based on non-modifiable demographic factors can negatively impact their expectations of birth, and can make them feel accountable for adverse outcomes (Jordan and Murphy, 2009).

Health professionals cannot control who the women are that they will care for. However, there are areas which could be modifiable based on my findings, both in terms of the behaviour of women, and the behaviour of staff.

The most modifiable factor included in my thesis is BMI. Women who were more obese were much more likely to have a caesarean section. Making women aware of the issues of being overweight once they are pregnant is too late. General Practitioners should discuss future family plans with overweight women, and advise them of the additional complications for pregnancy and childbirth of being overweight. However, although I have noted weight as the most modifiable factor, there are many difficulties associated with weight change, particularly due to the complex reasons why people are overweight and the numerous barriers to lifestyle change (National Institute for Health and Clinical Excellence, 2006).

Increasing age at birth was the most consistent demographic factor which increased the risk of women having any type of operative birth. Age at first birth has been increasing, and in 2008 the

average age of a mother at first birth in England and Wales was 27.5 years (ONS, 2009). The shift towards delayed childbearing is accepted in today's society. Books provide advice specifically for women considering or experiencing pregnancy over the age of 35 (e.g. Berryman et al., 1998, Sember, 2007). Furthermore, teenage childbearing is viewed as a major public health problem, with increased risks of adverse infant outcomes such as low birth weight (Lawlor et al., 2002), and "young women who become mothers before the age of 20 are demonized as agents of social disruption" (McDermott and Graham, 2005, p.59). However, detrimental outcomes for teenage mothers are likely to relate to their often more disadvantaged backgrounds, rather than their age (Lawlor et al., 2002). In their review of qualitative literature with UK teenage mothers, McDermott and Graham (2005) identified positive themes and a resilient attitude among young mothers who were often coping with issues of poverty and stigmatisation. They conclude that although teenage motherhood is often identified as a route to social exclusion, for some women teenage mothering "opened doors into valued roles and supportive relationships" (Graham and McDermott, 2006, p.34).

Beginning childbearing after the age of 35 decreases fertility and increases the risk of miscarriage (Heffner, 2004). Relating to fertility and pregnancy complications, in 2009 the RCOG released a statement on later maternal age, encouraging women to 'consider having families during the optimum period of fertility' and suggesting an 'urgent need for better public information on the issues surrounding later maternity' (RCOG, 2009). Although not mentioned in the RCOG statement the large volume of literature documenting increased risks of operative births with increasing age, supported by the findings of this thesis, need adding to that public information.

Although women may be delaying childbearing to achieve an optimal financial and emotional environment for motherhood, my findings support those highlighted by the RCOG, that this may not be the optimal physiological timing. Womens' bodies may be physiologically most ready for childbirth in the late teen years, with later childbearing increasing complications for the natural process of childbirth. The most recent review by The Care Quality Commission (CQC, 2010) indicated a significant increase in the age of childbearing women. Perhaps the attitudes of women and the wider society, towards age of beginning childbearing need to be reflected upon, and changed. Older childbearing age is a risk factor for a more complicated pregnancy and birth, but it is modifiable.

Socio-economic status, ethnicity and migration status were found to be predictive of mode of birth. Qualitative studies have found that health professionals feel that a lack of cultural knowledge and communication difficulties act as barriers to the care they can provide for minority ethnic groups (Kai et al., 2007, Puthussery et al., 2008), and stereotypical views relating to socio-economic status

may also hinder the relationship between women and health professionals (Green et al., 1990). Increased continuity of carer could act to break down these barriers, as midwives get to know the individual women, and need to rely less on stereotypical knowledge. In addition women from minority ethnic groups who have experienced a continuity of carer have reported more effective communication and better support from their midwife (McCourt and Pearce, 2000). However, as Green and colleagues point out , it may not be continuity of carer per se that is important (Green et al., 2000). In their review of the literature, women who had a known carer were not necessarily more satisfied than women who did not, and women did not always view continuity of carer as important. Having met a midwife before did not necessarily imply that women 'knew' their midwife. The authors summarised that although there has been an emphasis on continuity of *carer* there has been little emphasis on the quality of the care. In addition, continuity of *care* was found to be more important in some studies (e.g. Green et al., 1998b). These factors need to be considered when assessing how effective relationships can be developed between midwives and women.

Support during labour, as discussed in Chapter 8, has numerous benefits, including a reduction in operative births. The Cochrane review by Hodnett and colleagues has recently been updated with, for the first time, sub-group analyses by the person providing the support, and with the inclusion of studies where the support partner was someone from the woman's social network (Hodnett et al., 2011). The findings suggest that, as my findings have shown, continuous support from a support partner from the woman's social network can be beneficial. In terms of reducing caesarean section rates however, it was support from doulas that proved to be the most beneficial, with hospital staff and support partner sub-group analyses not significant. However, as has been identified previously (Ross-Davie, 2011), none of the 21 studies in the review were conducted in the UK, or in midwife-led maternity care, reducing the applicability of the findings to UK settings. Chapter 8 described how models of care with the aim of providing continuous support during labour have been shown to have reduced rates of operative births, but that the models of care differed so drastically from each other that it was impossible to establish the importance of continuous midwife support from other aspects of care such as a philosophy of normal birth, a more homely environment and fewer interventions in labour. It is clear that support during labour is extremely important to women, and can improve outcomes during labour (such as a reduction in the need for pain relief and shorter labour), satisfaction with the labour experience, and reduce the likelihood of operative birth. However, further UK research could seek to strengthen the evidence of the likely benefits of one-to-one midwife, doula and companion support for UK women.

This study provides additional evidence that women who have an induced labour are at an increased risk of operative birth, adding to the mounting literature in this area (see Chapter 8, section 8.4.2). According to NHS maternity statistics for England, induction rates have remained

fairly static between 2001 and 2011, with around 20-21% of women having an induced onset of labour (The Information Centre, 2009a). With around 1 in 5 women having induced labour, a change in practice to reduce the induction rates has the potential to reduce operative birth rates in the UK.

11.5.3 The need to adjust for case-mix

Caesarean section rates vary widely between hospitals, and the published hospital rates have caused wide-spread concern (Boseley, 2009, Rogers, 2009), with rates varying hugely, for example from 6% to 66% in the NSCSA (Paranjothy et al., 2005). There is an increased need to understand what is driving the differential rates between hospitals or within hospitals over time. The different populations served by hospitals can greatly affect their caesarean section rates. The ability to compare caesarean section rates is one of the biggest challenges facing researchers (Betran et al., 2009, Paranjothy et al., 2005, Robson, 2001). Various methods have been devised for comparing caesarean section rates. Two key examples include comparing 'standard' primipara (Cleary et al., 1996), and the Robson classification; classifying women according to pre-specified criteria based on their pregnancy, previous obstetric history, course of labour and gestation (Robson, 2001).

The standard primipara method compares only women who are White, aged 20-34, more than 155cm tall, presenting with a singleton cephalic fetus at more than 37 weeks, with no complications during labour (Cleary et al., 1996).

The Robson classification includes 10 groups, and has been successfully applied in both single units, and in a large multi-country data-set (Betran et al., 2009, McCarthy et al., 2007); however, it focuses only on obstetric information, and ignores demographic information. Overall, neither method allows for direct comparison of caesarean section rates between maternity units, while adjusting for case-mix differences (Paranjothy et al., 2005).

Paranjothy and colleagues (2005) used the NSCSA to assess the contribution of case-mix to the variation in hospital rates. Adjustment for age, ethnicity, number of previous vaginal births, number of previous caesarean sections, gestation and mode of onset of labour accounted for only 34% of the variance in hospital rates. The populations served by the 216 English and Welsh maternity units varied greatly. For example, the percentage of Bangladeshi women who gave birth in the units varied from 0% to 51.7%. My study demonstrates the need for better information on the characteristics of women who attend certain hospitals, to provide greater understanding of how much the variation between hospitals is explained by the population they serve.

11.5.4 Case-mix confounding

As discussed in Chapter 1, more research is needed to clarify both the short and long-term impact of mode of birth for mothers and their infants. As a trial of mode of birth has many ethical implications, and is not acceptable to women (Lavender and Kingdon, 2009), much research to date is observational in nature. This study provides further information on the case-mix factors which should be considered as confounders when examining the relationship between mode of birth and any possible outcomes.

11.5.5 The potential impact of changes to factors in the system of care between 2001 and 2011

Since the first wave of the MCS in 2000-2002, a decade has passed, during which time the population served by the UK maternity system has changed. The number of births has increased from around 663,000 in 2001-02 to 797,000 in 2009-10 due to an increase in the fertility of UK-born women and an increase of female migrants of childbearing age to the UK (ONS, 2011). The overall non-White population in England and Wales grew by an average of 4.1% in England and Wales between 2001 and 2009 (ONS, 2010). The average maternal age at birth has increased. In 2001 the average age of mothers at first birth in England and Wales was 26.5 (ONS, 2004), by 2008 mothers were on average a year older, with an average of 27.5 (ONS, 2009). Obesity has increased over the past decade among women of childbearing age. The NHS National Obesity Observatory report a change in the prevalence of obesity among women aged 16-44 from around 15% in 2000 to over 20% in 2008 according to results from the Health Survey for England (National Obesity Observatory, 2011).

The situation in the NHS maternity services has also changed in the past decade. Caesarean section rates have increased from around 21% in England to almost 25%, and there have been similar increases in the smaller countries of the UK. However, there has also been an increased focus on rising caesarean section rates which may have contributed to a slowing in the increase over the past few years. A review in England focusing on examining the practices of nine maternity units with very high or low caesarean section rates led to the development and launch of a ‘toolkit’ in 2007, which outlines the characteristics of units with low caesarean section rates (Baldwin et al., 2010). The impact of the toolkit is currently being evaluated.

Since the first wave of the MCS there have been several new sets of NICE guidelines for maternity care, including for caesarean section (National Institute for Health and Clinical Excellence, 2004b) (currently under revision), antenatal care (National Institute for Health and Clinical Excellence, 2003, National Institute for Health and Clinical Excellence, 2008a), intrapartum care (National

Institute for Health and Clinical Excellence, 2007) and induction of labour (National Institute for Health and Clinical Excellence, 2008b). It is likely these guidelines will have influenced the delivery of care, although there is little evidence documented on this. However, in a recent qualitative study, Kennedy and colleagues (2010) observed evidence of several practices supportive of normal birth from NICE and site-specific guidelines, such as discouragement of routine continuous electronic fetal monitoring, and keeping labouring woman out of bed. However, it should be noted that the two NHS trusts used in the study were chosen as they publicly identified their work to enhance normal birth, and this will not be representative of all maternity units.

Interestingly the most recently published guidelines for pregnancy focus on pregnant women with complex social needs (National Institute for Health and Clinical Excellence, 2010). The 2010 guideline focus on specific groups, including teenage mothers and non-UK born women or those who have language difficulties. The guidelines suggest that health professionals should use a variety of ways to communicate with women with language difficulties, and should undertake training in the needs of these women. These new guidelines reflect an increased interest in the differences in the maternity care experienced by women of different backgrounds in the UK.

There have been changes to the Terms and Conditions of employment for midwives under Agenda for Change (AfC), which was introduced in 2004 and re-graded pay grades for many midwives (National Institute for Health and Clinical Excellence, 2004a). In addition, increased budget restrictions, low staffing levels and heavy workloads have resulted in low morale, and impact on the service midwives can provide for women (The Royal College of Midwives, 2007).

Kennedy and colleagues (2010) interviewed staff and women from two NHS trusts, as well as conducting 6 months of observations in one. The trusts actively worked to normalise birth, yet they also served diverse and in many cases high risk populations. Poor staffing levels were cited as one of the key barriers to normal birth:

> *…there has been unfortunately in London a 25% increase in the birth rate and there has not been a 25% increase in staff… it's not just the women and the time, it's all the other bits of the job that have proliferated… a hundred times more paperwork than when I first became a midwife twenty-odd years ago…* (**Unnamed staff midwife, in Kennedy et al., p.265**).

The changes in the demand for midwifery care, and an increase in women who may experience more complications in labour put added strain on an already stretched midwifery care system, likely adding further barriers to providing one-to-one woman centred care.

11.5.6 Implications in the current policy context

The most important current policy drivers in maternity care are from the Department of Health (DoH); the *National Service Framework for Children, Young People and Maternity Services* (Department of Health, 2004) and *Maternity Matters* (Department of Health, 2007). The two documents have an emphasis on the following areas: reducing health inequalities, normal birth, individualised and woman-focused care, choice of how and where to access care, equal access to high quality care, and continuity of midwifery care.

This thesis shows demonstrable differences between women in the UK, not only in the mode of birth they experience, but also in their uptake of antenatal care by demographic background. Further research to increase the understanding of why these differences occur may decrease the disparities and allow more women to have a normal birth experience.

11.5.7 Implications for further research

In the UK there is a dearth of research regarding the predictors of mode of birth. Further research is needed to understand the associations identified between maternal and infant factors and mode of birth identified in this study. Some factors have been identified as independently predictive of mode of birth in this study, which to my knowledge have not been previously researched, e.g. age at first birth. In other cases, a lack of previous UK research, as with socio-economic status, signifies a need for additional information. These findings warrant exploration in further large UK data-sets. In addition, results from this study should be applied in future research adjusting hospital operative birth rates for case-mix differences.

Future research should also focus on generating deeper understanding of the relationship between demographic factors and mode of birth, and identifying to what extent these findings are attributable to the behaviours of health professionals and the women themselves, and are therefore modifiable. Qualitative or mixed methods approaches will be required in order to acquire an in-depth understanding of what is driving differences in mode of birth. In addition, if some differences are more attributable to biological reasons, future research could identify if different methods of care could help women in ‘high risk’ groups to achieve an unassisted birth.

The following specific topic areas are recommended for future research:

- To investigate the reasons for the increasing rates of operative birth with increasing maternal age. This should include further research of the biological theory, as well as exploring the attitudes and behaviours of women at different age groups and health professionals towards these women.

- To explore further the relationship between socio-economic status and mode of birth in large population samples, with information on individual-level socio-economic status, and interventions during labour, e.g. epidural use.
- To explore the experiences in labour and birth of women of different ethnic backgrounds, with a particular focus on the indications for mode of birth, communication between women and staff, stereotyping, and comparisons between women's self-reported health and birth experiences, and their medical records.
- To investigate the relationship between fetal sex and mode of birth by further studying fetal heart rate patterns by sex.
- To further explore the relationship between antenatal care and class attendance and mode of birth using data with additional information on obstetric history, and inter-pregnancy interval. In addition, if an association is again observed between attendance at antenatal classes and operative birth among multiparous women, to establish the attitudes of these women towards pregnancy and birth.

11.6 Conclusion

Caesarean sections and instrumental births have been increasing in the UK, with one in three women now having an operative birth. The procedures represent a significant health cost to women and their infants, as well as a substantial financial burden to the NHS. Little is understood about why operative birth rates are so high in the UK, in particular, there is a scarcity of research on the predictors of mode of birth.

This study has explored the maternal and infant characteristics which predict mode of birth, in a large representative UK sample. The study differed from the small amount of current UK literature in several ways. Firstly, mode of birth was categorised in four categories; (1) unassisted vaginal birth, (2) instrumental vaginal birth, (3) emergency caesarean section and (4) planned caesarean section, including both commonly used classifications of caesarean section, and instrumental births, which are rarely included in research. Secondly, a large number of predictors were examined using multivariate techniques to establish the independent effect of each on mode of birth. Thirdly, primiparous and multiparous women were examined separately.

The data revealed that the socio-demographic, socio-economic, and interpersonal characteristics of women, their health and the care they receive during pregnancy and labour, and the characteristics of their infant, independently predict the mode of birth they experience. In particular, operative births rose dramatically with increasing maternal age, women of low socio-economic status were at an increased risk of operative birth, and mode of birth differed significantly by ethnic background,

language and migration status. These findings are important considering the recent DoH policy drivers to reduce health inequalities and increase normal birth, and the latest NICE guidelines which aim to tackle differences in care for some more vulnerable groups. The results could also provide further understanding about how the different populations served by maternity units, contribute to the substantial variation in operative birth rates observed between units. Further research is needed to establish to what extent differences in mode of birth are a reflection of the attitudes and behaviours of women, or health professionals, and are therefore amenable to change.

Appendix 1: Literature search strategy

The following example combined mode of birth terms with terms for fetal sex (MEDLINE):

1. exp Cesarean Section/
2. caesarean.ti,ab.
3. cesarean.ti,ab.
4. cesarian.ti,ab.
5. caesarian.ti,ab.
6. exp Delivery, Obstetric/
7. (surgical adj2 delivery).ti,ab.
8. (surgical adj2 birth).ti,ab.
9. (operative adj2 birth).ti,ab.
10. (operative adj2 delivery).ti,ab.
11. (instrument* adj2 birth).ti,ab.
12. (instrument* adj2 delivery).ti,ab.
13. ventouse.ti,ab.
14. vacuum extraction.ti,ab.
15. exp Vacuum Extraction, Obstetrical/
16. exp Extraction, Obstetrical/
17. (forceps adj2 birth).ti,ab.
18. (forceps adj2 delivery).ti,ab.
19. exp Obstetrical Forceps/
20. (mode adj2 birth).ti,ab.
21. (mode adj2 delivery).ti,ab.
22. (method adj2 birth).ti,ab.
23. (method adj2 delivery).ti,ab.
24. (type adj2 birth).ti,ab.
25. (type adj2 delivery).ti,ab.
26. or/1-25
27. (fetal adj2 sex).ti,ab.
28. (fetal adj2 gender).ti,ab.
29. (fetus adj2 sex).ti,ab.
30. (fetus adj2 gender).ti,ab.
31. (infant adj2 gender).ti,ab.
32. (infant adj2 sex).ti,ab.
33. (female adj2 fetus).ti,ab.
34. (male adj2 fetus).ti,ab.
35. (female adj2 infant).ti,ab.
36. (male adj2 infant).ti,ab.

37. or/27- 36
38. 26 and 37
39. limit 38 to (english language and humans)

Appendix 2: Hospital level data

From the literature reviewed in Chapter 8 it is clear that variation exists between hospitals and between health care providers. The MCS interview data does not provide information about the hospital of birth that would allow exploration of the effect of place of birth on mode of birth. However, in 2007 centrally-collected hospital level data were made available that could be linked to the MCS data. In this section I explore the practicability of using the linked hospital data.

Background to the linked data

For reasons of limited health questions in the MCS questionnaire and possible recall errors at the nine-month interview regarding pregnancy and birth (Centre for Longitudinal Studies, 2008), data from the MCS have been linked to both hospital records and birth registration records for mothers who gave consent for matching (Dezateux et al., 2006, Johnson, 2007). Linked birth registration and hospital data were first made available in 2007.

Identifying variables from the MCS were sent to the holders of birth registration and hospital information in each country. For hospital records, trusts or hospitals are required to submit data held on their systems to the relevant country's health service department. For example, in England information is held centrally by the Department of Health. For women who gave birth in a private hospital only a minority will have information sent to central hospital records.

In England, Wales and Northern Ireland, matches were determined if there was complete agreement on common variables such as mother's date of birth, postcode at baby's birth and hospital of birth. In Scotland, records were linked to all possible pairs on a range of variables and a decision was then made as to which record belonged to the same individual. It is theoretically possible that false matches could occur if two individuals had identical matching variables. Overall, 90% of MCS women consented to have their data matched to birth registration data, and of those, 99% were successfully matched, meaning that 89% of MCS women have matched birth registration data. For hospital data 90% consented and of those 84% were successfully matched. Therefore 75% of MCS women have linked hospital data.

Birth registration record linkage provided seventeen variables regarding country, socio-economic variables such as social class and employment status and baby's birth weight and sex. Information regarding these variables was already available from the MCS questionnaire data.

Hospital record linkage provided sixty-five hospital-level variables. However, there is a great deal of variability in the information provided, both by country and by hospital. This is because

centrally-collected hospital record data are held in two levels. The 'general record' contains information about the mother's stay in hospital e.g. operations and diagnoses. Extra information regarding the birth of the baby, e.g. mode of birth and birth weight, is held in the 'tail record'. However, not all hospitals in England and Wales were able to supply the 'tail' information, and Northern Ireland does not hold this information at all.

Research has shown good agreement between data provided by women in the MCS and data from hospital records (Dezateux et al., 2006, Quigley et al., 2007). Additional information made available by the matching of hospital record data contains where the woman gave birth, including anonymised hospital and NHS trust of birth. This allows identification of which MCS women gave birth in the same hospital, without identifying the hospital.

Some further information regarding place of birth, e.g. type of ward, is available from the 'tail' data. Data concerning intended place of birth and actual place of birth were only collected in England and Wales, although they are not complete for every hospital. Scotland collected data regarding intended place of birth but not actual place of birth, and Northern Ireland collected no information about place of birth, as no tail data is held centrally. According to MCS information regarding the completeness of place of birth variables, Scotland achieved 100% and England and Wales achieved between 84% and 87% completeness (Dezateux et al., 2006). However, the actual figures from the separate hospital data files are shown later, in Table 1.

Data analyses to explore the hospital data

Hospital level data are provided in five separate files – one containing the anonymised hospital of birth variables and one each containing hospital episode data for England, Scotland, Wales and Northern Ireland.

Merging hospital data with MCS data

The anonymised hospital data and the hospital episode data for each country were merged with the MCS data (except Northern Ireland as the data contained no information about place of birth). To allow for merging, mothers who gave birth to twins or triplets in the hospital data were dropped.

Hospital of birth anonymised data

There were 300 hospitals from which at least one woman from the MCS gave birth. The highest number of women who gave birth at the same hospital was 394.

Hospital episode data

As discussed previously, not all hospitals in England and Wales supply 'tail' data from which place of birth is taken, and for those that do, it is not always complete. Among women for whom there is hospital data, for England around 70% have data on intended and actual place of birth and for Scotland there is data on intended place of birth for all women (but none for actual place of birth). For Wales however there is only data regarding place of birth for less than 20% of the women with hospital data (see Table 1).

Table 1: Proportion with of women with actual and intended place of birth from hospital data

Variable	**Country**			
	England N=8,689	**Scotland N=2,033**	**Wales N=2,370**	**Northern Ireland N=1,133**
Birth place (intended)	✓ 5,974 (68.75%)	✓ 2,033 (100%)	✓ 473 (19.96%)	Not collected
Birth place (actual)	✓ 6,065 (69.80%)	Not collected	✓ 470 (19.83%)	Not collected

The categories for the place of birth variables altered somewhat dependent on the country in which the data were collected. Table 2 shows the categories for place of birth in the hospital data and the raw frequencies within the England, Wales and Scotland hospital data.

Table 2: Linked hospital data: Place of birth variables (frequencies and percentages)

Country	Place of birth categories	Intended	Actual
England	NHS hospital - consultant ward	3,229 (54.05%)	3,559 (58.68%)
	NHS hospital - consultant/GP/midwife ward	2,363 (39.55%)	2,233 (36.82%)
	NHS hospital - midwife ward	179 (3.00%)	168 (2.77%)
	NHS hospital - GP ward	91 (1.52%)	53 (0.87%)
	Private hospital	2 (0.03%)	7 (0.12%)
	Other hospital or institution	10 (0.17%)	0
	NHS hospital - ward or unit without delivery suite	3 (0.05%)	2 (0.03%)
	Domestic address	34 (0.57%)	35 (0.58%)
	None of the above	63 (1.05%)	8 (0.13%)
Wales	NHS hospital - consultant ward	145 (30.66%)	224 (47.66%)
	NHS hospital - consultant/GP/midwife ward	10 (2.11%)	8 (1.70%)
	NHS hospital - midwife ward	4 (0.85%)	3 (0.64%)
	NHS hospital - GP ward	17 (3.59%)	13 (2.77%)
	Domestic address	216 (45.67%)	222 (47.23%)
	Not known	81 (17.12%)	0
Scotland	Consultant unit	1,846 (90.80%)	N/A
	Midwife unit	155 (7.62%)	N/A
	GP unit	15 (0.74%)	N/A
	Home birth	6 (0.30%)	N/A
	Not booked/other	9 (0.44%)	N/A
	Not known	2 (0.10%)	N/A

For England and Scotland the results in Table 2 seem fairly representative, with high proportions of women intending to give birth on some sort of consultant-led ward, and low home birth rates. However, for Wales the results do not seem to be representative. Table 1 showed that for women with hospital data from Wales, less than 20% (around 470 women) had data on intended or actual place of birth. For that small sample of women, place of birth data may not be representative of childbirth in Wales. Over 47% of women in the sample had a home birth. We know from the literature discussed in Chapter 8 that the UK as a whole has a home birth rate of less that 3%. As not all Welsh hospitals provide ‘tail’ data which contains place of birth, and a selected sub-sample

of those hospitals are included in the MCS, it may be that the small number of hospitals for which tail data is available in this study had high home birth rates in the area.

Recoding place of birth variables

The initial coding of the place of birth variables in each country are shown in Table 2. Intended and actual place of birth variables for England were recoded by combining consultant wards and wards with consultant-led care shared with other health professionals. Mothers who gave birth in a 'private' or 'other' hospital were combined with the mothers in the 'none of the above' category to create an overall 'other' category. Therefore the categories were reduced to five: consultant only or shared care ward, midwife ward, GP ward, domestic address and other (see Table 3).

Table 3: Intended and actual place of birth (England) for women with linked place of birth data

Place of birth variables from hospital episode data		**Unweighted sample size**	**Weighted percentages**
HES: Intended place of birth (England) N=5,796	**Consultant ward**	5,423	92.18
	Midwife ward	179	3.82
	GP ward	91	1.98
	Domestic address	34	0.06
	Other	69	1.42
HES: Actual place of birth (England) N=5,796	**Consultant ward**	5,614	94.48
	Midwife ward	168	3.60
	GP ward	53	1.15
	Domestic address	35	0.66
	Other	6	0.11

Summary

- The MCS data is linked to hospital data for around 75% of MCS women.
- Within the hospital data there were variables which described the type of ward of birth (e.g. midwife ward) – both intended and actual. However:
    - Data were patchy. For women who consented to having hospital data linked, not all had data on place of birth as not all hospitals collect that information. The worst case was Wales where less than 20% of women with hospital data have data on place of birth, with a home birth rate of over 40%. For Northern Ireland there was no place of birth data. For Scotland, data were only available for intended, not actual place of birth. The data for Northern Ireland, Wales and Scotland were therefore not useful.

- There was also little variation in ward type in the remaining English data, with 94% of women having given birth on a consultant ward.

Although there was an anonymised hospital variable, this would have provided information only as to which women gave birth at the same hospital. While it was possible to apply for a special license to access data that included the names of the hospitals, the lengthy process involved to find out details of those hospitals (e.g. caesarean section rates) was thought to be outside the scope of this thesis, especially as the focus is on the maternal and fetal risk factors for mode of birth. Previous research has shown that patient characteristics explain much more variation in caesarean section rates than do hospital factors (Burns et al., 1995).

Appendix 3: Variable coding

Further information is provided here for the coding of the three variables with multiple answers; problem/illness in pregnancy, complications in labour and mode of birth. In addition, further information is given for the unused question regarding pain relief.

Type of illness/problem during pregnancy

"Did you have any illnesses or other problems during your pregnancy that required medical attention or treatment?" If yes: "*What illnesses or problems did you have?"*

Up to seven responses (a-g) were reported for each woman (see Table 1). My categorisation was as follows:

No problems
Caesarean section risk factor
Other

Table 1: Responses to a question about illness or problems in pregnancy, coloured to indicate my coding

	Unweighted number of women							
MCS responses	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**Total**
~~don't know~~	2							**~~2~~**
not applicable	11,386							**11,386**
bleeding or threatened miscarriage in early pregnancy	1,104							**1,104**
bleeding in later pregnancy	418	228						**646**
~~pregnancy diagnosed as twins, triplets or more~~	16	13	5					**~~34~~**
persistent vomiting	801	184	43	4				**1,032**
raised blood pressure, eclampsia /preeclampsia or toxaemia	998	228	63	9	2			**1,298**
urinary infection	505	304	100	33	6	1		**949**
diabetes	190	67	22	9	6			**294**
too much fluid around the baby	48	33	23	9	5	2		**120**
suspected slow growth of baby	97	106	62	14	5	1	1	**286**
other/anaemia	369	72	17	3	2		1	**463**
other/blood group incompatibilities	30	13	4	1	1			**49**

other/other blood disorders including thromboses	91	36	12	3	1	1		**144**
other/backache, sciatica, prolapsed disc	226	65	16	8	1			**316**
other/symphysis pubis dysfunction (spd)	100	36	16	5	4			**161**
other/other pelvic joint problems	56	17	7	1				**81**
other/non-trivial infections	308	77	31	9	3	2		**430**
other/gestational diabetes, raised blood sugar, abnormal glucose tolerance	25	13	3	1	1			**43**
other/liver, gall bladder problems, cholestasis	69	19	7	1	1			**97**
other/asthma, hay fever, eczema or other allergies	85	22	12	3				**122**
other/depression or other mental illness	44	19	7	2	1			**73**
other/neurological problems: epilepsy, faint(s), Blackout(s)	45	11	11	3		1		**71**
other/other neurological problems, including migraine attacks	42	21	4	4				**71**
other/uterine/labour pains, threatened, incipient, or commenced labour	77	35	20	8	5	2		**147**
other/early rupture of membranes, leak of amniotic fluid	21	14	11	6	2	2		**56**
other/foetal heart slow, faint, inaudible, foetal distress	27	13	7					**47**
other/other foetal problem, suspected or diagnosed in pregnancy	60	29	4	8	5			**106**
other/bleeding due to low lying placenta (placenta praevia)	41	24	14	7	1			**87**
other/too little fluid around the baby	23	17	18	7	3			**68**
other/accident or injury	51	21	10	5	2	2		**91**
other answer	877	332	122	56	10	5	2	**1,404**
~~irrelevant response~~	6							**~~6~~**
any other suspected problems (please specify)	1							**1**

Complications during labour

"Were there any complications during [baby name] birth?"

Up to five responses (a-e) were reported for each woman (see Table 2). My categorisation was as follows:

No complications
Malpresentation
Fetal distress
Other

Table 2: Responses to a question about complications during the birth, coloured to indicate my coding

	Unweighted number of women					
MCS responses	**a**	**b**	**c**	**d**	**e**	**Total**
~~don't know~~	6					**~~6~~**
no complications	12,420					**12,420**
breech birth - feet first	438					**438**
other abnormal lie e.g. shoulder first	560	2				**562**
very long labour	1,138	131				**1,269**
very rapid labour	432	12	1			**445**
foetal distress - heart rate sign	1,470	471	38	1		**1,980**
foetal distress - meconium or other sign	525	276	89	11		**901**
other/raised blood pressure	33	12	3	1		**49**
other/bleeding due to low lying placenta (placenta praevia)	26	2				**28**
other/accidental haemorrhage, abruption	21	10	1	1		**33**
other/other haemorrhage, origin or timing unclear	64	24	3	1		**92**
other/cord around neck etc	365	133	30	5		**533**
other/head at the back (occipitoposterior)	47	21	9	1		**78**
other/baby s head too big/mother s pelvis too small	28	25	3	1		**57**
other/unable to push baby out (uterine inertia)	19	13				**32**
other/delay in labour, cervical	40	28	10	3	2	**83**
other/delay in labour, insufficient or partial information	157	79	25	3		**264**
other/severe maternal distress	20	16	5	4		**45**
~~other/baby ill, at or after birth, with~~	114	60	21	5		**~~200~~**
~~other/maternal or placental problem post delivery~~	123	33	5	4		**~~165~~**

other/breech delivery other than footling	14					**14**
~~other/baby born early, premature, low birthweight~~	32	11	5	1		~~**49**~~
~~other/instrumentation, forceps, ventouse~~	9	26	9		1	~~**45**~~
other/infection in labour	15	13	4	2		**34**
~~other/failed induction~~	9	2	1			~~**12**~~
~~other/caesarian section~~	12	54	16	10		~~**92**~~
~~Other/manual manipulation~~			1			~~**1**~~
~~other/early rupture of membranes~~	9	3	7			~~**17**~~
~~other answer (not codeable)~~	90	44	18	2		~~**154**~~
~~irrelevant response~~	2	1		1		~~**4**~~
~~other complication~~	1	1				~~**2**~~

Mode of birth

Mode of birth was prioritised in the following order: instrumental vaginal birth → planned caesarean section → emergency caesarean section (i.e. a woman who reported both planned and emergency caesarean section would be coded as emergency). Emergency caesarean section was prioritised as more invasive over planned caesarean section as a woman may be scheduled to have a planned caesarean section, but may then experience complications and require an emergency caesarean section. In addition, no women who originally said they had an emergency caesarean section reported another mode of birth. Table 3 shows the comparison of first, second and third responses. Red numbers indicate disagreement between answers. Numbers in Black are those where the first and second answer were coded the same (e.g. 1st answer = vacuum extraction, 2nd answer = forceps, both coded instrumental).

Table 3: Comparison of first, second and third responses for mode of birth

		2nd answer				3rd answer			
		UVB	**IVB**	**PCS**	**ECS**	**UVB**	**IVB**	**PCS**	**ECS**
1st answer	**UVB**	8	**82**	**1**	**8**		**7**		
	IVB		150	**10**	**19**			**2**	**11**
	PCS				**14**				
	ECS								
2nd answer	**UVB**								
	IVB						7	**2**	**11**
	PCS								
	ECS								

Type of pain relief

Which, if any, of the following types of pain relief did you have at any time during labour?

- *Gas and air*
- *Pethidine or demerol injection*
- *Epidural*
- *General anaesthetic*
- *TENS machine*
- *Other*
- *No pain relief*
- *Did not have labour*

Up to five responses (a-f) were reported for each woman. The information available on pain relief was uncertain. Although the question referred to pain relief during labour, we do not know whether women were reporting pain relief (e.g. epidural) during labour, or *for* the birth itself. This was highlighted by over 600 women reporting having a general anaesthetic. In addition, as discussed in Chapter 8, information about the timing and type of epidural is important, and this was unavailable.

Table 4: Responses to a question about pain relief during labour

	Unweighted number of women						
MCS responses	**a**	**b**	**c**	**d**	**e**	**f**	**Total**
refusal	3						**3**
don't know	13						**13**
gas and air	12,607						**12,607**
pethidine or demerol injection	687	4,778					**5,465**
epidural	2,194	2,296	1,386				**5,876**
general anaesthetic	271	143	127	71			**612**
tens machine	170	761	819	338	24		**2,112**
other/spinal block, spinal anaesthetic	190	48	43	19	3	1	**304**
other/morphine	7	39	13	12	1		**72**
other/diamorphine	25	151	74	24	4		**278**
other/minor pain killers	16	21	12	14	3		**66**
other/other general including alternative	8	17	13	12	2		**52**
other/local anaesthetic	5	4	3	3			**15**
other/water birth	4	18	23	7	2		**54**
other/spinal tap	15	2	5	1			**23**
other answer (not codeable)	22	52	29	14	8		**125**
irrelevant response	1	1	1	1			**4**
other		5	2		1		**8**
no pain relief	1,492	1					**1,493**
did not have labour	509	66	17	3			**595**

Appendix 4: Chapter 10 model results

Contents

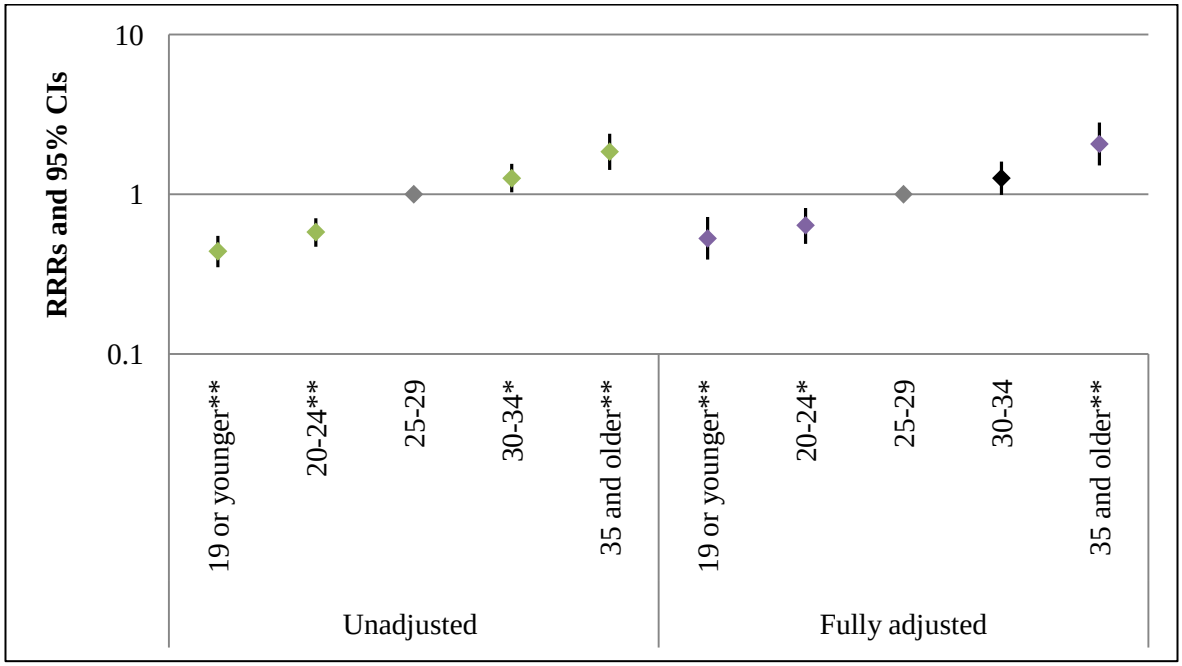
Independent predictors of instrumental birth

Primiparous women

Maternal age

The risk of instrumental birth for first-time mothers increased with increasing maternal age (see Figure 1). Adjustment for maternal and fetal characteristics made little difference to the increased risk, and for women aged 35 and over, adjustment for other covariates actually strengthened the association. Compared to women aged 25-29 at birth, women aged 35 and over were twice as likely to have an instrumental birth (fully adjusted RRR=2.07, p<0.001), whereas teenage women were around half as likely (fully adjusted RRR=0.53, p<0.001).

Figure 1: The effect of maternal age on the risk of instrumental birth for primiparous women

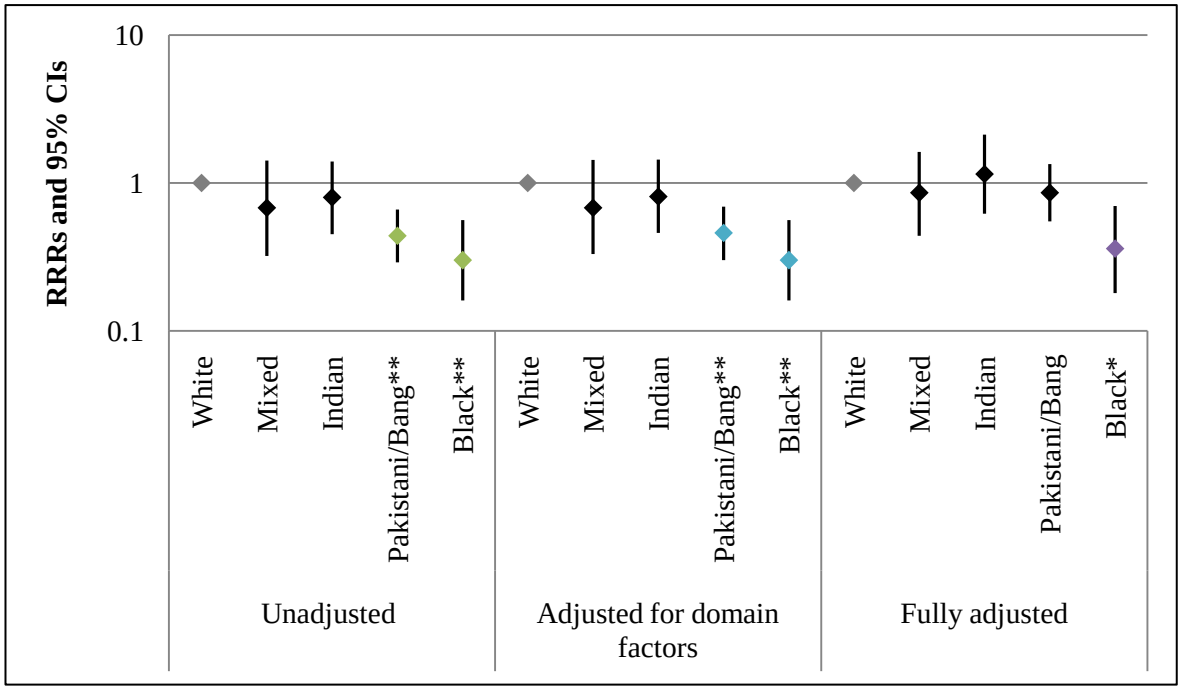


**p<0.001 *p<0.05

Ethnicity, migration status and language

Figure 2 shows the relationship between ethnicity and the risk of instrumental vaginal birth. Compared to White mothers, Black mothers were less likely to have an instrumental birth, and after full adjustment the risk was only slightly attenuated (unadjusted RRR=0.30, p<0.001 and fully adjusted RRR=0.36, p<0.05). Although in the unadjusted and domain models Pakistani and Bangladeshi women appeared to be at a decreased risk of instrumental birth compared to White women, after adjustment for other maternal and fetal factors, being Pakistani or Bangladeshi was no longer significant.

Figure 2: The effect of ethnicity on the risk of instrumental birth for primiparous women



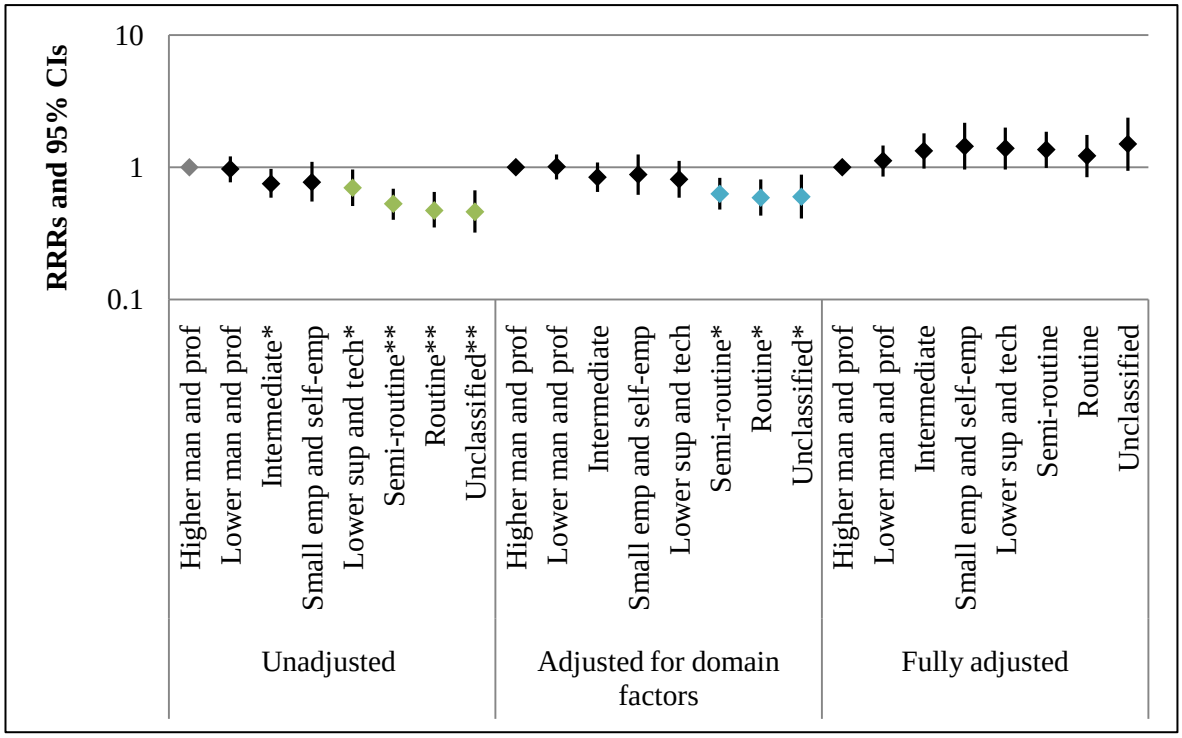
**p<0.001 *p<0.05

Although mothers who were from non-English speaking households were less likely to have an instrumental birth in unadjusted analyses, after adjustment for other domain factors, language was no longer significant. Migration status was unrelated to the risk of instrumental births in the unadjusted analyses.

Socio-economic factors

In the unadjusted and domain models, the risk of instrumental birth decreased with decreasing socio-economic status as measured by educational level and social class. However, in the fully adjusted model the direction of the association changed (see Figure 3). Compared to mothers from households where the highest occupation was higher managerial or professional, mothers in some lower social class bands were at an *increased* risk of an instrumental vaginal birth, although none of the results achieved statistical significance (e.g. fully adjusted RRR=1.36, p=0.06 for semi-routine). Educational level was no longer significantly related to the risk of instrumental birth.

Figure 3: The effect of social class on the risk of instrumental birth for primiparous women



**p<0.001 *p<0.05

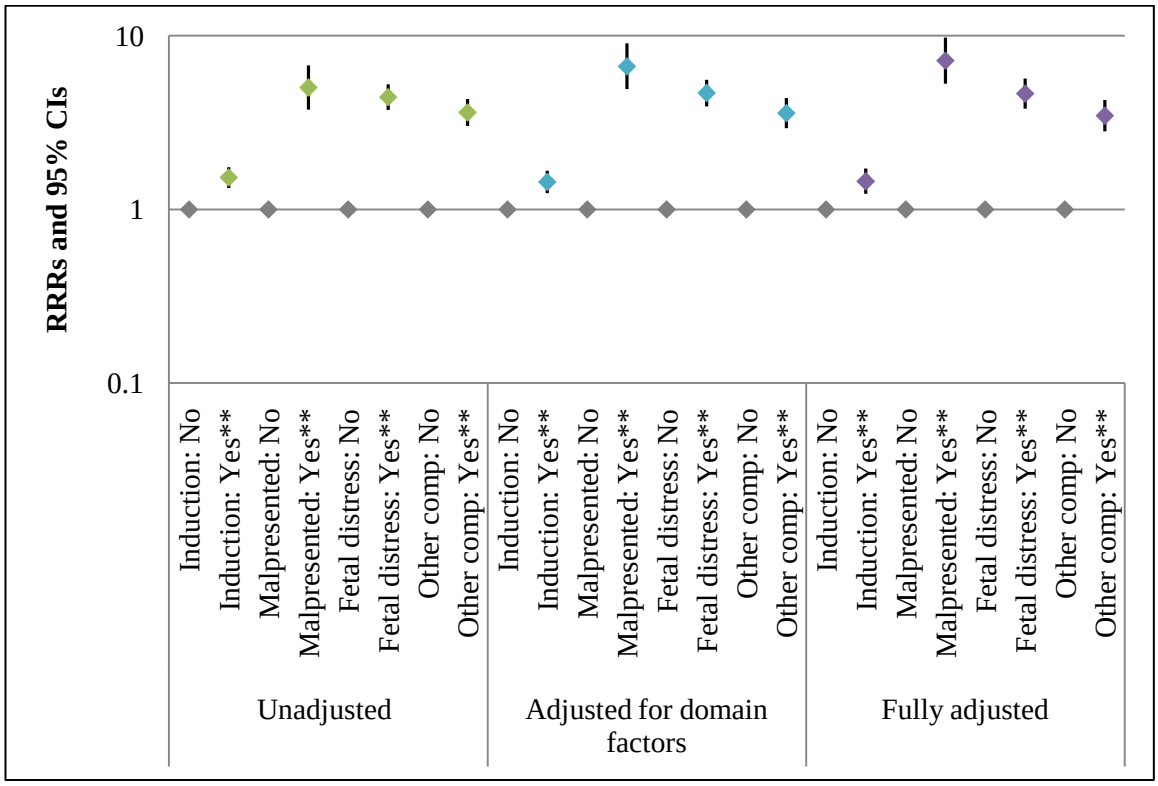
Height

Although height was unrelated to instrumental births in the unadjusted model, when fully adjusted, women who were 166-171cm (5ft 4 – 5ft 6) were at a decreased risk of instrumental birth compared to women of average height (160-165cm) (fully adjusted RRR=0.78, p<0.05).

Labour factors

Adjustment for other maternal or fetal characteristics made little difference to the effect of labour factors on the risk of instrumental birth (see Figure 4). Women who were induced were over 1.4 times more likely to have an instrumental birth than mothers who were not induced (fully adjusted RRR=1.45, p<0.001). Mothers who reported malpresentation, fetal distress and other complications during birth were over 7, 4 and 3 times more likely to have an instrumental birth, respectively compared to women who did not report these complications (fully adjusted RRR=7.19, p<0.001 for malpresentation, RRR=4.65, p<0.001 for fetal distress and RRR=3.46, p<0.001 for other complications).

Figure 4: The effect of induction and labour complications on the risk of instrumental birth for primiparous women

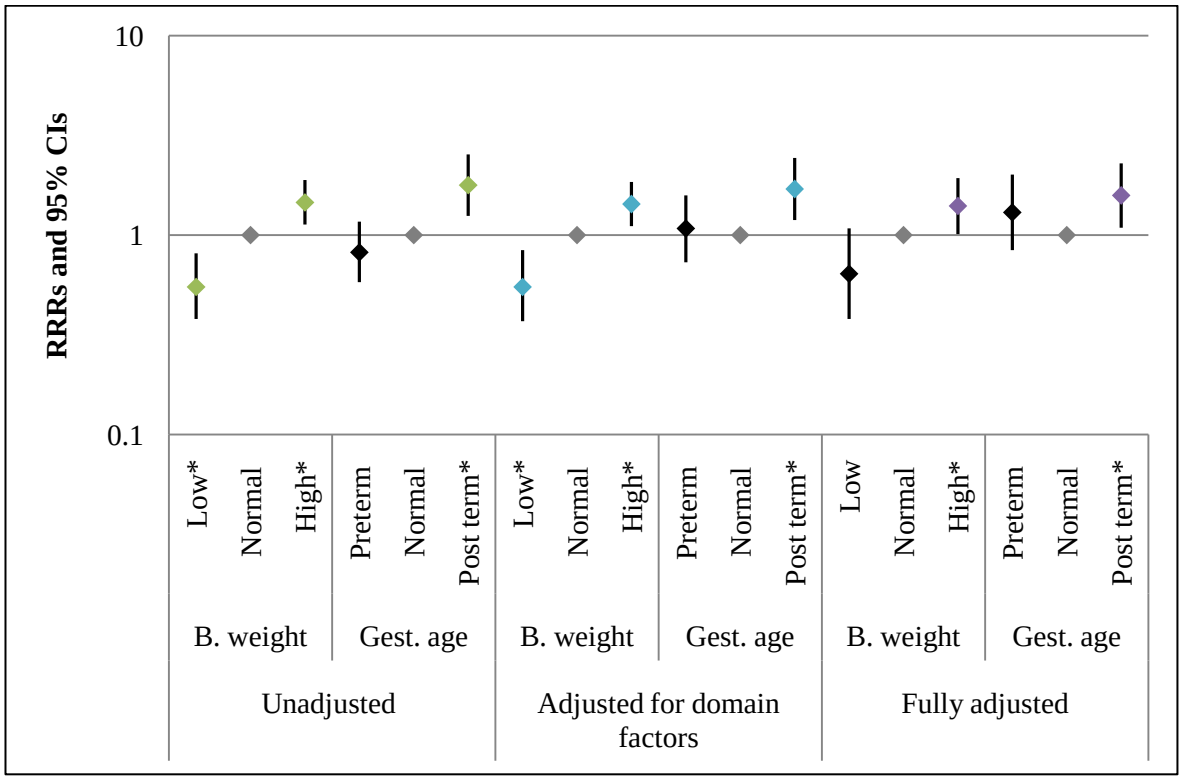


**p<0.001

Fetal factors

Figure 5 shows the effect of fetal factors on the risk of instrumental birth for first-time mothers. Mothers who gave birth post-term were at an increased risk of having an instrumental birth (fully adjusted RRR=1.58, p<0.05). In the unadjusted model, compared to mothers who had a normal birth weight infant, mothers who gave birth to low birth weight infants were at a decreased risk of instrumental birth and mothers who had a high birth weight infant were at an increased risk. After adjustment in the full model, high birth weight infants remained at an increased risk of instrumental birth (fully adjusted RRR=1.40, p<0.05).

Figure 5: The effect of infant birth weight and gestational age on the risk of instrumental birth for primiparous women



*p<0.05

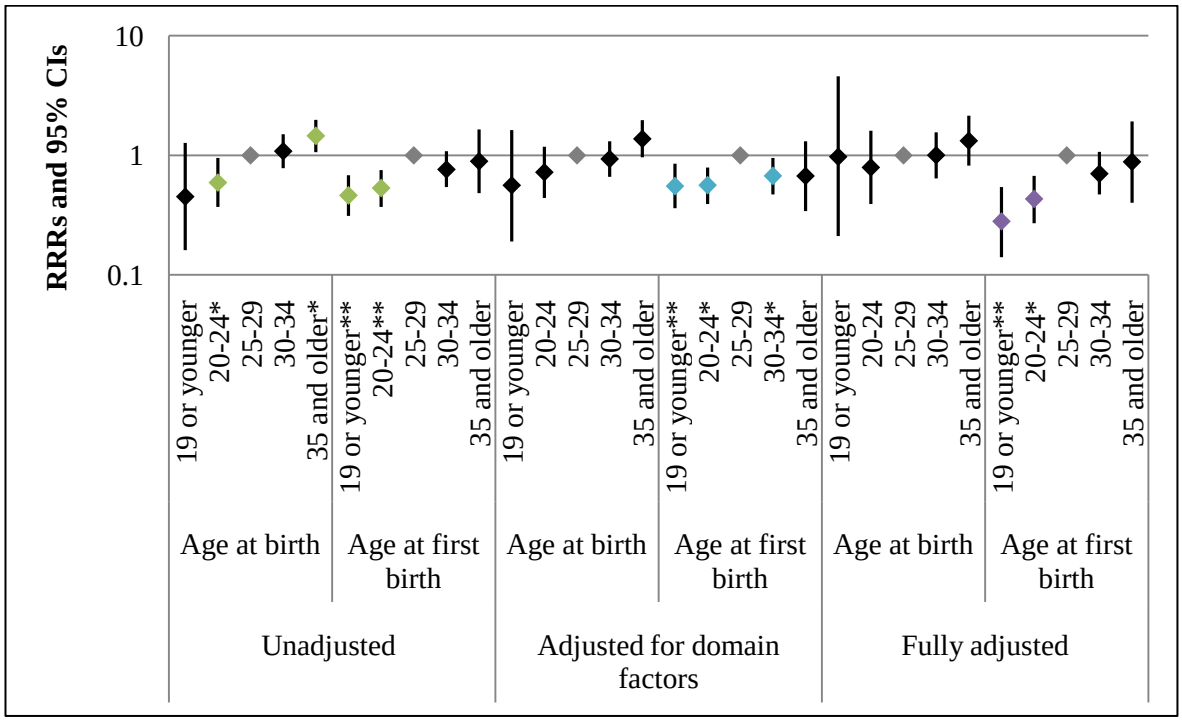
Interpersonal factors, pregnancy factors and health factors were found to be unrelated to the risk of instrumental birth for first-time mothers once adjusted for other maternal and fetal characteristics in the final model, although the result of a decreased risk of instrumental birth for mothers who were unhappy about the pregnancy was of borderline significance (fully adjusted RRR=0.78, p=0.05).

Multiparous women

Maternal age

Although mothers in their late thirties at the cohort member birth were at an increased risk of instrumental birth in unadjusted analyses, adjustment for age at first birth revealed that the age at first birth was important in predicting the risk of instrumental birth. Compared to mothers who had been 25-29 at their first birth, mothers who had been younger when they first gave birth were less likely to have an instrumental birth at the cohort birth (e.g. fully adjusted RRR=0.28, p<0.001 for women aged 19 or younger, see Figure 6).

Figure 6: The effect of maternal age at cohort member birth and at first birth on the risk of instrumental birth for multiparous women



**p<0.001 *p<0.05

Ethnicity, migration status and language

In the unadjusted models Pakistani/Bangladeshi women were less likely to have an instrumental birth compared to White women (unadjusted RRR=0.53, p<0.05), but language and migration status were unrelated to the risk of instrumental birth. However, in the fully adjusted model, ethnicity was no longer significantly related to risk of instrumental birth but women who had lived in the UK for less than five years were more likely to have an instrumental birth (fully adjusted RRR=3.72, p<0.05 compared to UK-born women).

Socio-economic factors

After full adjustment, mothers with an overseas qualification were over twice as likely to have an instrumental birth compared to mothers with degree level qualifications (fully adjusted RRR=2.79, p<0.05). Social class was unrelated to the risk of instrumental birth.

Interpersonal factors

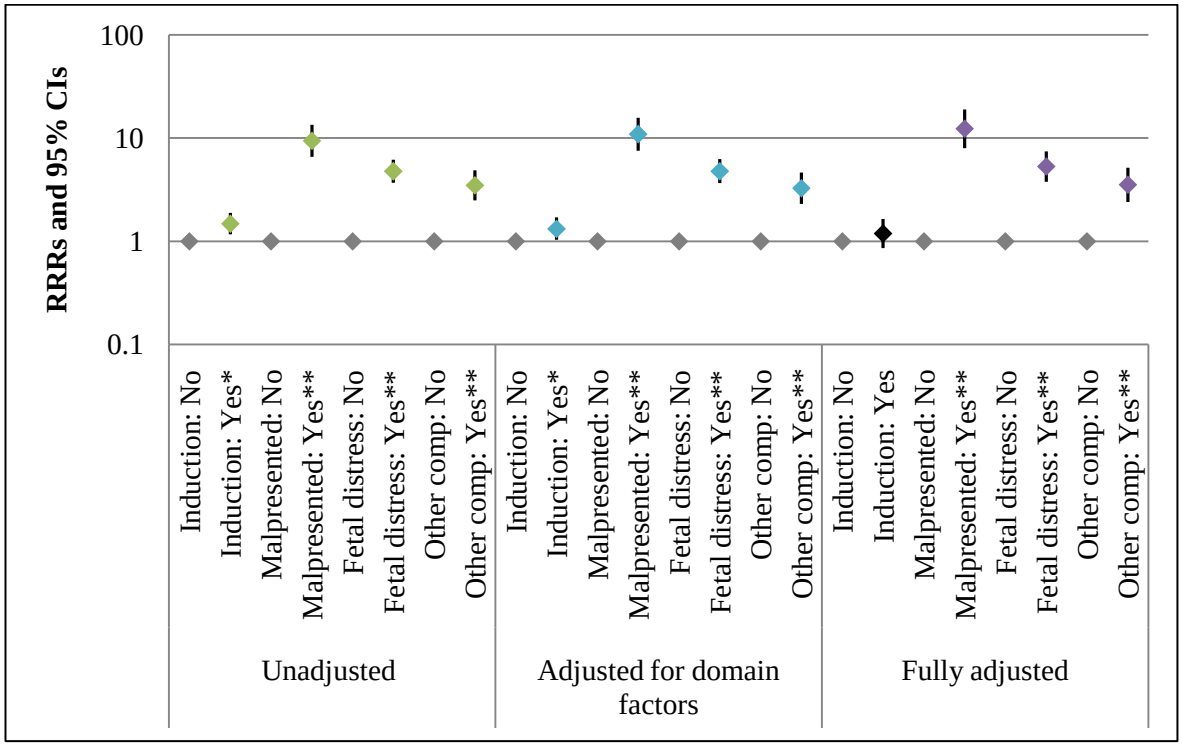
Women who had left home before the age of 17 were less likely than those who had not, to have an instrumental vaginal birth (fully adjusted RRR=0.49, p<0.05). Whether the woman's parents had ever separated and how the woman had felt when she discovered she was pregnant were unrelated to the risk of instrumental birth.

Labour factors

Figure 7 shows the effect of labour factors on the risk of instrumental birth for multiparous women. Although induction of labour increased the risk of instrumental birth in the unadjusted and domain model, in the fully adjusted model it was not significantly related (fully adjusted RRR=1.19, p=0.30).

As was observed for primiparous women, malpresentation, fetal distress and other complications increased the risk of instrumental birth. Malpresentation was the most important, increasing a woman's risk of instrumental birth over 12 times, fetal distress increased the risk 5 times and other complications increased the risk over 3 times (fully adjusted RRR=12.33, p<0.001 for malpresentation, RRR=5.31, p<0.001 for fetal distress and RRR=3.53, p<0.001 for other complications, compared to women who did not report these complications in labour).

Figure 7: The effect of induction and labour complications on the risk of instrumental birth for multiparous women



**p<0.001 *p<0.05

Maternal height, pregnancy, health and fetal factors were unrelated to the risk of instrumental birth among multiparous women.

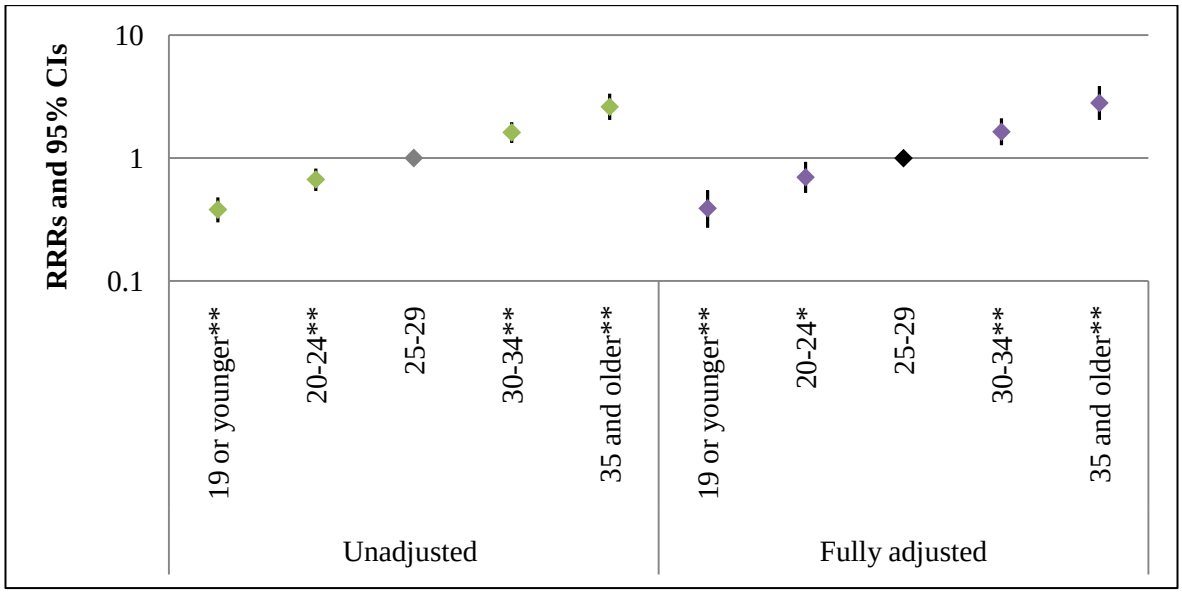
Independent predictors of emergency caesarean section

Primiparous women

Maternal age

Maternal age at birth had a significant impact on the risk of emergency caesarean section for first-time mothers, with a gradient of increasing risk with increasing age (see Figure 8). Full adjustment for maternal and fetal characteristics made little difference to the association between maternal age and risk of emergency caesarean section. Compared to mothers aged 25-29, younger mothers were less likely to have an emergency caesarean section whereas women aged over 30 were at an increased risk.(e.g. fully adjusted RRR=2.81, p<0.001 for 35 and older).

Figure 8: The effect of maternal age on the risk of emergency caesarean section for primiparous women

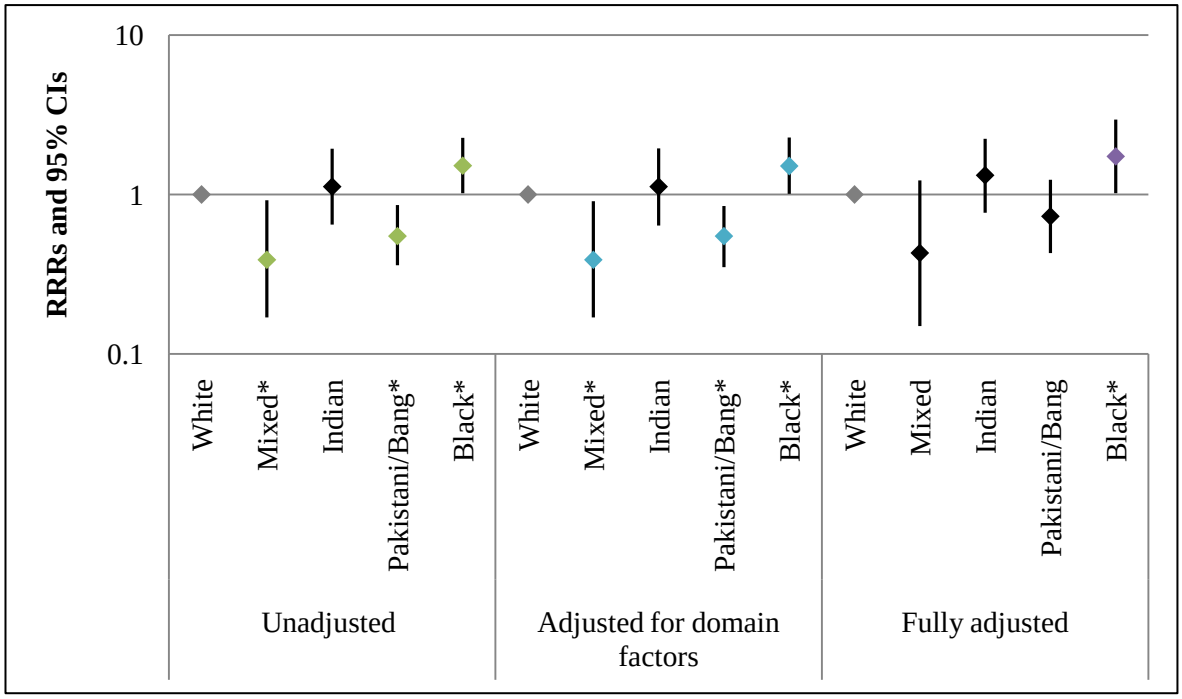


**p<0.001 *p<0.05

Ethnicity, migration status and language

In the unadjusted and domain models, Mixed ethnicity and Pakistani/Bangladeshi women were at a decreased risk of emergency caesarean section compared to White women and Black women were at an increased risk (see Figure 9). After adjustment for other maternal and fetal characteristics Black women remained at an increased risk of emergency caesarean section (fully adjusted RRR=1.74, p<0.05). Language and migration status were not significant predictors of emergency caesarean section.

Figure 9: The effect of ethnicity on the risk of emergency caesarean section for primiparous women

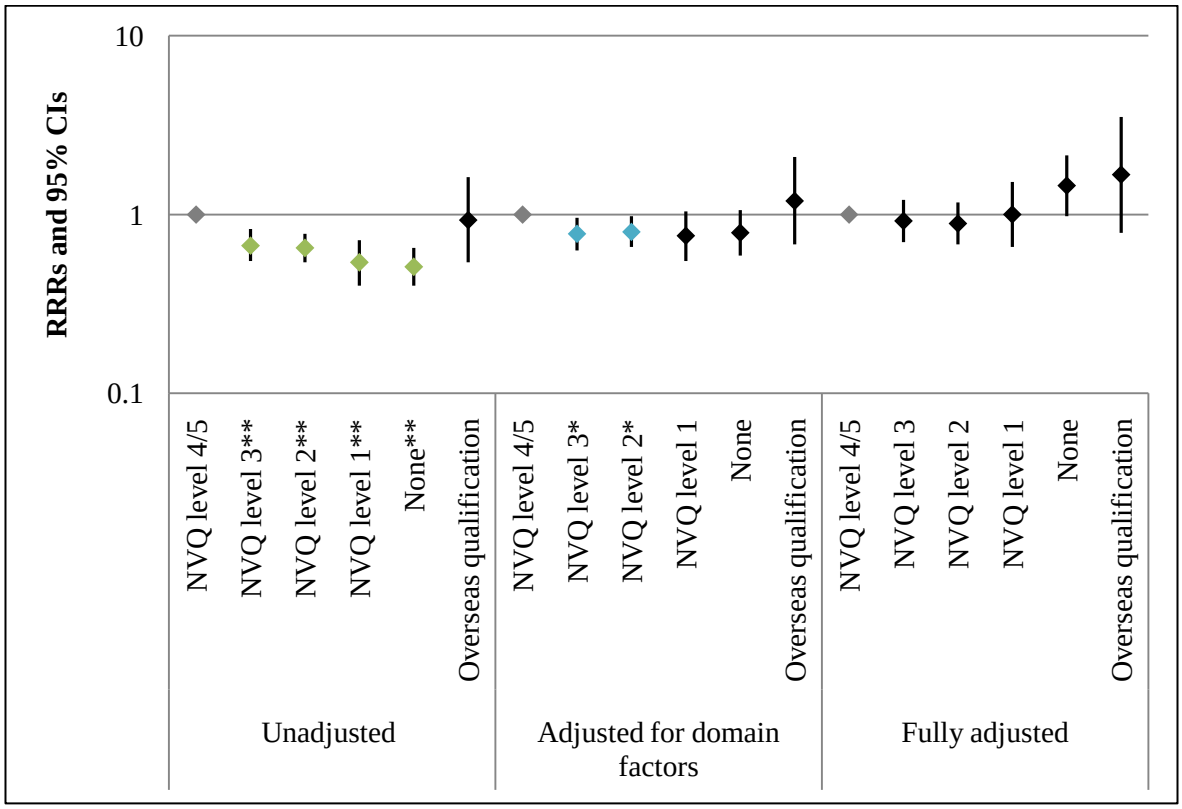


*p<0.05

Socio-economic factors

After full adjustment, women with no qualifications were at an increased risk of an emergency caesarean section compared to women with degree level qualifications, although the result was of borderline significance (fully adjusted RRR=1.45, p=0.06, see Figure 10). Social class was unrelated to the risk of emergency caesarean section in the fully adjusted model.

Figure 10: The effect of educational level on the risk of emergency caesarean section for primiparous women

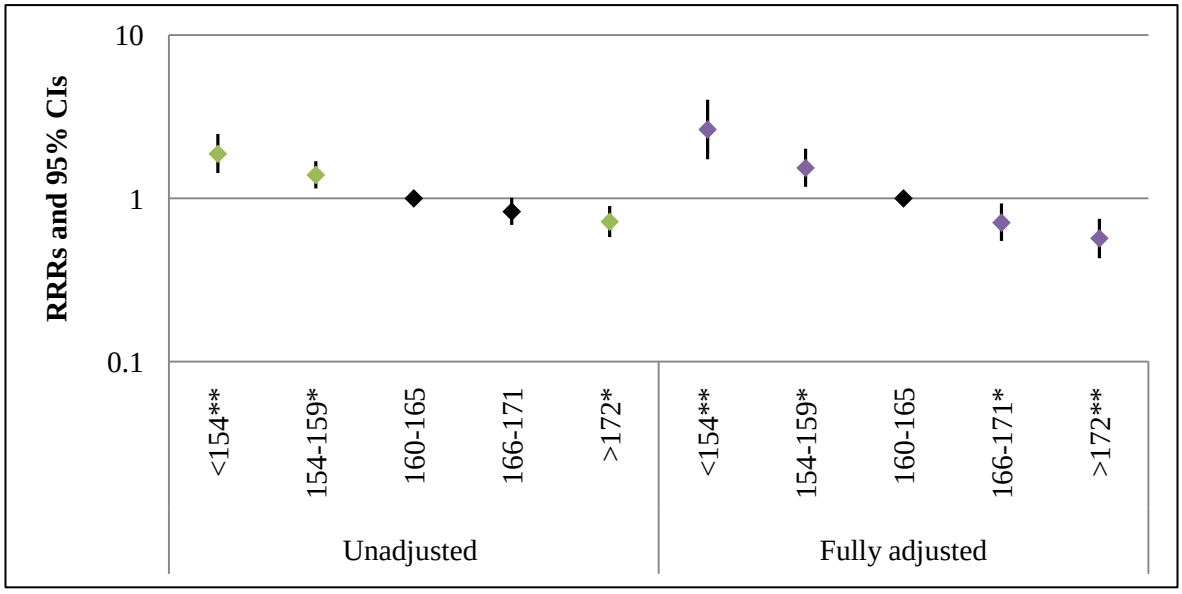


**p<0.001 *p<0.05

Height

The risk of emergency caesarean section increased with decreasing height. For example, compared to women 160-165cm tall (around 5ft 2 to 5ft 4), women in the shortest category (less than 5ft) were at more than double the risk of emergency caesarean section (fully adjusted RRR=2.64, p<0.001). Adjustment for maternal and fetal factors strengthened the association (see Figure 11).

Figure 11: The effect of height on the risk of emergency caesarean section for primiparous women



**p<0.001 *p<0.05

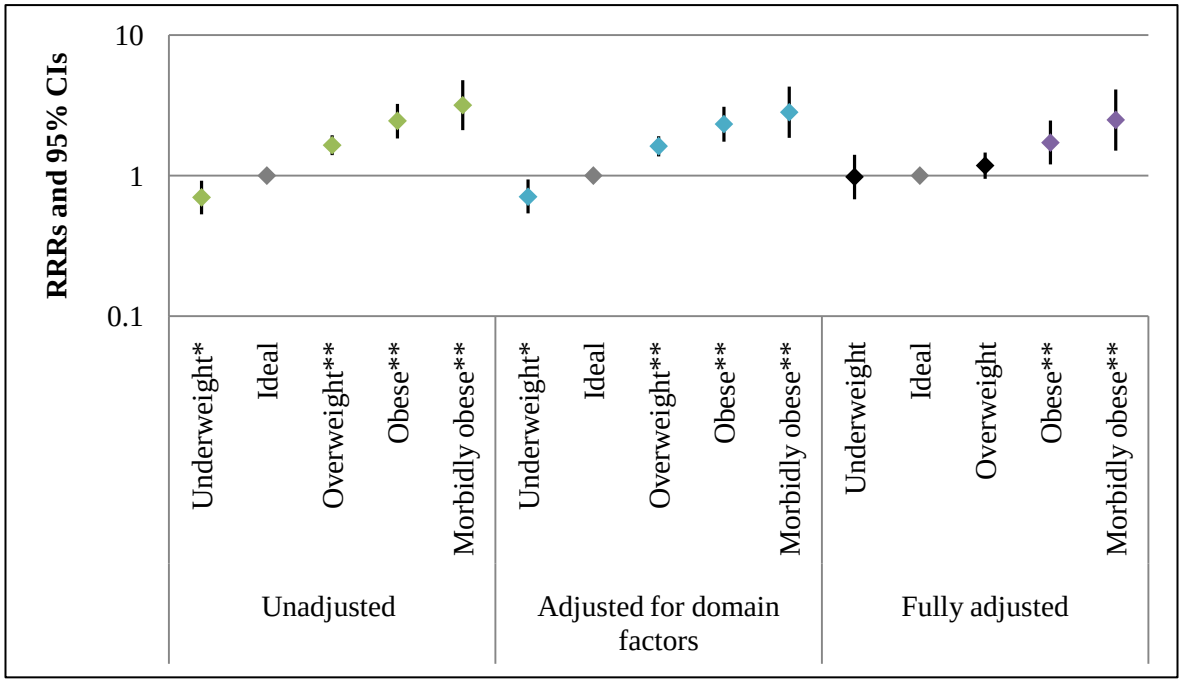
Interpersonal factors

Mothers who were unhappy or not bothered when they discovered they were pregnant were at a decreased risk of having an emergency caesarean section (unadjusted RRR=0.52, p<0.05). Adjustment for all other maternal and fetal factors attenuated the association only slightly (unadjusted RRR=0.62, p<0.05 compared to women who were happy about the pregnancy). Whether women had left home before the age of 17 and whether her parents had ever separated were not significantly related to the risk of emergency caesarean section after adjustment for other maternal and fetal factors.

Health factors

Figure 12 shows the effect of BMI on the risk of emergency caesarean section for first-time mothers. Being underweight was protective of having an emergency caesarean in the unadjusted and domain model, but when adjusted for other maternal and fetal factors, was no longer significant. Obese and morbidly obese women were at an increased risk of emergency caesarean section, with the highest risk for morbidly obese women who were over twice as likely to have the operation than women of an ideal BMI (fully adjusted RRR=2.49, p<0.001).

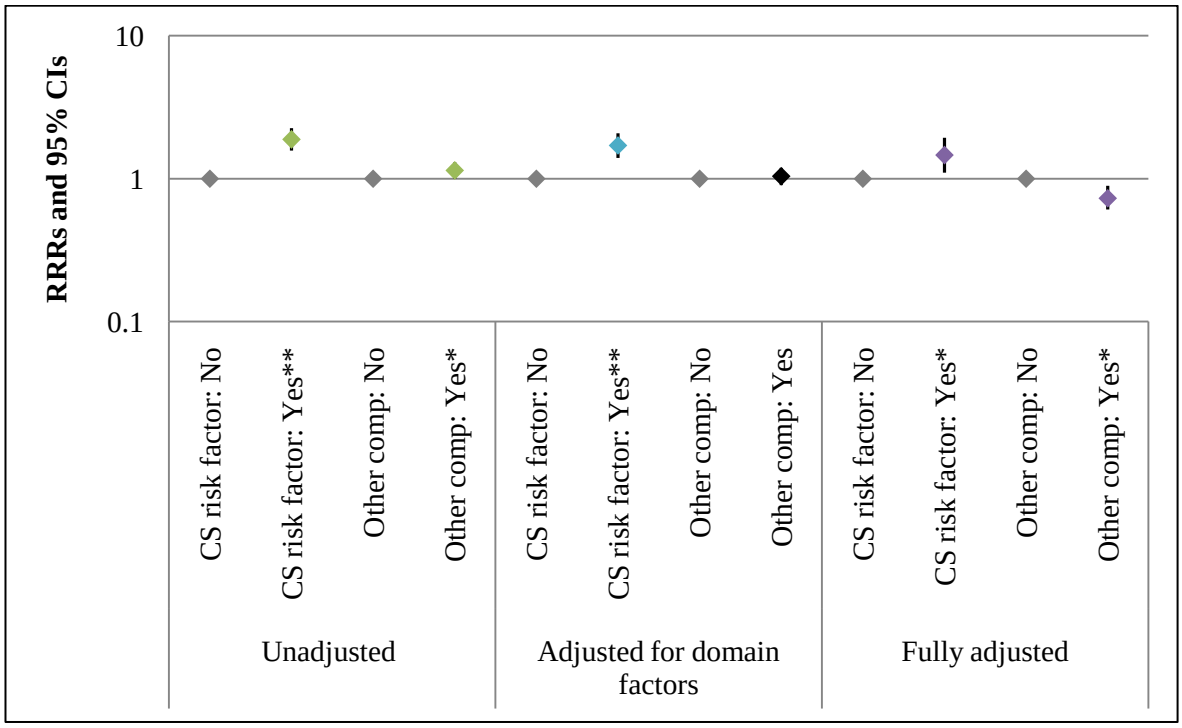
Figure 12: The effect of BMI on the risk of emergency caesarean section for primiparous women



**p<0.001 *p<0.05

Figure 13 shows the effect of reported problems during pregnancy on the risk of emergency caesarean section. Women who reported having a problem that could complicate the birth ('CS risk factor') were 1.4 times more likely to have an emergency caesarean section than women who reported no problems or illnesses during pregnancy (fully adjusted RRR=1.46, p<0.05). After adjustment for maternal and fetal factors, women who experienced a problem characterised as 'other' during pregnancy (i.e. not likely to complicate the birth), were significantly *less* likely to have an emergency caesarean section (fully adjusted RRR=0.73, p<0.05 compared to women who reported no problems during pregnancy).

Figure 13: The effect of complications during pregnancy on the risk of emergency caesarean section for primiparous women



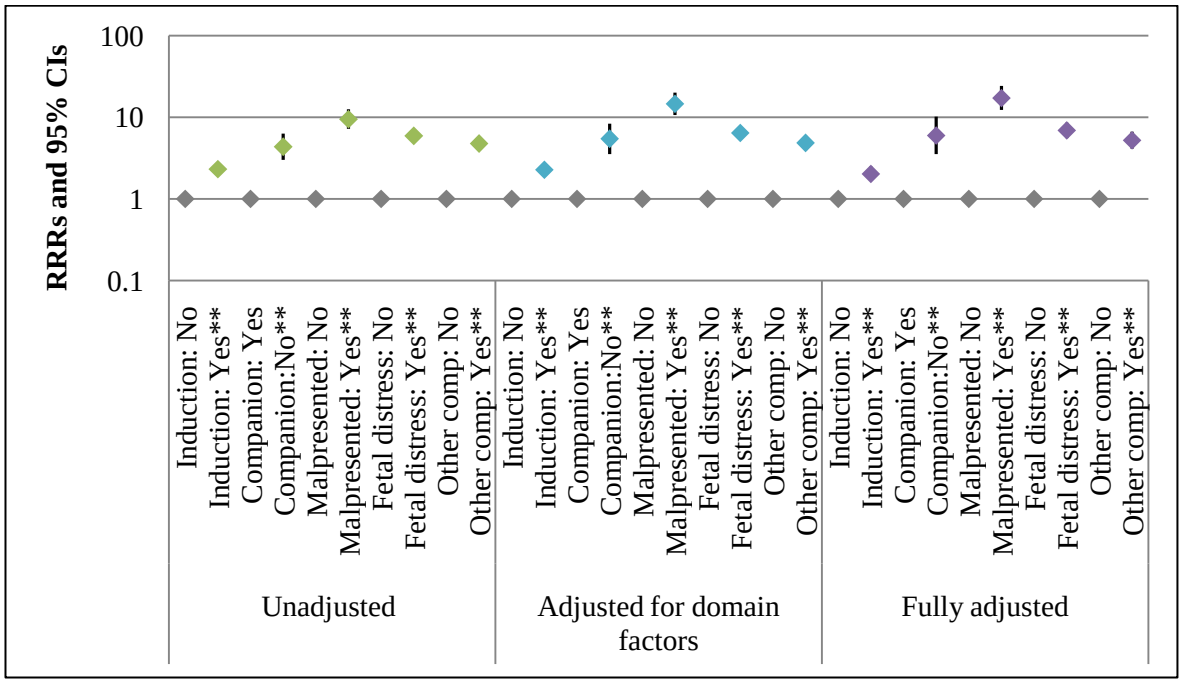
**p<0.001 *p<0.05

Labour factors

Women who were induced were twice as likely to have an emergency caesarean section (fully adjusted RRR=2.03, p<0.001, see Figure 14). Women who were unaccompanied during the labour were 6 times more likely to have an emergency caesarean section compared to women who reported having a companion (fully adjusted RRR=6.00, p<0.001).

Malpresentation substantially increased the risk of emergency caesarean section (fully adjusted RRR=17.25, p<0.001). Women who reported fetal distress were almost 7 times more likely to have an emergency caesarean section and women with other complications were over 5 times more likely compared to women who did not report these complications (fully adjusted RRR=6.92, p<0.001 for fetal distress and RRR=5.24, p<0.001 for other complications).

Figure 14: The effect of induction, companionship and labour complications on the risk of emergency caesarean section for primiparous women



**p<0.001

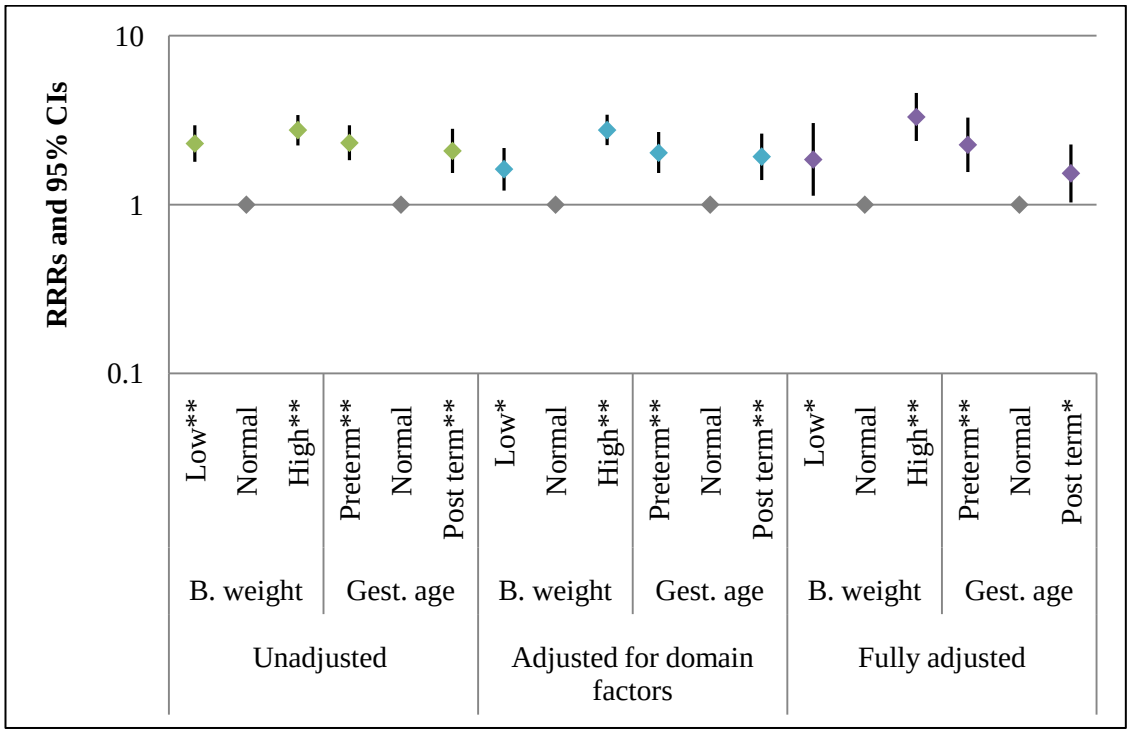
Fetal factors

Mothers who gave birth both pre and post-term were more likely to have an emergency caesarean section than mothers who gave birth at term (fully adjusted RRR=2.26, p<0.001 for preterm and RRR=1.53, p<0.05 for post-term mothers, see Figure 15).

Mothers giving birth to high birth weight infants were over three times more likely to have an emergency caesarean section than mothers who had a normal weight infant (fully adjusted RRR=3.31, p<0.001).

Mothers who had a low birth weight infant were also at an increased risk of emergency caesarean section (fully adjusted RRR=1.85, p<0.05). There was however evidence of effect modification. An interaction term included in the final model revealed that short mothers (who were found to be at an increased risk of emergency caesarean section, see Figure 10) who had a low birth weight infant were at a *decreased* risk of emergency caesarean section (fully adjusted RRR=0.49, p=0.05).

Figure 15: The effect of infant birth weight and gestational age on the risk of emergency caesarean section for primiparous women



**p<0.001 *p<0.05

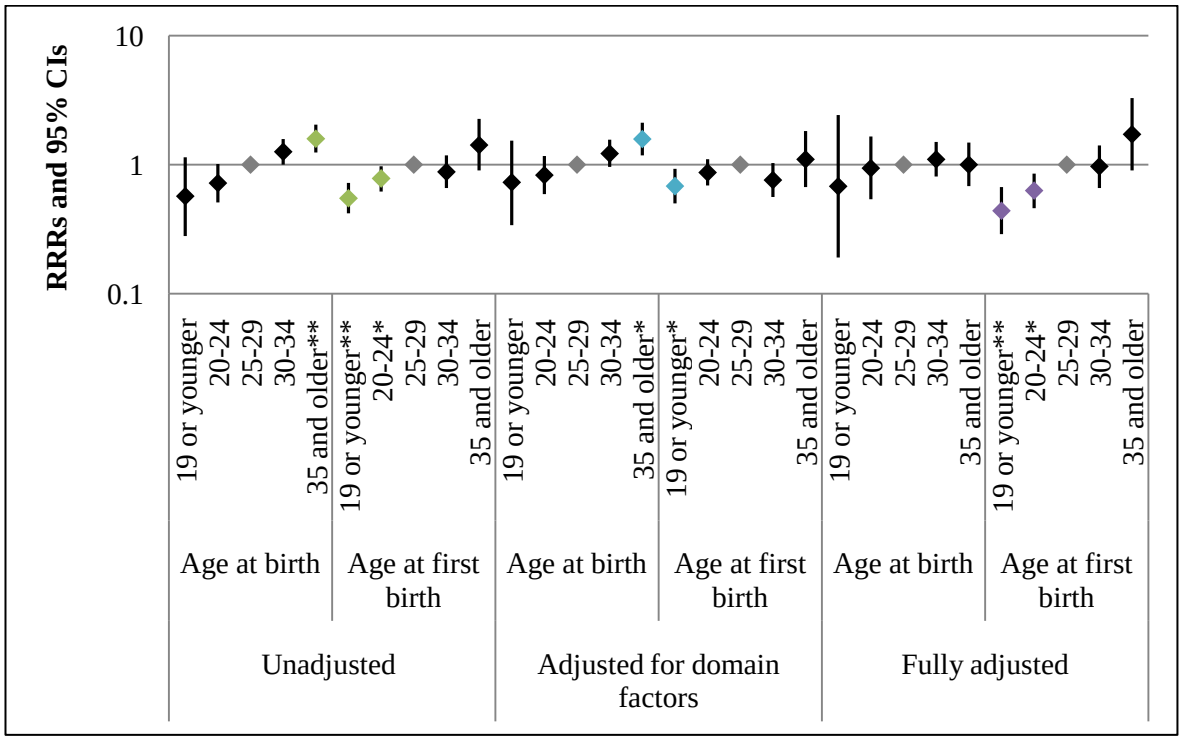
Socio-economic and pregnancy factors were found to be unrelated to the risk of emergency caesarean section among first-time mothers.

Multiparous women

Maternal age

As was found for instrumental birth, age at first birth was a more important predictor of emergency caesarean section for multiparous women than age at the cohort member birth. After adjustment in the final model, age at cohort member birth was unrelated to the risk of emergency caesarean section, whereas young age at first birth was protective against the risk of emergency caesarean section (see Figure 16). Adjustment for other maternal and fetal factors strengthened the association between age at first birth and emergency caesarean section (fully adjusted RRR=0.44, p<0.001 for women aged 19 or younger at first birth compared to women aged 25-29).

Figure 16: The effect of maternal age at cohort member birth and at first birth on the risk of emergency caesarean section for multiparous women

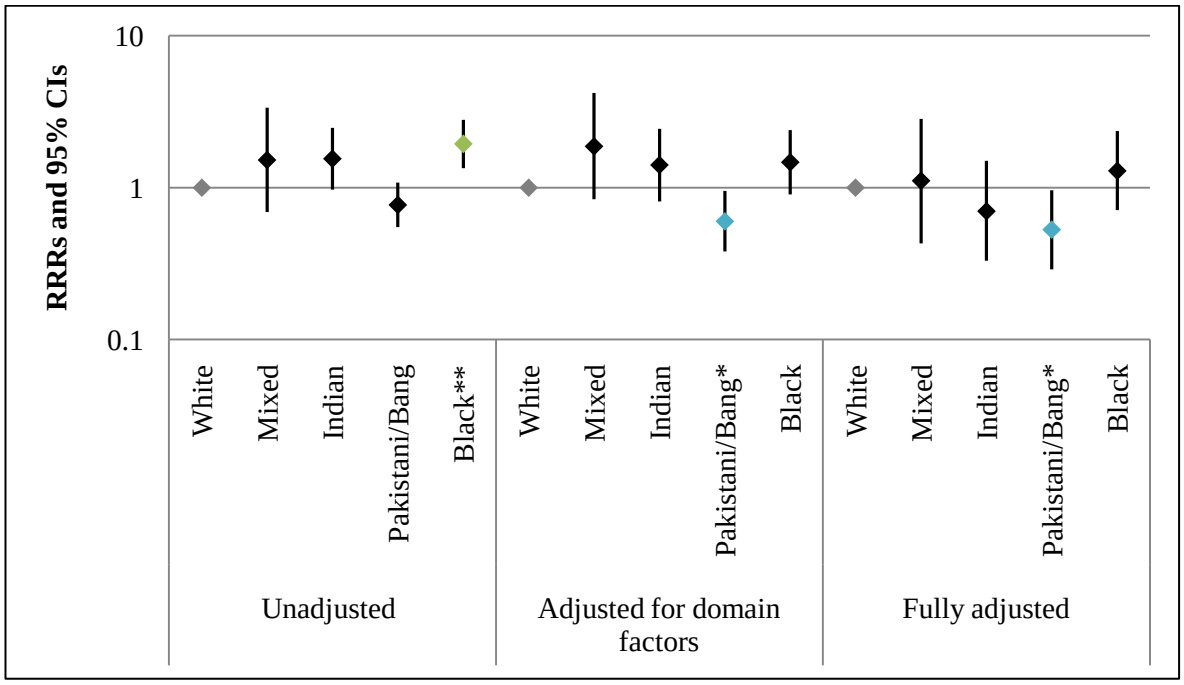


**p<0.001 *p<0.05

Ethnicity, migration status and language

In the unadjusted model, Black women were at an increased risk of emergency caesarean section compared to White women (unadjusted RRR=1.94, p<0.001). However when adjusted for migration status the relationship was no longer significant. In the domain and the fully adjusted model, Pakistani/Bangladeshi mothers were at a reduced risk of emergency caesarean section compared to White women (fully adjusted RRR=0.53, p<0.05, see Figure 17).

Figure 17: The effect of ethnicity on the risk of emergency caesarean section for multiparous women



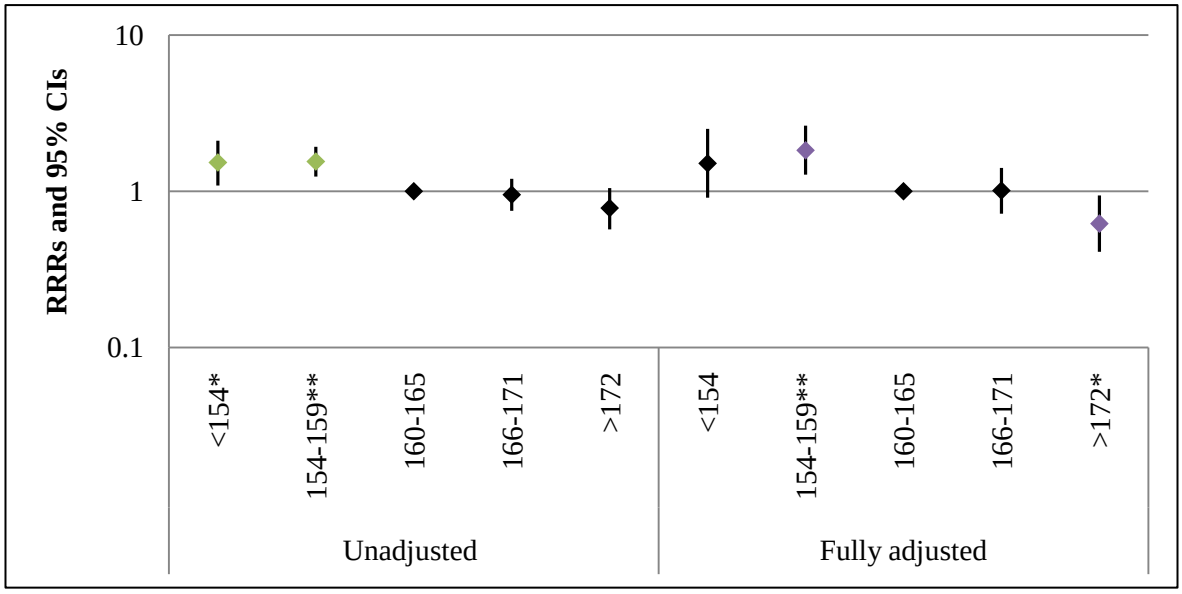
**p<0.001 *p<0.05

Mothers who had been born outside of the UK, but had lived in the UK for more than five years were almost twice as likely to have an emergency caesarean section than UK-born mothers (fully adjusted RRR=1.86, p<0.05). Language spoken at home was unrelated to the risk of emergency caesarean section for multiparous women.

Height

For multiparous women there was an effect of height on the risk of emergency caesarean section (see Figure 18), although less strong than the effect for primiparous women. Compared to women 160-165cm tall, shorter women were more likely to have an emergency caesarean section (fully adjusted RRR=1.83, p<0.001 for women 154-159cm). Women in the tallest group were at a reduced risk of emergency caesarean section (fully adjusted RRR=0.62, p<0.05).

Figure 18: The effect of height on the risk of emergency caesarean section for multiparous women



**p<0.001 *p<0.05

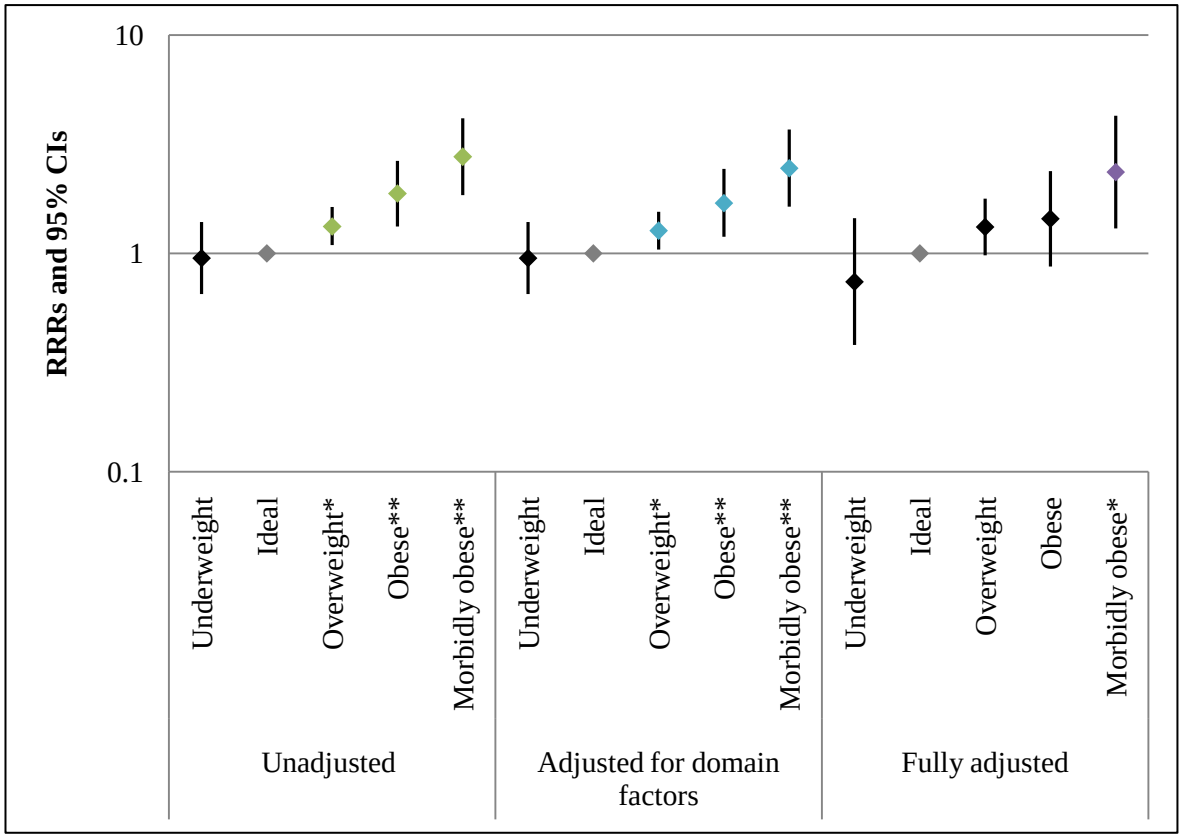
Pregnancy factors

Multiparous women who attended antenatal classes were at an increased risk of emergency caesarean section compared to women who had not attended classes. Adjustment for other factors from the pregnancy domain and full model made little difference to the (unadjusted RRR=1.39, p<0.05 and fully adjusted RRR=1.43, p<0.05). Whether the pregnancy had been planned and fertility treatment were not significant predictors of emergency caesarean section among multiparous women.

Health factors

Figure 19 shows the effect of pre-pregnancy BMI on the risk of emergency caesarean section for multiparous women. Morbidly obese women were over twice as likely to have an emergency caesarean section than women who reported a pre-pregnancy weight classed as 'ideal' (fully adjusted RRR=2.36, p<0.05). Unlike for overweight primiparous women who were at an increased risk of emergency caesarean section once fully adjusted for maternal and fetal factors, being overweight was of borderline significance after adjustment in the final model for multiparous women (RRR=1.32, p=0.07).

Figure 19: The effect of BMI on the risk of emergency caesarean section for multiparous women



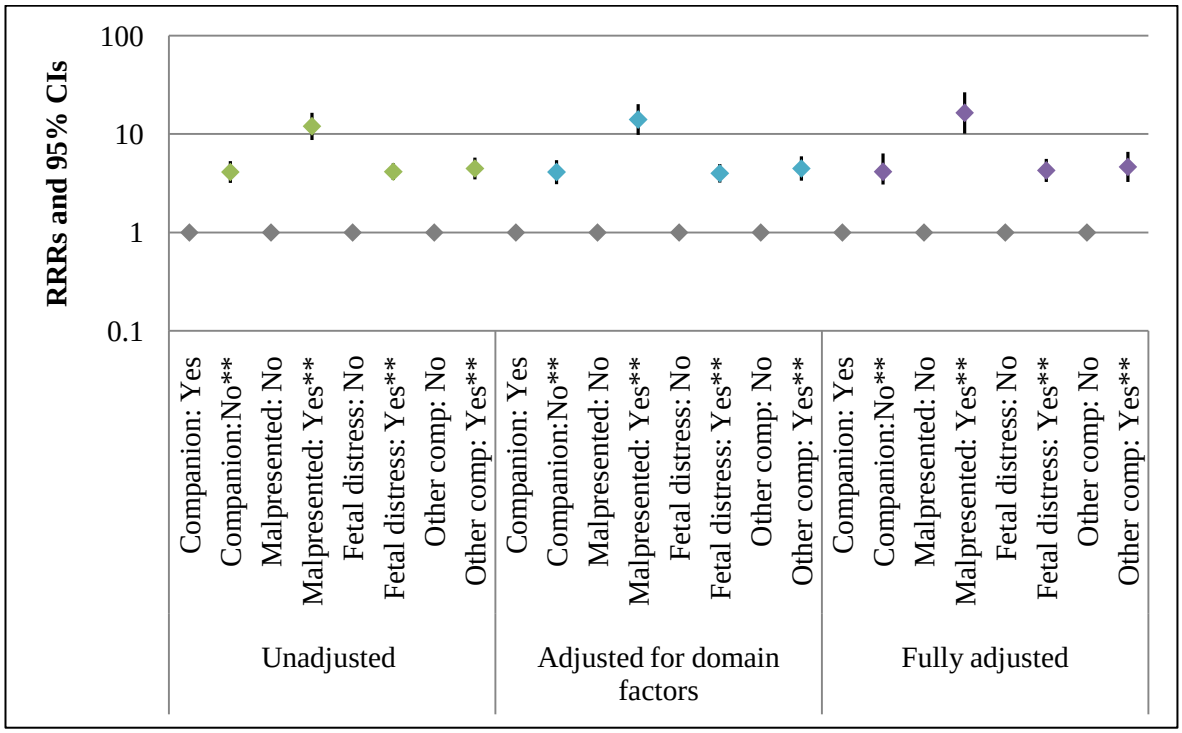
**p<0.001 *p<0.05

Women who experienced a problem or illness during pregnancy which could complicate the birth were more likely to have an emergency caesarean section after adjustment for maternal and fetal factors (RRR=1.56, p<0.05). 'Other' problems or illnesses during pregnancy did not affect the risk of emergency caesarean section.

Labour factors

As for primiparous women, women who reported having no companion during labour were at an increased risk of an emergency caesarean section (fully adjusted RRR=4.13, p<0.001). Complications relating to malpresentation increased the risk of emergency caesarean section to the largest degree, with over 16 times the risk compared to women who did not report malpresentation. Women who reported fetal distress and 'other' complications were over 4 times more likely to have an emergency caesarean section than women who did not report these complications (fully adjusted RRR=16.42, p<0.001 for malpresentation, RRR=4.26, p<0.001 for fetal distress and RRR=4.64, p<0.001 for other complications). Induction of labour did not affect the risk of emergency caesarean section among multiparous women (see Figure 20).

Figure 20: The effect of labour complications on the risk of emergency caesarean section for multiparous women



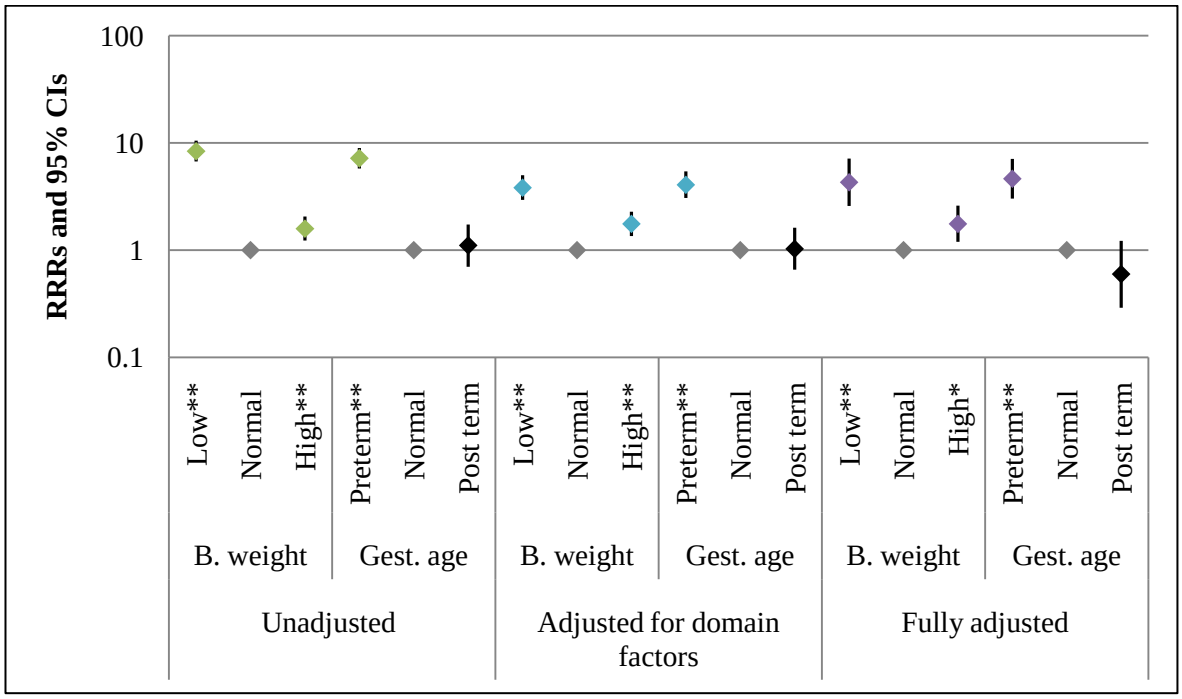
**p<0.001 *p<0.05

Fetal factors

Adjusting for gestational age accounted for some of the excess risk of emergency caesarean section for mothers with a low birth weight infant (unadjusted RRR=8.41, p<0.001 and adjusted for gestational age RRR=3.83, p<0.001, see Figure 21). However when fully adjusted, mothers with a low birth infant remained over 4 times more likely to have an emergency caesarean section than mothers who had a normal weight infant (fully adjusted RRR=4.30, p<0.001). Mothers with a high birth weight infant were also at an increased risk of emergency caesarean section, although to a lesser degree with a 1.8 times increased risk (fully adjusted RRR=1.76, p<0.05).

A high risk of emergency caesarean section for women who gave birth preterm was also to a certain extent explained by the low birth weight of preterm infants. However, after adjustment for birth weight and maternal factors in the final model, mothers with a preterm infant were more than 4 times more likely to have an emergency caesarean section (fully adjusted RRR=4.64, p<0.001). Unlike primiparous women, multiparous women who gave birth post-term were not more likely than those who gave birth at term to have an emergency caesarean section.

Figure 21: The effect of infant birth weight and gestational age on the risk of emergency caesarean section for multiparous women



**p<0.001 *p<0.05

Socio-economic and interpersonal factors were not predictive of emergency caesarean section for multiparous women.

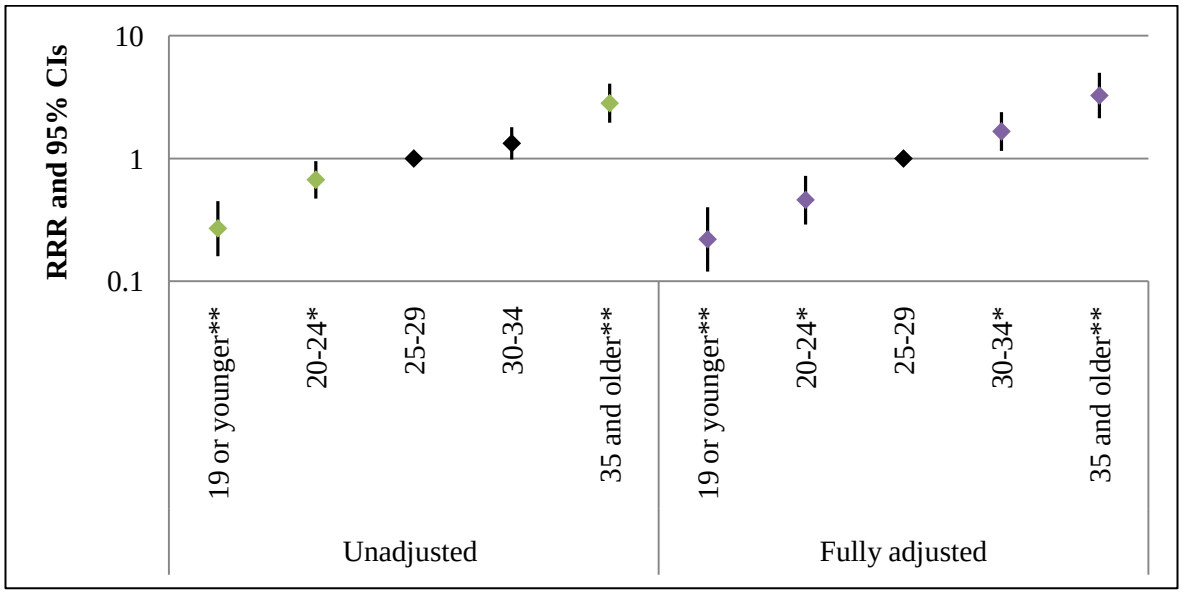
Independent predictors of planned caesarean section

Primiparous women

Maternal age

The risk of a woman having a planned caesarean section for her first birth increased with age, and adjustment for other maternal and fetal factors strengthened the association (see Figure 22). For example, compared to women aged 25-29 women aged 35 and over were at over three times the risk of a planned caesarean section (fully adjusted RRR=3.26, p<0.001).

Figure 22: The effect of maternal age on the risk of planned caesarean section for primiparous women



**p<0.001 *p<0.05

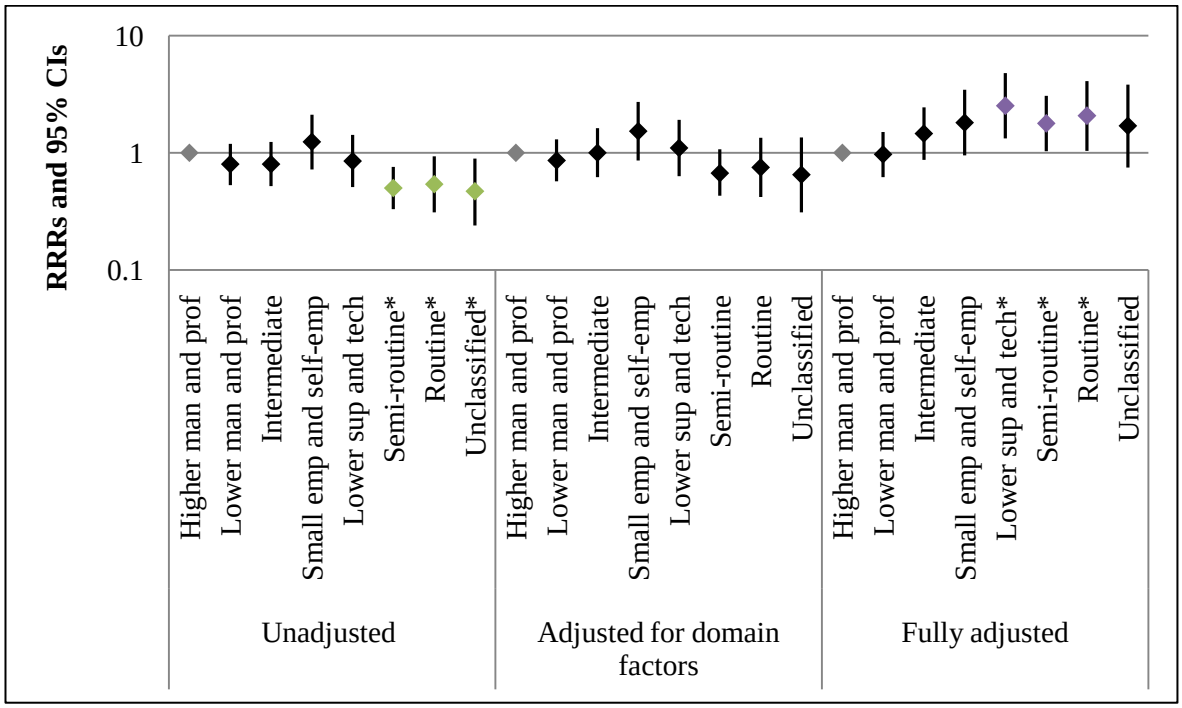
Ethnicity, migration status and language

Although in unadjusted analyses ethnicity was unrelated to the risk of planned caesarean section, after adjustment for other maternal and fetal factors, Black women were less likely to have a planned caesarean section, although the result was of borderline significance (fully adjusted RRR=0.46, p=0.06). Migration status and language were not predictive of planned caesarean section for first-time mothers.

Socio-economic factors

In the unadjusted model, women in the lowest social class bands were at a decreased risk of planned caesarean section compared to women from households with the highest occupation of higher managerial and professional. However, in the fully adjusted model the direction of the association reversed, with women in the lower social class bands at an *increased* risk of planned caesarean section (see Figure 23). For example women in routine occupations were twice as likely to have a planned caesarean section (fully adjusted RRR=2.07, p<0.05).

Figure 23: The effect of social class on the risk of planned caesarean section for primiparous women



*p<0.05

Interpersonal factors

First-time mothers who were unhappy or 'not bothered' when they discovered they were pregnant were less likely to have a planned caesarean section than mothers who were happy. Although adjustment for maternal and fetal factors attenuated the decreased risk, after adjustment mothers who had been unhappy when they found out they were pregnant were still at around half the risk of planned caesarean section compared to mothers who were happy about the pregnancy (fully adjusted RRR=0.49, p<0.05). Whether the mother had left home before the age of 17, and whether her parents had ever separated were unrelated to the risk of planned caesarean section.

Pregnancy factors

Mothers who had attended no antenatal classes were at an increased risk of a planned caesarean section in the final fully adjusted model (fully adjusted RRR=1.44, p=0.06). Whether the pregnancy was planned and fertility treatment were unrelated to the risk of planned caesarean section in the final model.

Health factors

Compared to first-time mothers who reported having no problems during pregnancy, mothers who reported having problems which could complicate birth ('CS risk factor') and women who reported

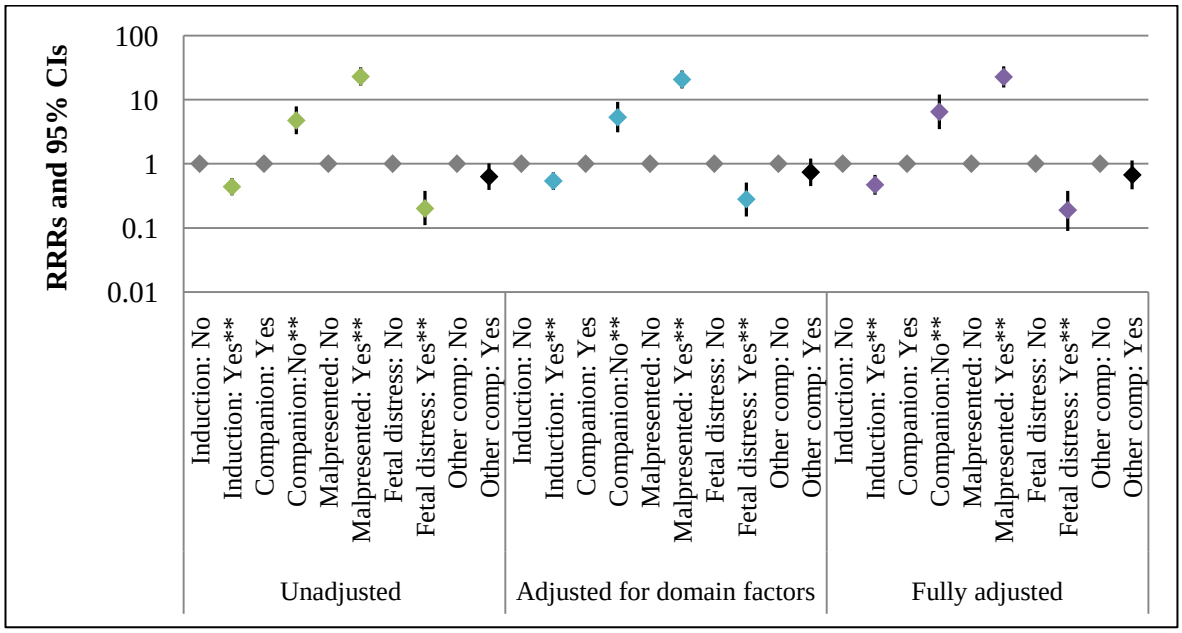
other problems were more likely to have a planned caesarean section (fully adjusted RRR=1.65, p<0.05 for CS risk factor and RRR=1.48, p<0.05 for 'other' problem). BMI was unrelated to the risk of planned caesarean section for first-time mothers.

'Labour' factors

Women who reported having a malpresented fetus were over 20 times more likely to have a planned caesarean section than women who did not (fully adjusted RRR=22.72, p<0.001, see Figure 24). In addition women who reported having no companion were over 6 times more likely to have a planned caesarean section (fully adjusted RRR=6.47, p<0.001).

Women who were induced were less likely to have a planned caesarean section than women who were not induced (fully adjusted RRR=0.47, p<0.001). In addition, women who reported fetal distress during the birth were also less likely to have had a planned caesarean section than women who did not (fully adjusted RRR=0.19, p<0.001). Other complications were not predictive of planned caesarean section.

Figure 24: The effect of induction and labour complications on the risk of planned caesarean section for primiparous women



**p<0.001

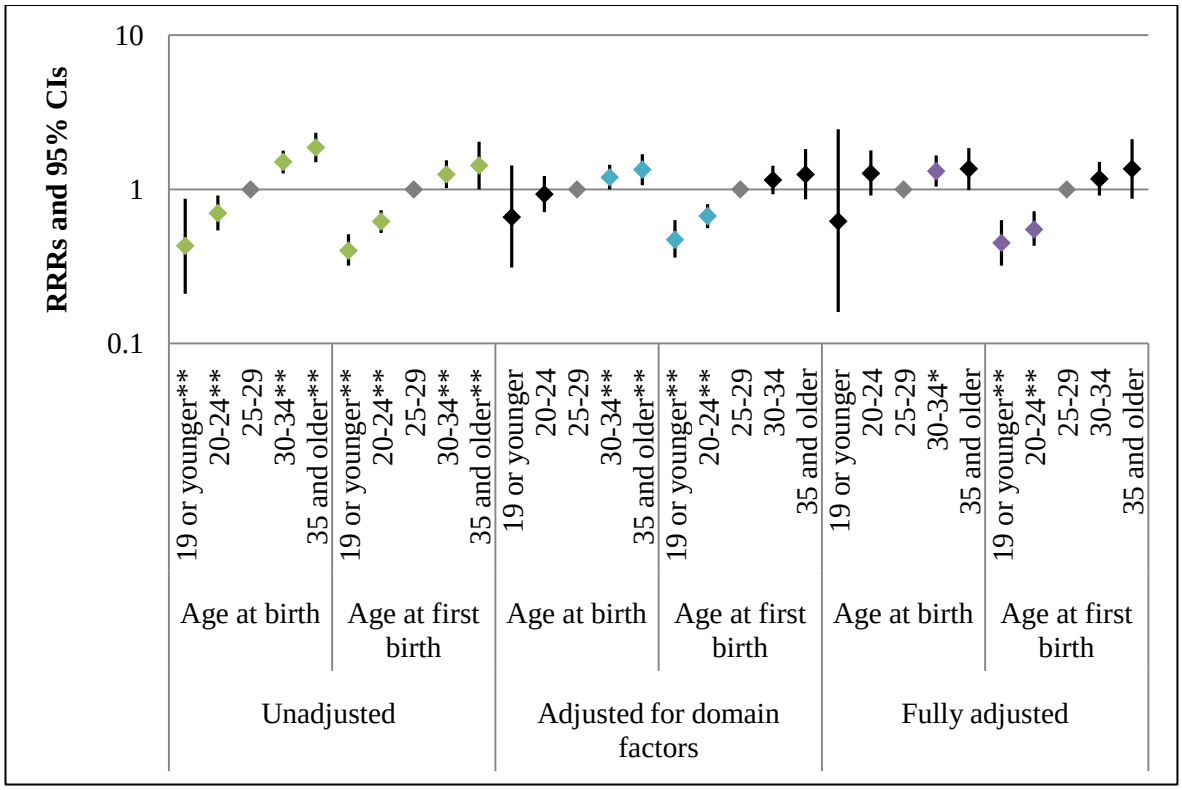
Height and infant factors were unrelated to the risk of planned caesarean section for first-time mothers.

Multiparous women

Maternal age

After full adjustment, young age at first birth was protective of having a planned caesarean section in the later cohort birth (e.g. fully adjusted RRR=0.45, p<0.001 for 19 or younger compared to 25-29), whereas women over 30 at the cohort birth were at around a 30% increased risk (fully adjusted RRR=1.31, p<0.001, see Figure 25).

Figure 25: The effect of maternal age at cohort member birth and at first birth on the risk of planned caesarean section for multiparous women



**p<0.001 *p<0.05

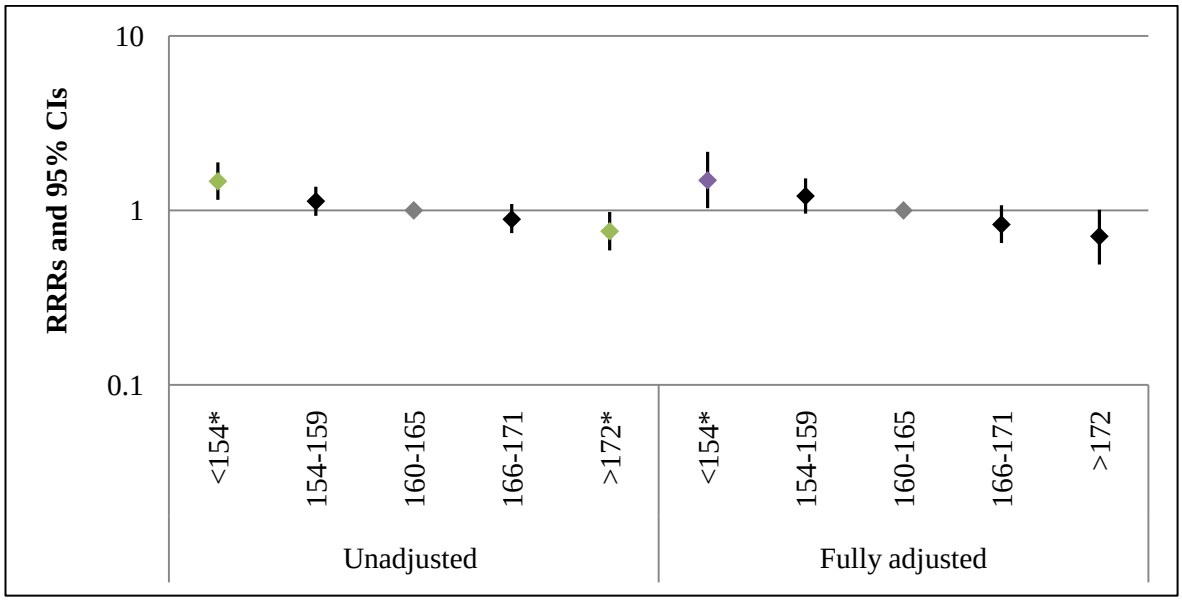
Ethnicity, migration status and language

Pakistani/Bangladeshi women were at a decreased risk of having a planned caesarean section compared to White women; however, the result was of borderline significance (unadjusted RRR=0.78, p=0.08 and fully adjusted RRR=0.60, p=0.06). Language spoken at home and migration status were unrelated to the risk of planned caesarean section for multiparous women.

Height

Multiparous women in the shortest category (less than 154cm or 5ft) were 50% more likely to have a planned caesarean section than mothers of average height (160-165cm) (fully adjusted RRR=1.49, p<0.05), whereas women in the tallest category (over 172cm) were comparatively less likely (fully adjusted RRR=0.71, p=0.06, see Figure 26).

Figure 26: The effect of height on the risk of planned caesarean section for multiparous women



*p<0.05

Pregnancy factors

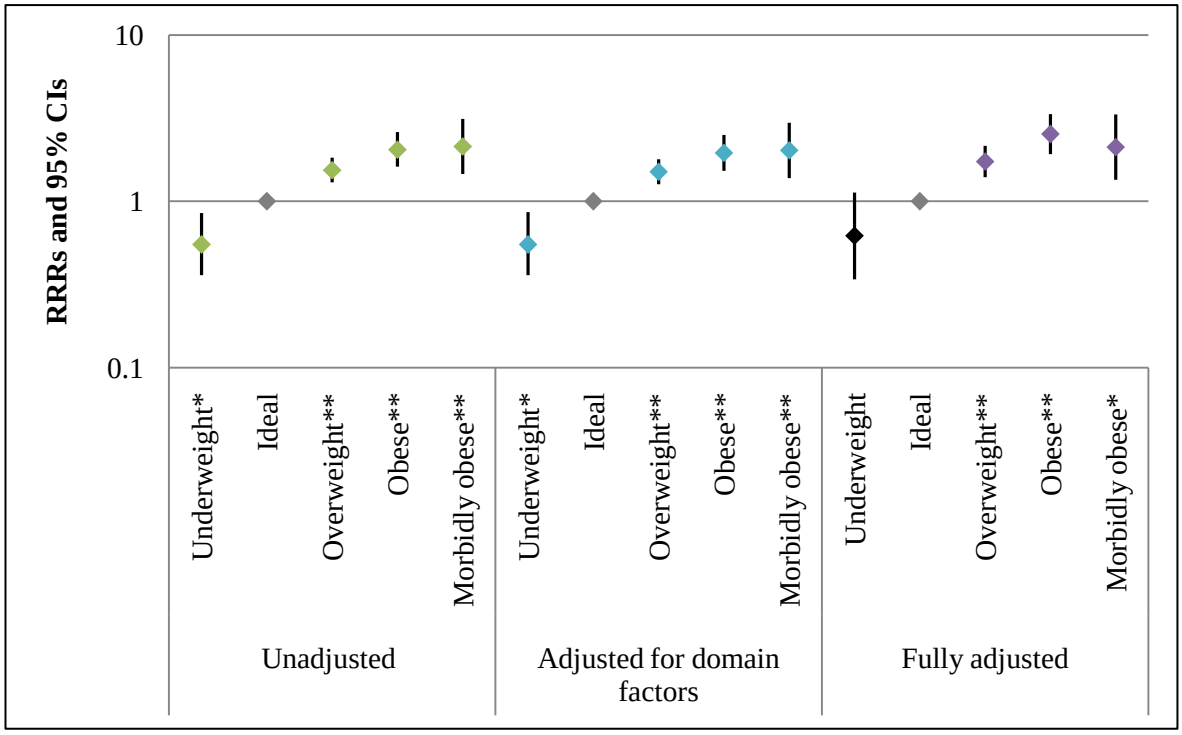
Mothers who had received fertility treatment during their pregnancy were 2.7 times more likely to have a planned caesarean section than mothers who had not received fertility treatment in order to become pregnant (unadjusted RRR=3.19, p<0.001 and fully adjusted RRR=2.71, p<0.001).

Whether the mother had planned the pregnancy and whether she had received antenatal care were not related to the risk of planned caesarean section for multiparous mothers.

Health factors

Figure 27 shows the risk of planned caesarean section for women according to their pre-pregnancy BMI. Multiparous women who were overweight, obese and morbidly obese were 1.7, 2.5 and 2.1 times more likely to have a planned caesarean section, respectively, compared to women with an ideal pre-pregnancy BMI (fully adjusted RRR=1.74, p<0.001 for overweight, RRR=2.54, p<0.001 for obese and RRR=2.12, p<0.001 for morbidly obese).

Figure 27: The effect of BMI on the risk of planned caesarean section for multiparous women



**p<0.001 *p<0.05

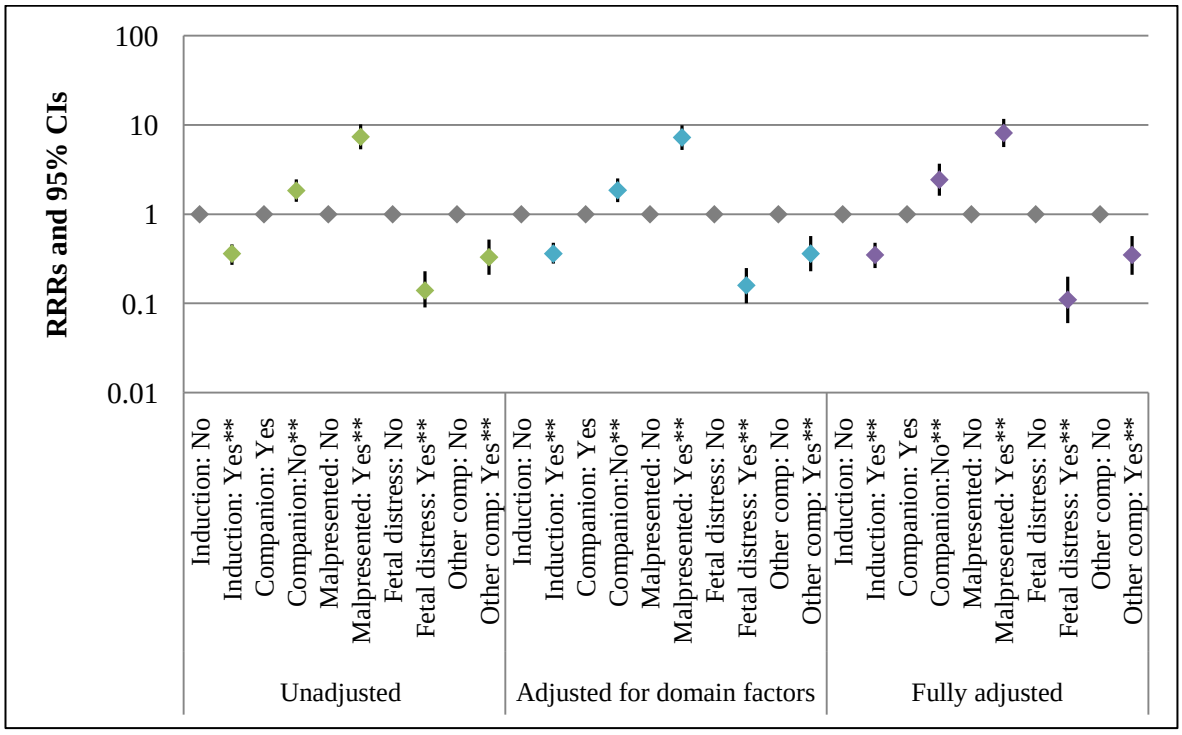
Women who experienced a 'CS risk factor' during pregnancy were more likely to have a planned caesarean section (unadjusted RRR=1.83, p<0.001 and fully adjusted RRR=2.13, p<0.001 compared to mothers who had did not report a CS risk factor). 'Other' problems were not related to the risk of planned caesarean section.

'Labour' factors

Women who reported having a malpresented fetus were 8 times more likely to have a planned caesarean section than women who did not (fully adjusted RRR=22.72, p<0.001, see Figure 28). In addition women who reported having no companion were over twice as_likely to have a planned caesarean section (fully adjusted RRR=6.47, p<0.001).

Women who were induced were less likely to have a planned caesarean section than women who were not induced (fully adjusted RRR=0.35, p<0.001). In addition, women who reported fetal distress and other complications during the birth were also less likely to have had a planned caesarean section than women who did not report these complications (fully adjusted RRR=0.11, p<0.001 for fetal distress and RRR=0.35, p<0.001 for other complications).

Figure 28: The effect of induction and labour complications on the risk of planned caesarean section for multiparous women



**p<0.001

Socio-economic status, interpersonal factors and infant factors were not predictive of planned caesarean section for multiparous women.

Glossary of terms

Amniotomy	surgical rupture of the amniotic sac for induction or acceleration of labour
Augmentation	acceleration of labour
Breech presentation	longitudinal lie with the fetal buttocks presenting first
Brachial plexus injury	injury to the nerve plexus situated in the root of the neck
Caesarean section	operation to extract the fetus from the uterus through an incision in the abdominal and uterine walls
Cephalic presentation	the fetal head enters the pelvis first
Dystocia	difficult or abnormal labour (see failure to progress)
Epidural anaesthesia	injection of local analgesic into the epidural space to block the spinal nerves
Failure to progress	prolonged or slowly progressing labour
Forceps	surgical instrument with two blades which can be used to deliver the baby's head
Gestational age	weeks from the first day of the last normal menstrual period
Hypertension	abnormally high blood pressure
Induction of labour	artificially starting labour with pessaries, amniotomy or intravenous oxytocin
Instrumental vaginal birth	(forceps and vacuum extraction)
Macrosomia	large baby
Malpresentation	presentation which is not cephalic, e.g. breech
Multipara	woman who has given birth to more than one viable infant
Oxytocin	hormone secreted by the posterior pituitary gland which causes uterine contractions (synthetic version used for induction)
Parity	the number of babies of viable gestation a woman has given birth to in her life
Pre-eclampsia	pregnancy hypertension combined with oedema (excess fluid), protein in the urine and other system changes
Primipara	woman who has given birth to one viable infant
Ventouse/vacuum extraction	a silicone cap is attached to the baby's head via suction

Definitions

Operative birth	any birth which is not an unassisted vaginal birth
Unassisted vaginal birth	a birth without operative assistance

Abbreviations

ACOG	American College of Obstetricians and Gynecologists
ALSPAC	Avon Longitudinal Study of Parents and Children
BMI	body mass index (body weight/height^2)
BW	birth weight
CS	caesarean section
EFM	electronic fetal monitoring
FBS	fetal blood sampling
FHR	fetal heart rate
FSBC	free-standing birth centre
HES	Hospital Episode Statistics
IA	intermittent auscultation
IBC	integrated birth centre
IBM	Integrated Behavioural Model
LBW	low birth weight (less than 2500g)
MCS	Millennium Cohort Study
NCT	National Childbirth Trust
NHS	National Health Service
NICE	National Institute for Health and Clinical Excellence
NSCSA	National Sentinel Caesarean Section Audit
ONS	Office of National Statistics
PGD	pregestational diabetes
PROM	pre labour rupture of membranes
PTSD	post-traumatic stress disorder

RCOG	Royal College of Obstetricians and Gynaecologists
RCT	randomised controlled trial
SES	socio-economic status
TPB	Theory of Planned Behaviour
VB	vaginal birth
VBAC	vaginal birth after caesarean section
VLBW	very low birth weight (less than 1500g)

References

ABDOOL, Z., THAKAR, R. & SULTAN, A. H. 2009. Postpartum female sexual function. *Eur J Obstet Gynecol Reprod Biol,* 145**,** 133-7.

ACOG. 2009. *ACOG Releases 2009 Medical Liability Survey* [Online]. Washington: The American College of Obstetricians and Gynecologists. Available: http://www.acog.org/from_home/publications/press_releases/nr09-11-09.cfm [Accessed March 2010].

AGARWAL, U., ANASTASAKIS, E. & KADIR, R. A. 2009. The effect of fetal sex on the outcome of labour induction. *J Obstet Gynaecol,* 29**,** 711-3.

AL-MUFTI, R., MCCARTHY, A. & FISK, N. M. 1997. Survey of obstetricians' personal preference and discretionary practice. *Eur J Obstet Gynecol Reprod Biol,* 73**,** 1-4.

ALFIREVIC, Z., DEVANE, D. & GYTE, G. M. 2006. Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour. *Cochrane Database Syst Rev,* 3**,** CD006066.

ALI, N. & BURCHETT, H. 2004. *Experiences of Maternity Services: Muslim Women's Perspectives,* London, The Maternity Alliance.

ALLEN, V. M., WILSON, R. D. & CHEUNG, A. 2006. Pregnancy outcomes after assisted reproductive technology. *J Obstet Gynaecol Can,* 28**,** 220-50.

ALVES, B. & SHEIKH, A. 2005. Investigating the relationship between affluence and elective caesarean sections. *BJOG,* 112**,** 994-6.

ANANTH, C. V., MISRA, D. P., DEMISSIE, K. & SMULIAN, J. C. 2001. Rates of preterm delivery among Black women and White women in the United States over two decades: an age-period-cohort analysis. *Am J Epidemiol,* 154**,** 657-65.

ANIM-SOMUAH, M., SMYTH, R. & HOWELL, C. 2005. Epidural versus non-epidural or no analgesia in labour. *Cochrane Database Syst Rev***,** CD000331.

ARON, D. C., HARPER, D. L., SHEPARDSON, L. B. & ROSENTHAL, G. E. 1998. Impact of risk-adjusting cesarean delivery rates when reporting hospital performance. *Jama,* 279**,** 1968-72.

ARTIETA-PINEDO, I., PAZ-PASCUAL, C., GRANDES, G., REMIRO-FERNANDEZDEGAMBOA, G., ODRIOZOLA-HERMOSILLA, I., BACIGALUPE, A. & PAYO, J. 2010. The benefits of antenatal education for the childbirth process in Spain. *Nurs Res,* 59**,** 194-202.

ASHDOWN-LAMBERT, J. R. 2005. A review of low birth weight: predictors, precursors and morbidity outcomes. *J R Soc Promot Health,* 125**,** 76-83.

ASTHANA, A. 2005. 'Too posh to push' births under fire. The Observer [Online], 4th September 2005 Available:

http://www.guardian.co.uk/society/2005/sep/04/health.medicineandhealth1 [Accessed June 2010].

BAETEN, J. M., BUKUSI, E. A. & LAMBE, M. 2001. Pregnancy complications and outcomes among overweight and obese nulliparous women. *Am J Public Health,* 91**,** 436-40.

BALDWIN, J., BRODRICK, A., COWLEY, S. & MASON, N. 2010. An innovative toolkit to support normal birth. *J Midwifery Womens Health,* 55**,** 270-2.

BARLEY, K., AYLIN, P., BOTTLE, A. & JARMAN, B. 2004. Social class and elective caesareans in the English NHS. *BMJ,* 328**,** 1399.

BARRON, S. L. 1968. The epidemiology of human pregnancy. *Proc R Soc Med,* 61**,** 1200-6.

BASSO, O. & BAIRD, D. D. 2003. Infertility and preterm delivery, birthweight, and Caesarean section: a study within the Danish National Birth Cohort. *Hum Reprod,* 18**,** 2478-84.

BASTON, H. A. 2006. *Women's experience of emergency caesarean birth.* Unpublished doctoral thesis, University of York.

BAYRAMPOUR, H. & HEAMAN, M. 2010. Advanced maternal age and the risk of cesarean birth: a systematic review. *Birth,* 37**,** 219-26.

BEHAGUE, D. P., VICTORA, C. G. & BARROS, F. C. 2002. Consumer demand for caesarean sections in Brazil: informed decision making, patient choice, or social inequality? A population based birth cohort study linking ethnographic and epidemiological methods. *BMJ,* 324**,** 942-5.

BEKEDAM, D. J., ENGELSBEL, S., MOL, B. W., BUITENDIJK, S. E. & VAN DER PAL-DE BRUIN, K. M. 2002. Male predominance in fetal distress during labor. *Am J Obstet Gynecol,* 187**,** 1605-7.

BERGSTROM, M., KIELER, H. & WALDENSTROM, U. 2009. Effects of natural childbirth preparation versus standard antenatal education on epidural rates, experience of childbirth and parental stress in mothers and fathers: a randomised controlled multicentre trial. *BJOG,* 116**,** 1167-76.

BERRYMAN, J., THORPE, K. & WINDRIDGE, K. 1998. *Older Mothers: Conception, Pregnancy and Birth After 35,* London, Pandora.

BETRAN, A. P., GULMEZOGLU, A. M., ROBSON, M., MERIALDI, M., SOUZA, J. P., WOJDYLA, D., WIDMER, M., CARROLI, G., TORLONI, M. R., LANGER, A., NARVAEZ, A., VELASCO, A., FAUNDES, A., ACOSTA, A., VALLADARES, E., ROMERO, M., ZAVALETA, N., REYNOSO, S. & BATAGLIA, V. 2009. WHO global survey on maternal and perinatal health in Latin America: classifying caesarean sections. *Reprod Health,* 6**,** 18.

BETRAN, A. P., MERIALDI, M., LAUER, J. A., BING-SHUN, W., THOMAS, J., VAN LOOK, P. & WAGNER, M. 2007. Rates of caesarean section: analysis of global, regional and national estimates. *Paediatr Perinat Epidemiol,* 21**,** 98-113.

BEWLEY, S. & COCKBURN, J. 2002. II. The unfacts of 'request' caesarean section. *BJOG,* 109**,** 597-605.

BHARJ, K. K. & SALWAY, S. M. 2008. *Addressing ethnic inequalities in maternity service experiences and outcomes: responding to women's needs and experiences,* London, Race Equality Foundation.

BHATTACHARYA, S., CAMPBELL, D. M., LISTON, W. A. & BHATTACHARYA, S. 2007. Effect of Body Mass Index on pregnancy outcomes in nulliparous women delivering singleton babies. *BMC Public Health,* 7**,** 168.

BHATTACHARYA, S., TOWNEND, J., SHETTY, A., CAMPBELL, D. & BHATTACHARYA, S. 2008. Does miscarriage in an initial pregnancy lead to adverse obstetric and perinatal outcomes in the next continuing pregnancy? *BJOG,* 115**,** 1623-9.

BHOPAL, R. 2007. *Ethnicity, race and health in multicultural societies: foundations for better epidemiology, public health and health care,* Oxford, Oxford University Press.

BHOPAL, R. 2009. Medicine and public health in a multiethnic world. *J Public Health (Oxf),* 31**,** 315-21.

BLACK, C., KAYE, J. A. & JICK, H. 2005. Cesarean delivery in the United Kingdom: time trends in the general practice research database. *Obstet Gynecol,* 106**,** 151-5.

BLAND, M. 2000. *An introduction to medical statistics: Third edition,* Oxford, Oxford University Press.

BLONDEL, B. & MARSHALL, B. 1998. Poor antenatal care in 20 French districts: risk factors and pregnancy outcome. *J Epidemiol Community Health,* 52**,** 501-6.

BORDERS, N. 2006. After the afterbirth: a critical review of postpartum health relative to method of delivery. *J Midwifery Womens Health,* 51**,** 242-8.

BOSELEY, S. 2009. Caesarean births: high number and postcode variation worries experts. The Guardian [Online], 27 October 2009, Available: http://www.guardian.co.uk/lifeandstyle/2009/oct/27/caesarean-births-high-number [Accessed November 2009].

BOSELEY, S. & DOMOKOS, J. 2009. *Celebrated Albany Midwifery Practice loses King's College Hospital contract* [Online]. London: The Guardian. Available: http://www.guardian.co.uk/society/2009/dec/07/albany-midwives-kings-college-hospital [Accessed December 2009].

BOULVAIN, M., STAN, C. & IRION, O. 2005. Membrane sweeping for induction of labour. *Cochrane Database Syst Rev***,** CD000451.

BOULVAIN, M., STAN, C. & IRION, O. 2009. Elective delivery in diabetic pregnant women. *Cochrane Database Syst Rev***,** CD001997.

BOWERS, B. B. 2002. Mothers' experiences of labor support: exploration of qualitative research. *Journal of Obstetric, Gynecologic, and Neonatal Nursing,* 31**,** 742-52.

BOWES, A. & DOMOKOS, J. 1996. Pakistani women and maternity care: raising muted voices. *Sociology of Health & Illness,* 18**,** 45-65.

BOWES, A. & DOMOKOS, T. 2003. Your dignity is hung up at the door: Pakistani and White women's experiences of childbirth. *In:* EARLE, S. & LETHERBY, G. (eds.) *Gender, identity and reproduction.* Basingstoke: Palgrave Macmillan.

BOWLER, I. 1993. 'They're not the same as us': midwives' stereo-types of South Asian descent maternity patients. *Sociology of Health & Illness,* 15**,** 157-178.

BRAGG, F., CROMWELL, D. A., EDOZIEN, L. C., GUROL-URGANCI, I., MAHMOOD, T. A., TEMPLETON, A. & VAN DER MEULEN, J. H. 2010. Variation in rates of caesarean section among English NHS trusts after accounting for maternal and clinical risk: cross sectional study. *BMJ,* 341**,** c5065.

BRAVEMAN, P., EGERTER, S., EDMONSTON, F. & VERDON, M. 1995. Racial/ethnic differences in the likelihood of cesarean delivery, California. *Am J Public Health,* 85**,** 625-30.

BREART, G., GOUJARD, J., MAILLARD, F., CHAVIGNY, C., RUMEAU-ROUQUETTE, C. & SUREAU, C. 1982. Comparison of two obstetrical policies with regard to artificial induction of labour at term. A randomised trial. *Journal de Gynecologie, Obstetrique et Biologie de la Reproduction,* 11**,** 107-12.

BRITTEN, N. & WEISS, M. 2004. What is Concordance? *In:* BOND, C. (ed.) *Concordance: a partnership in medicine-taking* London: Pharmaceutical Press.

BROWN, H. C., PARANJOTHY, S., DOWSWELL, T. & THOMAS, J. 2008. Package of care for active management in labour for reducing caesarean section rates in low-risk women. *Cochrane Database Syst Rev***,** CD004907.

BRUNNER HUBER, L. R. 2007. Validity of self-reported height and weight in women of reproductive age. *Matern Child Health J,* 11**,** 137-44.

BUCK, N. & SCOTT, J. 1993. She's Leaving Home - but Why - an Analysis of Young-People Leaving the Parental Home. *Journal of Marriage and the Family,* 55**,** 863-874.

BUESCHER, P. A. & MITTAL, M. 2006. Racial disparities in birth outcomes increase with maternal age: recent data from North Carolina. *N C Med J,* 67**,** 16-20.

BURNS, L. R., GELLER, S. E. & WHOLEY, D. R. 1995. The effect of physician factors on the cesarean section decision. *Med Care,* 33**,** 365-82.

CAMMU, H., MARTENS, G., RUYSSINCK, G. & AMY, J. J. 2002. Outcome after elective labor induction in nulliparous women: a matched cohort study. *Am J Obstet Gynecol,* 186**,** 240-4.

CAMPBELL, D. 2009. Mothers-to-be turn to 'doulas' in midwife shortage. The Observer [Online], 4 October 2009, Available: http://www.guardian.co.uk/lifeandstyle/2009/oct/04/doula-labour-pregnancy-midwife-motherhood [Accessed November 2009].

CAMPERO, L., GARCIA, C., DIAZ, C., ORTIZ, O., REYNOSO, S. & LANGER, A. 1998. "Alone, I wouldn't have known what to do": a qualitative study on social support during labor and delivery in Mexico. *Social Science & Medicine,* 47**,** 395-403.

CARSTAIRS, V. & MORRIS, R. 1991. *Deprivation and Health in Scotland,* Aberdeen, Aberdeen University Press.

CASSELL, E. J. 2005. Consent or obedience? Power and authority in medicine. *N Engl J Med,* 352**,** 328-30.

CENTRE FOR LONGITUDINAL STUDIES. 2008. *SN 5614 -Millennium Cohort Study, 2001-2003: Birth Registration and Maternity Hospital Episode Data* [Online]. London: UK Data Archive. Available: http://www.data-archive.ac.uk/findingData/snDescription.asp?sn=5614 [Accessed December 2009].

CESARONI, G., FORASTIERE, F. & PERUCCI, C. A. 2008. Are cesarean deliveries more likely for poorly educated parents? A brief report from Italy. *Birth,* 35**,** 241-4.

CHALMERS, B., KACZOROWSKI, J., DARLING, E., HEAMAN, M., FELL, D. B., O'BRIEN, B. & LEE, L. 2010. Cesarean and vaginal birth in canadian women: a comparison of experiences. *Birth,* 37**,** 44-9.

CHAMBERS, G. M., CHAPMAN, M. G., GRAYSON, N., SHANAHAN, M. & SULLIVAN, E. A. 2007. Babies born after ART treatment cost more than non-ART babies: a cost analysis of inpatient birth-admission costs of singleton and multiple gestation pregnancies. *Hum Reprod,* 22**,** 3108-15.

CHAUHAN, S. P., GROBMAN, W. A., GHERMAN, R. A., CHAUHAN, V. B., CHANG, G., MAGANN, E. F. & HENDRIX, N. W. 2005. Suspicion and treatment of the macrosomic fetus: a review. *Am J Obstet Gynecol,* 193**,** 332-46.

CHERNIAK, D. & FISHER, J. 2008. Explaining obstetric interventionism: Technical skills, common conceptualisations, or collective countertransference? *Women's Studies International Forum,* 31**,** 270-277.

CHERVENAK, F. A. & MCCULLOUGH, L. B. 1992. What is obstetric ethics? *Clin Obstet Gynecol,* 35**,** 709-19.

CHU, S. Y., KIM, S. Y., SCHMID, C. H., DIETZ, P. M., CALLAGHAN, W. M., LAU, J. & CURTIS, K. M. 2007. Maternal obesity and risk of cesarean delivery: a meta-analysis. *Obes Rev,* 8**,** 385-94.

CLEARY-GOLDMAN, J., MALONE, F. D., VIDAVER, J., BALL, R. H., NYBERG, D. A., COMSTOCK, C. H., SAADE, G. R., EDDLEMAN, K. A., KLUGMAN, S., DUGOFF, L., TIMOR-TRITSCH, I. E., CRAIGO, S. D., CARR, S. R., WOLFE, H. M., BIANCHI, D. W. & D'ALTON, M. 2005. Impact of maternal age on obstetric outcome. *Obstet Gynecol,* 105**,** 983-90.

CLEARY, R., BEARD, R. W., CHAPPLE, J., COLES, J., GRIFFIN, M., JOFFE, M. & WELCH, A. 1996. The standard primipara as a basis for inter-unit comparisons of maternity care. *BJOG,* 103**,** 223-229.

CLEMENT, S. 2001. Psychological aspects of caesarean section. *Best Pract Res Clin Obstet Gynaecol,* 15**,** 109-26.

CLIFF, D. & DEERY, R. 1997. Too much like school: social class, age, marital status and attendance/non-attendance at antenatal classes. *Midwifery,* 13**,** 139-45.

CMACE 2010. *Perinatal Mortality 2008: United Kingdom,* London, Centre for Maternal and Child Enquiries.

CNATTINGIUS, R., CNATTINGIUS, S. & NOTZON, F. C. 1998. Obstacles to reducing cesarean rates in a low-cesarean setting: the effect of maternal age, height, and weight. *Obstet Gynecol,* 92**,** 501-6.

CNATTINGIUS, S. & LAMBE, M. 2002. Trends in smoking and overweight during pregnancy: prevalence, risks of pregnancy complications, and adverse pregnancy outcomes. *Semin Perinatol,* 26**,** 286-95.

CONDE-AGUDELO, A., ROSAS-BERMUDEZ, A. & KAFURY-GOETA, A. C. 2006. Birth spacing and risk of adverse perinatal outcomes: a meta-analysis. *JAMA,* 295**,** 1809-23.

CONDE-AGUDELO, A., ROSAS-BERMUDEZ, A. & KAFURY-GOETA, A. C. 2007. Effects of birth spacing on maternal health: a systematic review. *Am J Obstet Gynecol,* 196**,** 297-308.

CONRAD, P., MACKIE, T. & MEHROTRA, A. 2010. Estimating the costs of medicalization. *Soc Sci Med,* 70**,** 1943-7.

COPPER, R. L., GOLDENBERG, R. L., CLIVER, S. P., DUBARD, M. B., HOFFMAN, H. J. & DAVIS, R. O. 1993. Anthropometric assessment of body size differences of full-term male and female infants. *Obstet Gynecol,* 81**,** 161-4.

CQC. 2010. *National NHS patient survey programme: Survey of women's experiences of maternity services 2010: Full national results tables* [Online]. Newcastle Upon Tyne: The Care Quality Commission. Available: http://www.cqc.org.uk/aboutcqc/howwedoit/involvingpeoplewhouseservices/patientsurveys/maternityservices.cfm [Accessed February 2011].

CRANDON, A. J. 1979. Maternal anxiety and obstetric complications. *J Psychosom Res,* 23**,** 109-11.

CROWLEY, P. 2003. Interventions for preventing or improving the outcome of delivery at or beyond term. *Cochrane Database Syst Rev***,** CD000170.

DAVIS-FLOYD, R. 2001. The technocratic, humanistic, and holistic paradigms of childbirth. *Int J Gynaecol Obstet,* 75 Suppl 1**,** S5-S23.

DAVIS-FLOYD, R. E. 1994. The technocratic body: American childbirth as cultural expression. *Soc Sci Med,* 38**,** 1125-40.

DAVIS-FLOYD, R. E. & SARGENT, C. F. (eds.) 1997. *Childbirth and Authoritative Knowledge: Cross Cultural Perspectives,* Berkeley: University of California Press.

DAWES, N. W., DAWES, G. S., MOULDEN, M. & REDMAN, C. W. 1999. Fetal heart rate patterns in term labor vary with sex, gestational age, epidural analgesia, and fetal weight. *Am J Obstet Gynecol,* 180**,** 181-7.

DE MARCO, M., THORBURN, S. & ZHAO, W. 2008. Perceived discrimination during prenatal care, labor, and delivery: an examination of data from the Oregon Pregnancy Risk Assessment Monitoring System, 1998-1999, 2000, and 2001. *Am J Public Health,* 98**,** 1818-22.

DE VRIES, R., BENOIT, C., VAN TEIJLINGEN, E. R. & WREDE, S. (eds.) 2001a. *Birth by Design: Pregnancy, Maternity Care & Midwifery in North America and Europe,* London: Routledge.

DE VRIES, R., SALVESEN, H. B., WIEGERS, T. A. & WILLIAMS, S. 2001b. What (and Why) Do Women Want? The Desires of Women and the Design of Maternity Care. *In:* DE VRIES, R., BENOIT, C., VAN TEIJLINGEN, E. R. & WREDE, S. (eds.) *Birth by Design: Pregnancy, Maternity Care & Midwifery in North America and Europe.* London: Routledge.

DE VRIES, R. G. 1981. Birth and Death: Social Construction at the Poles of Existence. *Social Forces,* 59**,** 1074-1093

DEEKS, J. J., DINNES, J., D'AMICO, R., SOWDEN, A. J., SAKAROVITCH, C., SONG, F., PETTICREW, M. & ALTMAN, D. G. 2003. Evaluating non-randomised intervention studies. *Health Technol Assess,* 7**,** iii-x, 1-173.

DEPARTMENT OF HEALTH 1993. *Changing Childbirth: Vol. 1. Report of the Expert Maternity Group,* London, HMSO.

DEPARTMENT OF HEALTH 2002. *Improvement, expansion and reform: the next three years. Priorities and planning framework 2003-2006,* London, Department of Health.

DEPARTMENT OF HEALTH 2003. *Tackling Health Inequalities: A Programme for Action,* London, Department of Health.

DEPARTMENT OF HEALTH 2004. *Maternity Standard, National Service Framework for Children, Young People and Maternity Services,* London, Department of Health.

DEPARTMENT OF HEALTH 2007. *Maternity Matters: Choice, access and continuity of care in a safe service,* London, Department of Health.

DEPARTMENT OF THE ENVIRONMENT, T. A. T. R. 2000. *Measuring Multiple Deprivation at the Small Area Level: The Indices of Deprivation 2000,* London, DETR.

DEX, S. & JOSHI, H. 2004. *Millennium Cohort study First Survey: A User's Guide to Initial Findings* [Online]. London: Centre for Longitudinal Studies. Available:

http://www.cls.ioe.ac.uk/studies.asp?section=0001000200010012 [Accessed 1st August 2008].

DEX, S., JOSHI, H., SMITH, K., WARD, K. & PLEWIS, I. 2005. Introduction. *In:* DEX, S. & JOSHI, H. (eds.) *Children of the 21st Century: From birth to nine months.* Bristol: The Policy Press.

DEYO, R. A. 2002. Cascade effects of medical technology. *Annu Rev Public Health,* 23**,** 23-44.

DEZATEUX, C., HOCKLEY, C., JOHNSON, J., JOSHI, H., QUIGLEY, M. & ROSENBERG, R. 2006. *Millennium Cohort Study: Birth Registration and Maternity Hospital Episode Statistics Linkage. A Guide to the SPSS Dataset*

London, Centre for Longitudinal Studies

DI RENZO, G. C., ROSATI, A., SARTI, R. D., CRUCIANI, L. & CUTULI, A. M. 2007. Does fetal sex affect pregnancy outcome? *Gend Med,* 4**,** 19-30.

DICKSON, M. J. & WILLETT, M. 1999. Midwives Would Prefer a Vaginal Delivery. *BMJ: British Medical Journal,* 319**,** 1008.

DODD, J. M., CROWTHER, C. A., HUERTAS, E., GUISE, J. M. & HOREY, D. 2004. Planned elective repeat caesarean section versus planned vaginal birth for women with a previous caesarean birth. *Cochrane Database Syst Rev***,** CD004224.

DOULA UK. 2005. *About Doulas* [Online]. Willenhall: Doula UK Ltd. Available: http://www.doula.org.uk/content/duk/about/default.asp [Accessed December 2009].

DOWD, J. B. 2007. Early childhood origins of the income/health gradient: the role of maternal health behaviors. *Soc Sci Med,* 65**,** 1202-13.

DOWSWELL, T., THORNTON, J. G., HEWISON, J. & LILFORD, R. J. 1996a. Should there be a trial of home versus hospital delivery in the United Kingdom? *Bmj,* 312**,** 753.

DOWSWELL, T., THORNTON, J. G., HEWISON, J., LILFORD, R. J., RAISLER, J., MACFARLANE, A., YOUNG, G., NEWBURN, M., DODDS, R. & SETTATREE, R. S. 1996b. Should there be a trial of home versus hospital delivery in the United Kingdom? *Bmj,* 312**,** 753-7.

DUBLIN, S., LYDON-ROCHELLE, M., KAPLAN, R. C., WATTS, D. H. & CRITCHLOW, C. W. 2000. Maternal and neonatal outcomes after induction of labor without an identified indication. *Am J Obstet Gynecol,* 183**,** 986-94.

DUJARDIN, B., VAN CUTSEM, R. & LAMBRECHTS, T. 1996. The value of maternal height as a risk factor of dystocia: a meta-analysis. *Trop Med Int Health,* 1**,** 510-21.

ECKER, J. L., CHEN, K. T., COHEN, A. P., RILEY, L. E. & LIEBERMAN, E. S. 2001. Increased risk of cesarean delivery with advancing maternal age: Indications and associated factors in nulliparous women. *American Journal of Obstetrics and Gynecology,* 185**,** 883-887.

ECONOMIC AND SOCIAL DATA SERVICE. 2010. *SN 4683 -Millennium Cohort Study: First Survey, 2001-2003* [Online]. Essex: Universities of Essex and Manchester. Available: http://www.esds.ac.uk/findingData/snDescription.asp?sn=4683 [Accessed August 2010].

ELFORD, J. & BEN-SHLOMO, Y. 2004. Geography and migration with special reference to cardiovascular disease. *In:* KUH, D. & BEN-SHLOMO, Y. (eds.) *A life course approach to chronic disease epidemiology: Second edition.* Oxford: Oxford University Press.

EOGAN, M. A., GEARY, M. P., O'CONNELL, M. P. & KEANE, D. P. 2003. Effect of fetal sex on labour and delivery: retrospective review. *BMJ,* 326**,** 137.

ESCOTT, D., SLADE, P. & SPIBY, H. 2009. Preparation for pain management during childbirth: the psychological aspects of coping strategy development in antenatal education. *Clin Psychol Rev,* 29**,** 617-22.

ESSEX, H. N. & PICKETT, K. E. 2008. Mothers without companionship during childbirth: an analysis within the Millennium Cohort Study. *Birth,* 35**,** 266-76.

FABIAN, H. M., RADESTAD, I. J. & WALDENSTROM, U. 2004. Characteristics of Swedish women who do not attend childbirth and parenthood education classes during pregnancy. *Midwifery,* 20**,** 226-35.

FABIAN, H. M., RADESTAD, I. J. & WALDENSTROM, U. 2005. Childbirth and parenthood education classes in Sweden. Women's opinion and possible outcomes. *Acta Obstet Gynecol Scand,* 84**,** 436-43.

FAIRLEY, L., DUNDAS, R. & LEYLAND, A. H. 2011. The influence of both individual and area based socioeconomic status on temporal trends in Caesarean sections in Scotland 1980-2000. *BMC Public Health,* 11**,** 330.

FEIG, D. S., RAZZAQ, A., SYKORA, K., HUX, J. E. & ANDERSON, G. M. 2006. Trends in deliveries, prenatal care, and obstetrical complications in women with pregestational diabetes: a population-based study in Ontario, Canada, 1996-2001. *Diabetes Care,* 29**,** 232-5.

FEINMANN, J. 2002. How to limit caesareans on demand--too NICE to push? *Lancet,* 359**,** 774.

GAGNON, A. J., MEIER, K. M. & WAGHORN, K. 2007. Continuity of nursing care and its link to cesarean birth rate. *Birth,* 34**,** 26-31.

GAGNON, A. J. & SANDALL, J. 2007. Individual or group antenatal education for childbirth or parenthood, or both. *Cochrane Database Syst Rev***,** CD002869.

GAREEN, I. F., MORGENSTERN, H., GREENLAND, S. & GIFFORD, D. S. 2003. Explaining the association of maternal age with cesarean delivery for nulliparous and parous women. *Journal of Clinical Epidemiology,* 56**,** 1100-1110.

GATRAD, A. R. 1994. Attitudes and beliefs of Muslim mothers towards pregnancy and infancy. *Arch Dis Child,* 71**,** 170-4.

GAWANDE, A. 2006. *The score: How childbirth went industrial* [Online]. New York: The New Yorker. Available: http://www.newyorker.com/archive/2006/10/09/061009fa_fact [Accessed November 2009].

GERONIMUS, A. T. 1992. The weathering hypothesis and the health of African-American women and infants: evidence and speculations. *Ethn Dis,* 2**,** 207-21.

GERONIMUS, A. T. 1996. Black/white differences in the relationship of maternal age to birthweight: a population-based test of the weathering hypothesis. *Soc Sci Med,* 42**,** 589-97.

GERONIMUS, A. T., HICKEN, M., KEENE, D. & BOUND, J. 2006. "Weathering" and Age Patterns of Allostatic Load Scores Among Blacks and Whites in the United States. *Am J Public Health,* 96**,** 826-833.

GIBB, D. M. F. & ARULKUMARAN, S. 1997. *Fetal Monitoring in Practice,* Oxford, Butterworth-Heinemann.

GIPSON, J. D., KOENIG, M. A. & HINDIN, M. J. 2008. The effects of unintended pregnancy on infant, child, and parental health: a review of the literature. *Stud Fam Plann,* 39**,** 18-38.

GISSLER, M. & HEMMINKI, E. 1994. Amount of antenatal care and infant outcome. *Eur J Obstet Gynecol Reprod Biol,* 56**,** 9-14.

GITHENS, P. B., GLASS, C. A., SLOAN, F. A. & ENTMAN, S. S. 1993. Maternal Recall and Medical Records: An Examination of Events During Pregnancy, Childbirth, and Early Infancy. *Birth,* 20**,** 136-141.

GOER, H. 1995. *Obstetric Myths versus Research Realities: A Guide to the Medical Literature,* Westpot, Conneticut, Bergin & Garvey.

GOLDENBERG, R. L., CULHANE, J. F., IAMS, J. D. & ROMERO, R. 2008. Epidemiology and causes of preterm birth. *Lancet,* 371**,** 75-84.

GOLDING, J., PEMBREY, M. & JONES, R. 2001. ALSPAC--the Avon Longitudinal Study of Parents and Children. I. Study methodology. *Paediatr Perinat Epidemiol,* 15**,** 74-87.

GOLDSTICK, O., WEISSMAN, A. & DRUGAN, A. 2003. The circadian rhythm of "urgent" operative deliveries. *Isr Med Assoc J,* 5**,** 564-6.

GOMES, U. A., SILVA, A. A., BETTIOL, H. & BARBIERI, M. A. 1999. Risk factors for the increasing caesarean section rate in Southeast Brazil: a comparison of two birth cohorts, 1978-1979 and 1994. *Int J Epidemiol,* 28**,** 687-94.

GOODWIN DEVELOPMENT TRUST. 2009. *Volunteer Doula Project gains national funding* [Online]. Hull: Goodwin Development Trust. Available: http://www.goodwintrust.org/index.php?id=333&secid=04 [Accessed December 2009].

GORDIS, L. 2004 *Epidemiology: Third Edition,* Philadelphia, Elsevier.

GOULD, J. B., DAVEY, B. & STAFFORD, R. S. 1989. Socioeconomic differences in rates of cesarean section. *N Engl J Med,* 321**,** 233-9.

GRAHAM, H. 2007. *Unequal Lives. Health and Socioeconomic Inequalities,* Maidenhead, Open University Press.

GRAHAM, H., HAWKINS, S. S. & LAW, C. 2010. Lifecourse influences on women's smoking before, during and after pregnancy. *Soc Sci Med,* 70**,** 582-7.

GRAHAM, H., INSKIP, H. M., FRANCIS, B. & HARMAN, J. 2006. Pathways of disadvantage and smoking careers: evidence and policy implications. *J Epidemiol Community Health,* 60 Suppl 2**,** 7-12.

GRAHAM, H. & MCDERMOTT, E. 2006. Qualitative Research and the Evidence Base of Policy: Insights from Studies of Teenage Mothers in the UK. *Journal of Social Policy,* 35**,** 21-37.

GRANT, A. & GLAZENER, C. M. 2010. Elective caesarean section versus expectant management for delivery of the small baby. *Cochrane Database Syst Rev***,** CD000078.

GREEN, C. R., ANDERSON, K. O., BAKER, T. A., CAMPBELL, L. C., DECKER, S., FILLINGIM, R. B., KALAUOKALANI, D. A., LASCH, K. E., MYERS, C., TAIT, R. C., TODD, K. H. & VALLERAND, A. H. 2003. The unequal burden of pain: confronting racial and ethnic disparities in pain. *Pain Med,* 4**,** 277-94.

GREEN, J., CURTIS, P., PRICE, H. & RENFREW, M. 1998a. *Continuing to care. The organization of midwifery services in the UK: a structured review of the evidence,* Cheshire, Books for Midwives Press.

GREEN, J. M. & BASTON, H. A. 2007. Have women become more willing to accept obstetric interventions and does this relate to mode of birth? Data from a prospective study. *Birth,* 34**,** 6-13.

GREEN, J. M., COUPLAND, V. A. & KITZINGER, J. V. 1998b. *Great Expectations: A Prospective Study of Women's Expectations and Experiences of Childbirth,* Cheshire, Books for Midwives Press.

GREEN, J. M., KITZINGER, J. V. & COUPLAND, V. A. 1990. Stereotypes of childbearing women: a look at some evidence. *Midwifery,* 6**,** 125-32.

GREEN, J. M., RENFREW, M. J. & CURTIS, P. A. 2000. Continuity of carer: what matters to women? A review of the evidence. *Midwifery,* 16**,** 186-96.

GUIHARD, P. & BLONDEL, B. 2001. Trends in risk factors for caesarean sections in France between 1981 and 1995: lessons for reducing the rates in the future. *BJOG,* 108**,** 48-55.

GULMEZOGLU, A. M., CROWTHER, C. A. & MIDDLETON, P. 2006. Induction of labour for improving birth outcomes for women at or beyond term. *Cochrane Database Syst Rev***,** CD004945.

GUNN, T. R., FISHER, A., LLOYD, P. & O'DONNELL, S. 1983. Antenatal education: does it improve the quality of labour and delivery? *N Z Med J,* 96**,** 51-3.

HALL, M. H. & CARR-HILL, R. 1982. Impact of sex ratio on onset and management of labour. *BMJ (Clin Res Ed),* 285**,** 401-3.

HAMLYN, B., BROOKER, S., OLEINIKOVA, K. & WANDS, S. 2002. *Infant Feeding 2000,* London, The Stationery Office.

HANSEN, K. E., JOHNSON, J., JOSHI, H., CALDERWOOD, L., JONES, E., MCDONALD, J., SHEPHERD, P., SMITH, K. & MILLENNIUM COHORT TEAM. 2010. *Millennium Cohort Study First, Second, Third and Fourth Surveys: A Guide to the Datasets* [Online]. London: Centre for Longitudinal Studies. Available: http://www.cls.ioe.ac.uk/studies.asp?section=00010002000100050003 [Accessed August 2010].

HATEM, M., SANDALL, J., DEVANE, D., SOLTANI, H. & GATES, S. 2008. Midwife-led versus other models of care for childbearing women. *Cochrane Database Syst Rev***,** CD004667.

HAWTHORNE, G., ROBSON, S., RYALL, E. A., SEN, D., ROBERTS, S. H. & PLATT, M. P. W. 1997. Prospective population based survey of outcome of pregnancy in diabetic women: results of the Northern Diabetic Pregnancy Audit, 1994. *BMJ,* 315**,** 279-281.

HEALTHCARE COMMISSION 2008. *Towards better births: A review of maternity services in England,* London, Commission for Healthcare Audit and Inspection.

HEFFNER, L. J. 2004. Advanced maternal age--how old is too old? *N Engl J Med,* 351**,** 1927-9.

HEFFNER, L. J., ELKIN, E. & FRETTS, R. C. 2003. Impact of labor induction, gestational age, and maternal age on cesarean delivery rates. *Obstet Gynecol,* 102**,** 287-93.

HELMERHORST, F. M., PERQUIN, D. A., DONKER, D. & KEIRSE, M. J. 2004. Perinatal outcome of singletons and twins after assisted conception: a systematic review of controlled studies. *BMJ,* 328**,** 261.

HEWSON, D. & BENNETT, A. 1987. Childbirth research data: medical records or women's reports? *Am J Epidemiol,* 125**,** 484-91.

HINDLEY, C., HINSLIFF, S. W. & THOMSON, A. M. 2006. English midwives' views and experiences of intrapartum fetal heart rate monitoring in women at low obstetric risk: conflicts and compromises. *J Midwifery Womens Health,* 51**,** 354-60.

HODNETT, E. D., DOWNE, S., EDWARDS, N. & WALSH, D. 2005. Home-like versus conventional institutional settings for birth. *Cochrane Database Syst Rev***,** CD000012.

HODNETT, E. D., GATES, S., HOFMEYR, G. J. & SAKALA, C. 2007. Continuous support for women during childbirth. *Cochrane Database Syst Rev***,** CD003766.

HODNETT, E. D., GATES, S., HOFMEYR, G. J., SAKALA, C. & WESTON, J. 2011. Continuous support for women during childbirth. *Cochrane Database Syst Rev*.

HOFMEYR, G., NEILSON, J., ALFIREVIC, Z., CROWTHER, C., DULEY, L., GULMEZOGLU, A., GYTE, G. & HODNETT, E. 2008. *A Cochrane pocketbook : pregnancy and childbirth,* Chichester, John Wiley & Sons.

HOFMEYR, G. J., NIKODEM, V. C., WOLMAN, W. L., CHALMERS, B. E. & KRAMER, T. 1991. Companionship to modify the clinical birth environment: effects on progress and perceptions of labour, and breastfeeding. *British Journal of Obstetrics and Gynaecology,* 98**,** 756-64.

HOLZMAN, C., EYSTER, J., KLEYN, M., MESSER, L. C., KAUFMAN, J. S., LARAIA, B. A., O'CAMPO, P., BURKE, J. G., CULHANE, J. & ELO, I. T. 2009. Maternal weathering and risk of preterm delivery. *Am J Public Health,* 99**,** 1864-71.

HOSPITAL EPISODE STATISTICS. 2009. *Table 6: Anaesthetics used before or during delivery by method of onset of labour and method of delivery, 2007-08* [Online]. London: The Health and Social Care Information Centre. Available: http://www.hesonline.nhs.uk [Accessed August 2009].

HOWELL, C. J. 2000. Epidural versus non-epidural analgesia for pain relief in labour. *Cochrane Database Syst Rev***,** CD000331.

HOWIE, L. & CARLISLE, C. 2005. 'I felt like they were all kind of staring at me'. *RCM Midwives,* 8**,** 304-8.

HURST, M. & SUMMEY, P. S. 1984. Childbirth and social class: the case of cesarean delivery. *Soc Sci Med,* 18**,** 621-31.

HUTCHINSON, J., PICKETT, K. E., GREEN, J. & WAKSCHLAG, L. S. 2010. Smoking in pregnancy and disruptive behaviour in 3-year-old boys and girls: an analysis of the UK Millennium Cohort Study. *J Epidemiol Community Health,* 64**,** 82-8.

IBISON, J. M. 2005. Ethnicity and mode of delivery in 'low-risk' first-time mothers, East London, 1988-1997. *Eur J Obstet Gynecol Reprod Biol,* 118**,** 199-205.

IM, E. O. & YANG, K. 2006. Theories on immigrant women's health. *Health Care Women Int,* 27**,** 666-81.

INCH, S. 1982. *Birthrights: What Every Parent Should Know About Childbirth in Hospitals,* New York, Pantheon Books

INGEMARSSON, I. 2003. Gender aspects of preterm birth. *BJOG,* 110 Suppl 20**,** 34-8.

ISTVAN, J. 1986. Stress, anxiety, and birth outcomes: a critical review of the evidence. *Psychol Bull,* 100**,** 331-48.

JANSSEN, P., NOLAN, M. L., SPIBY, H., GREEN, J., GROSS, M., CHEYNE, H., HUNDLEY, V., RIJNDERS, M., DE JONGE, A. & BUITENDIJK, S. 2009. Roundtable Discussion: Early Labor: What's the Problem? *Birth,* 36**,** 332-339.

JENSEN, D. M., DAMM, P., MOELSTED-PEDERSEN, L., OVESEN, P., WESTERGAARD, J. G., MOELLER, M. & BECK-NIELSEN, H. 2004. Outcomes in type 1 diabetic pregnancies: a nationwide, population-based study. *Diabetes Care,* 27**,** 2819-23.

JOFFE, M. & GRISSO, J. A. 1985. Comparison of Ante-Natal Hospital Records with Retrospective Interviewing. *Journal of Biosocial Science,* 17**,** 113-119.

JOHANSON, R., NEWBURN, M. & MACFARLANE, A. 2002. Has the medicalisation of childbirth gone too far? *BMJ,* 324**,** 892-5.

JOHNSON, J. 2007. *Millennium Cohort Study: MCS Hospital of Birth Coding. A Guide to the Datasets*

London, Centre for Longitudinal Studies.

JOHNSON, R. & SLADE, P. 2002. Does fear of childbirth during pregnancy predict emergency caesarean section? *BJOG,* 109**,** 1213-21.

JORDAN, R. G. & MURPHY, P. A. 2009. Risk assessment and risk distortion: finding the balance. *J Midwifery Women's Health,* 54**,** 191-200.

JOSEPH, K. S., DODDS, L., ALLEN, A. C., JONES, D. V., MONTERROSA, L., ROBINSON, H., LISTON, R. M. & YOUNG, D. C. 2006. Socioeconomic status and receipt of obstetric services in Canada. *Obstet Gynecol,* 107**,** 641-50.

JOSHI, H., PLEWIS, I., CULLIS, A., SADIGH, M., MOJADDAD, M., DODD, K., WOODS, J. & CHAPMAN, A. 2002. *Mobile families and other challenges in the design of the Millennium Cohort Study* [Online]. London: Centre for Longitudinal Studies. Available: http://www.cls.ioe.ac.uk/text.asp?section=0001000200010010 [Accessed July 2011].

KAI, J., BEAVAN, J., FAULL, C., DODSON, L., GILL, P. & BEIGHTON, A. 2007. Professional uncertainty and disempowerment responding to ethnic diversity in health care: a qualitative study. *PLoS Med,* 4**,** e323.

KARA, F., YESILDAGLAR, N. & UYGUR, D. 2005. Maternal height as a risk factor for Caesarean section. *Arch Gynecol Obstet,* 271**,** 336-7.

KARLSEN, S. & NAZROO, J. 2006. Defining and measuing ethnicity and 'race'. *In:* NAZROO, J. (ed.) *Health and social research in multiethnic societies.* London: Routledge.

KATBAMNA, S. 2000. *'Race' and Childbirth,* Buckingham, Open University Press.

KELLY, Y., PANICO, L., BARTLEY, M., MARMOT, M., NAZROO, J. & SACKER, A. 2009. Why does birthweight vary among ethnic groups in the UK? Findings from the Millennium Cohort Study. *J Public Health (Oxf),* 31**,** 131-7.

KENNEDY, H. P., GRANT, J., WALTON, C., SHAW-BATTISTA, J. & SANDALL, J. 2010. Normalizing birth in England: a qualitative study. *J Midwifery Womens Health,* 55**,** 262-9.

KENNEDY, H. P., NARDINI, K., MCLEOD-WALDO, R. & ENNIS, L. 2009. Top-selling childbirth advice books: a discourse analysis. *Birth,* 36**,** 318-24.

KINGDON, C., NEILSON, J., SINGLETON, V., GYTE, G., HART, A., GABBAY, M. & LAVENDER, T. 2009. Choice and birth method: mixed-method study of caesarean delivery for maternal request. *BJOG.*

KIRZ, D. S., DORCHESTER, W. & FREEMAN, R. K. 1985. Advanced maternal age: the mature gravida. *Am J Obstet Gynecol,* 152**,** 7-12.

KITZINGER, S. 2006. *Birth Crisis,* Abingdon, Oxfordshire, Routledge.

KITZINGER, S., GREEN, J. M., CHALMERS, B., KEIRSE, M., LINDSTROM, K. & HEMMINKI, E. 2006. Why do women go along with this stuff? *Birth,* 33**,** 154-8.

KLAUS, M. H., KENNELL, J. H., BERKOWITZ, G. & KLAUS, P. 1992. Maternal Assistance and Support in Labour: Father, Nurse, Midwife, or Doula? *Clinical Consultations in Obstetrics and Gynecology,* 4**,** 211 - 217.

KLAUS, M. H., KENNELL, J. H., ROBERTSON, S. S. & SOSA, R. 1986. Effects of social support during parturition on maternal and infant morbidity. *British Medical Journal (Clinical Research Ed.),* 293**,** 585-7.

KLEIN, M. C. 2006. Does epidural analgesia increase rate of cesarean section? *Can Fam Physician,* 52**,** 419-21, 426-8.

KLEIN, M. C. 2010. What do episiotomy and cesarean have to do with Copernicus, Galileo, and Newton? *Birth,* 37**,** 1-2.

KLEINMAN, A. & BENSON, P. 2006. Anthropology in the clinic: the problem of cultural competency and how to fix it. *PLoS Med,* 3**,** e294.

KNIGHT, M., KURINCZUK, J. J., SPARK, P. & BROCKLEHURST, P. 2009. Inequalities in maternal health: national cohort study of ethnic variation in severe maternal morbidities. *BMJ,* 338**,** b542.

KRIEGER, N. 1992. Overcoming the absence of socioeconomic data in medical records: validation and application of a census-based methodology. *Am J Public Health,* 82**,** 703-10.

LAGAN, B., SINCLAIR, M. & KERNOHAN, W. 2010. Internet use in pregnancy informs women's decision making: A web-based survey. *Birth,* 37**,** 106-115.

LANGER, A., CAMPERO, L., GARCIA, C. & REYNOSO, S. 1998. Effects of psychosocial support during labour and childbirth on breastfeeding, medical interventions, and mothers' wellbeing in a Mexican public hospital: a randomised clinical trial. *British Journal of Obstetrics and Gynaecology,* 105**,** 1056-63.

LANGER, A. & VILLAR, J. 2002. Promoting evidence based practice in maternal care. *BMJ,* 324**,** 928-9.

LAVENDER, T., DOWNE, S., FINLAYSON, K. & WALSH, D. 2007. *Access to Antenatal Care: A Systematic Review,* Preston, University of Central Lancashire.

LAVENDER, T., HOFMEYR, G. J., NEILSON, J. P., KINGDON, C. & GYTE, G. M. 2006. Caesarean section for non-medical reasons at term. *Cochrane Database Syst Rev,* 3**,** CD004660.

LAVENDER, T. & KINGDON, C. 2009. Primigravid women's views of being approached to participate in a hypothetical term cephalic trial of planned vaginal birth versus planned cesarean birth. *Birth,* 36**,** 213-9.

LAWLOR, D. A., BEN-SHLOMO, Y. & LEON, D. A. 2004. Pre-adult influences on cardiovascular disease. *In:* KUH, D. & BEN-SHLOMO, Y. (eds.) *A life course approach to chronic disease epidemiology: Second edition.* Oxford: Oxford University Press.

LAWLOR, D. A. & SHAW, M. 2002. Too much too young? Teenage pregnancy is not a public health problem. *Int J Epidemiol,* 31**,** 552-4.

LAWLOR, D. A., SHAW, M., SCALLY, G., RICH-EDWARDS, J. & SMITH, S. 2002. Point-counterpoint: Too much too young? Teenage pregnancy is not a public health problem. *Int J Epidemiol,* 31**,** 552-4.

LAZARUS, E. 1997. What Do Women Want? Issues of Choice, Control, and Class in American Pregnancy and Childbirth. *In:* DAVIS-FLOYD, R. & SARGENT, C. (eds.) *Childbirth and Authoriative Knowledge: Cross-Cultural Perspectives.* Berkeley: University of California Press.

LEEB, K., BAIBERGENOVA, A., WEN, E., WEBSTER, G. & ZELMER, J. 2005. Are There Socio-Economic Differences in Caesarean Section Rates in Canada? *Healthcare Policy,* 1**,** 48-54.

LERCHL, A. 2005. Where are the Sunday babies? Observations on a marked decline in weekend births in Germany. *Naturwissenschaften,* 92**,** 592-4.

LEWIS, G. (ed.) 2007. *The Confidential Enquiry into Maternal and Child Health (CEMACH). Saving Mothers' Lives: reviewing maternal deaths to make motherhood safer - 2003-2005. The Seventh Report on Confidential Enquiries into Maternal Deaths in the United Kingdom* London: CEMACH.

LIA-HOAGBERG, B., RODE, P., SKOVHOLT, C. J., OBERG, C. N., BERG, C., MULLETT, S. & CHOI, T. 1990. Barriers and motivators to prenatal care among low-income women. *Soc Sci Med,* 30**,** 487-95.

LIALIOS, G., KAPONIS, A. & ADONAKIS, G. 1999. Maternal age as an independent risk factor for cesarean delivery. *International Journal of Gynecology & Obstetrics,* 67**,** 187-188.

LIEBERMAN, E., LANG, J. M., COHEN, A. P., FRIGOLETTO, F. D., JR., ACKER, D. & RAO, R. 1997. The association of fetal sex with the rate of cesarean section. *Am J Obstet Gynecol,* 176**,** 667-71.

LIEBERMAN, E. & O'DONOGHUE, C. 2002. Unintended effects of epidural analgesia during labor: a systematic review. *Am J Obstet Gynecol,* 186**,** S31-68.

LILFORD, R. J. 1987. Clinical experimentation in obstetrics. *Br Med J (Clin Res Ed),* 295**,** 1298-300.

LINTON, A., PETERSON, M. R. & WILLIAMS, T. V. 2004. Effects of maternal characteristics on cesarean delivery rates among U.S. Department of Defense healthcare beneficiaries, 1996-2002. *Birth,* 31**,** 3-11.

LO, M. C. & STACEY, C. L. 2008. Beyond cultural competency: Bourdieu, patients and clinical encounters. *Sociol Health Illn,* 30**,** 741-55.

LOBEL, M. & DELUCA, R. S. 2007. Psychosocial sequelae of cesarean delivery: review and analysis of their causes and implications. *Soc Sci Med,* 64**,** 2272-84.

LOVE, E. R., BHATTACHARYA, S., SMITH, N. C. & BHATTACHARYA, S. 2010. Effect of interpregnancy interval on outcomes of pregnancy after miscarriage: retrospective analysis of hospital episode statistics in Scotland. *BMJ,* 341.

LOZOFF, B., JORDAN, B. & MALONE, S. 1988. Childbirth in cross-cultural perspective. *Marriage & Family Review***,** 35-60.

LUCAS, D. N., YENTIS, S. M., KINSELLA, S. M., HOLDCROFT, A., MAY, A. E., WEE, M. & ROBINSON, P. N. 2000. Urgency of caesarean section: a new classification. *J R Soc Med,* 93**,** 346-50.

LUKE, B. & BROWN, M. B. 2007. Elevated risks of pregnancy complications and adverse outcomes with increasing maternal age. *Hum Reprod,* 22**,** 1264-72.

LYONS, S. M., O'KEEFFE, F. M., CLARKE, A. T. & STAINES, A. 2008. Cultural diversity in the Dublin maternity services: the experiences of maternity service providers when caring for ethnic minority women. *Ethn Health,* 13**,** 261-76.

MAASSEN, M. S., HENDRIX, M. J., VAN VUGT, H. C., VEERSEMA, S., SMITS, F. & NIJHUIS, J. G. 2008. Operative deliveries in low-risk pregnancies in The Netherlands: primary versus secondary care. *Birth,* 35**,** 277-82.

MACFARLANE, A. & MUGFORD, M. 2000. *Birth Counts: Statistics of Pregnancy and Childbirth,* London, The Stationery Office.

MACFARLANE, A. J. 2004. Social class and elective caesareans in the NHS: analysis is not really about social class. *BMJ,* 329**,** 291; author reply 291.

MAHMOOD, T. A., CAMPBELL, D. M. & WILSON, A. W. 1988. Maternal height, shoe size, and outcome of labour in white primigravidas: a prospective anthropometric study. *BMJ,* 297**,** 515-7.

MAIN, D. M., MAIN, E. K. & MOORE, D. H., 2ND 2000. The relationship between maternal age and uterine dysfunction: a continuous effect throughout reproductive life. *Am J Obstet Gynecol,* 182**,** 1312-20.

MANDER, R. 2007. *Caesarean: Just another way of birth?* , New York, Routledge.

MARTEL, M., WACHOLDER, S., LIPPMAN, A., BROHAN, J. & HAMILTON, E. 1987. Maternal age and primary cesarean section rates: a multivariate analysis. *Am J Obstet Gynecol,* 156**,** 305-8.

MARTIN, N. 2001. Caesarean celebrities who are 'too posh to push'. The Telegraph [Online], 22nd May 2001, Available: http://www.telegraph.co.uk/news/uknews/1331204/Caesarean-celebrities-who-are-too-posh-to-push.html [Accessed May 2010].

MCCARTHY, F. P., RIGG, L., CADY, L. & CULLINANE, F. 2007. A new way of looking at Caesarean section births. *Aust N Z J Obstet Gynaecol,* 47**,** 316-20.

MCCONNELL, D. 2007. Too posh to push: Pregnant Chistian Aguilara opts for a Caesarean. The Daily Mail [Online], 20th December 2010, Available: http://www.dailymail.co.uk/tvshowbiz/article-503612/Too-posh-push-Pregnant-Christina-Aguilera-opts-Caesarean.html [Accessed June 2010].

MCCOURT, C. & PEARCE, A. 2000. Does continuity of carer matter to women from minority ethnic groups? *Midwifery,* 16**,** 145-54.

MCCOURT, C., WEAVER, J., STATHAM, H., BEAKE, S., GAMBLE, J. & CREEDY, D. K. 2007. Elective cesarean section and decision making: a critical review of the literature. *Birth,* 34**,** 65-79.

MCDERMOTT, E. & GRAHAM, H. 2005. Resilient young mothering: Social inequalities, late modernity and the 'problem' of 'teenage' motherhood. *Journal of Youth Studies,* 8**,** 59-79.

MCGUINNESS, B. J. & TRIVEDI, A. N. 1999. Maternal height as a risk factor for Caesarean section due to failure to progress in labour. *Aust N Z J Obstet Gynaecol,* 39**,** 152-4.

MCILWAINE, G., BOULTON-JONES, C., COLE, S. & WILKINSON, C. 1998. *Caesarean Section in Scotland 1994/5: a National Audit,* Edinburgh, Scottish Programme for Clinical Effectiveness in Reproductive Health.

MCMILLAN, A., BARLOW, J. & REDSHAW, M. 2009. *Birth and Beyond: A Review of the Evidence about Antenatal Education* [Online]. Department of Health. Available: http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_109832 [Accessed May 2010].

MERCHANT, K. M., VILLAR, J. & KESTLER, E. 2001. Maternal height and newborn size relative to risk of intrapartum caesarean delivery and perinatal distress. *BJOG,* 108**,** 689-96.

METZGER, B. E., BUCHANAN, T. A., COUSTAN, D. R., DE LEIVA, A., DUNGER, D. B., HADDEN, D. R., HOD, M., KITZMILLER, J. L., KJOS, S. L., OATS, J. N., PETTITT, D. J., SACKS, D. A. & ZOUPAS, C. 2007. Summary and recommendations of the Fifth International Workshop-Conference on Gestational Diabetes Mellitus. *Diabetes Care,* 30 Suppl 2**,** S251-60.

MILLER, T. 1995. Shifting boundaries: Exploring the influence of cultural traditions and religious beliefs of Bangladeshi women on antenatal interactions. *Women's Studies International Forum,* 18**,** 299-309.

MONARI, F., DI MARIO, S., FACCHINETTI, F. & BASEVI, V. 2008. Obstetricians' and midwives' attitudes toward cesarean section. *Birth,* 35**,** 129-35.

MORRIS, T. & MCINERNEY, K. 2010. Media Representations of Pregnancy and Childbirth: An Analysis of Reality Television Programs in the United States. *Birth,* 37**,** 134-140.

MOZURKEWICH, E., CHILIMIGRAS, J., KOEPKE, E., KEETON, K. & KING, V. J. 2009. Indications for induction of labour: a best-evidence review. *BJOG,* 116**,** 626-36.

MULLER, C. & NEWBURN, M. 2009. NCT antenatal classes 2009: our service from the parents' point of view. *New Digest,* 48**,** 16-19.

MUTRYN, C. S. 1993. Psychosocial impact of cesarean section on the family: a literature review. *Soc Sci Med,* 37**,** 1271-81.

NAFTALIN, J. & PATERSON-BROWN, S. 2008. A pilot study exploring the impact of maternal age and raised body mass index on caesarean section rates. *J Obstet Gynaecol,* 28**,** 394-7.

NATIONAL CHILDBIRTH TRUST. 2009. *National Childbirth Trust* [Online]. London: National Childbirth Trust. Available: http://www.nctpregnancyandbabycare.com/home [Accessed November 2009].

NATIONAL INSTITUTE FOR HEALTH AND CLINICAL EXCELLENCE 2003. *Antenatal care: routine care for the healthy pregnant women,* London, RCOG Press.

NATIONAL INSTITUTE FOR HEALTH AND CLINICAL EXCELLENCE 2004a. *Agenda for Change: Final Agreement,* London, RCOG Press.

NATIONAL INSTITUTE FOR HEALTH AND CLINICAL EXCELLENCE 2004b. *Caesarean Section: Clinical Guideline,* London, RCOG Press.

NATIONAL INSTITUTE FOR HEALTH AND CLINICAL EXCELLENCE 2006. *Obesity: Guidance on the Prevention, Identification, Assessment and Management of Overweight and Obesity in adults and children,* London, RCOG Press.

NATIONAL INSTITUTE FOR HEALTH AND CLINICAL EXCELLENCE 2007. *Intrapartum care: Care of healthy women and their babies during childbirth,* London, RCOG Press.

NATIONAL INSTITUTE FOR HEALTH AND CLINICAL EXCELLENCE 2008a. *Antenatal care: routine care for the healthy pregnant women,* London, RCOG Press.

NATIONAL INSTITUTE FOR HEALTH AND CLINICAL EXCELLENCE 2008b. *Induction of Labour: Clinical Guideline,* London, RCOG Press.

NATIONAL INSTITUTE FOR HEALTH AND CLINICAL EXCELLENCE 2010. *Pregnancy and complex social factors: A model for service provision for pregnant women with complex social factors,* London, RCOG Press.

NATIONAL OBESITY OBSERVATORY. 2011. *Epidemiology of maternal obesity* [Online]. Stockton on Tees: North East Public Health Observatory. Available: http://www.noo.org.uk/NOO_about_obesity/maternal_obesity/epidemiology [Accessed July 2011].

NATIONAL PERINATAL EPIDEMIOLOGY UNIT. 2011. *Birthplace in England Research Programme* [Online]. Oxford: National Perinatal Epidemiology Unit. Available: http://www.npeu.ox.ac.uk/birthplace [Accessed May 2011].

NAZROO, J. 1997. *The Health of Britain's Ethnic Minorities,* London, Policy Studies Institute.

NAZROO, J. Y. 2003. The structuring of ethnic inequalities in health: economic position, racial discrimination, and racism. *Am J Public Health,* 93**,** 277-84.

NELSON, M. 1983. Working-class women, middle-class women, and models of childbirth. *Social Problems,* 30**,** 284-297.

NELSON, M. & POPENOE, R. 2001. Looking Within: Race, Class and Birth. *In:* DEVRIES, R., BENOIT, C., VAN TEIJLINGEN, E. & WREDE, S. (eds.) *Birth by Design: Pregnancy, Maternity Care, and Midwifery in North America and Europe.* London: Routledge.

NOLAN, M. 2009. Information giving and education in pregnancy: A review of qualitative studies. *The Journal of Perinatal Education,* 18**,** 21-30.

NOLAN, M. 2010. Childbirth Education: Politics, Equality and Relevance. *In:* WALSH, D. & DOWNE, S. (eds.) *Essential Midwifery Practice: Intrapartum Care*. Chichester: Wiley-Blackwell.

NOTZON, F. C. 2008. QuickStats: rates of cesarean deliveries - selected countries, 2005. *Birth,* 35**,** 336-7.

O'BRIEN, P. 2005. Stemming the rising caesarean section rate. *British Journal of Midwifery,* 13**,** 328.

O'DRISCOLL, K. 1994. Active management of labour. True purpose has been misunderstood. *BMJ,* 309**,** 1015.

O'DRISCOLL, K., JACKSON, R. J. & GALLAGHER, J. T. 1969. Prevention of prolonged labour. *BMJ,* 2**,** 477-80.

O'DRISCOLL, K., STRONGE, J. M. & MINOGUE, M. 1973. Active management of labour. *BMJ,* 3**,** 135-7.

OLDE, E., VAN DER HART, O., KLEBER, R. & VAN SON, M. 2006. Posttraumatic stress following childbirth: a review. *Clin Psychol Rev,* 26**,** 1-16.

OLESKE, D. M., GLANDON, G. L., GIACOMELLI, G. J. & HOHMANN, S. F. 1991. The cesarean birth rate: influence of hospital teaching status. *Health Serv Res,* 26**,** 325-37.

OLSEN, O. 1997. Meta-analysis of the safety of home birth. *Birth,* 24**,** 4-13; discussion 14-6.

OLSEN, O. & JEWELL, M. D. 2006. Home versus hospital birth. *Cochrane Database Syst Rev***,** CD000352.

ONS. 2004. *Average age of mother: by birth order: Social Trends 34* [Online]. London: Office for National Statistics. Available: http://www.statistics.gov.uk/STATBASE/ssdataset.asp?vlnk=7273&More=Y [Accessed July 2011].

ONS 2009. Statistical Bulletin: Who is having babies? London: Office for National Statistics.

ONS 2010. Population Trends: Summer 2011. *In:* SMITH, C. (ed.). London: Office for National Statistics.

ONS. 2011. *Population change* [Online]. Newport: Office for National Statistics. Available: http://www.statistics.gov.uk/cci/nugget.asp?ID=950 [Accessed July 2011].

PAGE, L. 2003. When normal birth is in the minority. *British Journal of Midwifery,* 11**,** 356.

PARANJOTHY, S., FROST, C. & THOMAS, J. 2005. How much variation in CS rates can be explained by case mix differences? *BJOG,* 112**,** 658-66.

PARER, J. T., IKEDA, T. & KING, T. L. 2009. The 2008 national institute of child health and human development report on fetal heart rate monitoring. *Obstet Gynecol,* 114**,** 136-8.

PARER, J. T. & KING, T. 2000. Fetal heart rate monitoring: is it salvageable? *Am J Obstet Gynecol,* 182**,** 982-7.

PARSONS, L., MACFARLANE, A. & GOLDING, J. 1993. Pregnancy, birth and maternity care. *In:* AHMAD, W. (ed.) *'Race' and health in contemporary Britain.* Buckingham: Open University Press.

PASQUALOTTO, F. F., BORGES JUNIOR, E. & PASQUALOTTO, E. B. 2008. The male biological clock is ticking: a review of the literature. *Sao Paulo Med J,* 126**,** 197-201.

PATEL, R. R. & MURPHY, D. J. 2004. Forceps delivery in modern obstetric practice. *BMJ,* 328**,** 1302-5.

PATEL, R. R., PETERS, T. J. & MURPHY, D. J. 2005. Prenatal risk factors for Caesarean section. Analyses of the ALSPAC cohort of 12,944 women in England. *Int J Epidemiol,* 34**,** 353-67.

PATEL, R. R., STEER, P., DOYLE, P., LITTLE, M. P. & ELLIOTT, P. 2003. Does gestation vary by ethnic group? A London-based study of over 122000 pregnancies with spontaneous onset of labour. *International Journal of Epidemiology,* 33**,** 107-113.

PERKIN, M. R., BLAND, J. M., PEACOCK, J. L. & ANDERSON, H. R. 1993. The effect of anxiety and depression during pregnancy on obstetric complications. *BJOG,* 100**,** 629-634.

PETROU, S. & GLAZENER, C. 2002. The economic costs of alternative modes of delivery during the first two months postpartum: results from a Scottish observational study. *BJOG,* 109**,** 214-217.

PETROU, S., KUPEK, E., VAUSE, S. & MARESH, M. 2003. Antenatal visits and adverse perinatal outcomes: results from a British population-based study. *Eur J Obstet Gynecol Reprod Biol,* 106**,** 40-9.

PICKETT, K. E., ABRAMS, B. & SELVIN, S. 2000a. Defining preterm delivery--the epidemiology of clinical presentation. *Paediatr Perinat Epidemiol,* 14**,** 305-8.

PICKETT, K. E., ABRAMS, B. & SELVIN, S. 2000b. Maternal height, pregnancy weight gain, and birthweight. *Am J Hum Biol,* 12**,** 682-687.

PICKETT, K. E., WILKINSON, R. G. & WAKSCHLAG, L. S. 2009. The psychosocial context of pregnancy smoking and quitting in the Millennium Cohort Study. *J Epidemiol Community Health,* 63**,** 474-80.

PICKETT, K. E., WOOD, C., ADAMSON, J., D'SOUZA, L. & WAKSCHLAG, L. S. 2008. Meaningful differences in maternal smoking behaviour during pregnancy: implications for infant behavioural vulnerability. *J Epidemiol Community Health,* 62**,** 318-24.

PLEWIS, I. 2007. Non-Response in a Birth Cohort Study: The Case of the Millennium Cohort Study. *Int. J. Social Research Methodology,* 10**,** 325–334.

PLEWIS, I., CALDERWOOD, L., HAWKES, D., HUGHES, G. & JOSHI, H. 2007. *The Millennium Cohort Study: Technical Report on Sampling. 4th Edition* [Online]. London: Centre for Longitudinal Studies. Available: http://www.cls.ioe.ac.uk/studies.asp?section=00010002000100050004 [Accessed 1st August 2008].

PLEWIS, I. E., CALDERWOOD, L., HAWKES, D., HUGHES, G. & JOSHI, H. 2004. *Millennium cohort study first survey: Technical report on sampling, 4th Edition* [Online]. London: Centre for Longitudinal Studies. Available: http://www.cls.ioe.ac.uk/text.asp?section=00010002000100050004 [Accessed August 2010].

POMA, P. A. 1999. Effects of obstetrician characteristics on cesarean delivery rates. A community hospital experience. *Am J Obstet Gynecol,* 180**,** 1364-72.

POOBALAN, A. S., AUCOTT, L. S., GURUNG, T., SMITH, W. C. & BHATTACHARYA, S. 2009. Obesity as an independent risk factor for elective and emergency caesarean delivery in nulliparous women--systematic review and meta-analysis of cohort studies. *Obes Rev,* 10**,** 28-35.

POTTER, J. E., BERQUO, E., PERPETUO, I. H., LEAL, O. F., HOPKINS, K., SOUZA, M. R. & FORMIGA, M. C. 2001. Unwanted caesarean sections among public and private patients in Brazil: prospective study. *Bmj,* 323**,** 1155-8.

PUTHUSSERY, S., TWAMLEY, K., HARDING, S., MIRSKY, J., BARON, M. & MACFARLANE, A. 2008. 'They're more like ordinary stroppy British women': attitudes and expectations of maternity care professionals to UK-born ethnic minority women. *Journal of Health Services Research & Policy,* 13**,** 195-201.

PUTHUSSERY, S., TWAMLEY, K., MACFARLANE, A., HARDING, S. & BARON, M. 2010. 'You need that loving tender care': maternity care experiences and expectations of ethnic minority women born in the United Kingdom. *J Health Serv Res Policy,* 15**,** 156-62.

QUIGLEY, M. A., HOCKLEY, C. & DAVIDSON, L. L. 2007. Agreement between hospital records and maternal recall of mode of delivery: evidence from 12 391 deliveries in the UK Millennium Cohort Study. *Bjog,* 114**,** 195-200.

RAUH, V. A., ANDREWS, H. F. & GARFINKEL, R. S. 2001. The contribution of maternal age to racial disparities in birthweight: a multilevel perspective. *Am J Public Health,* 91**,** 1815-24.

RAYBURN, W. F. & ZHANG, J. 2002. Rising rates of labor induction: present concerns and future strategies. *Obstet Gynecol,* 100**,** 164-7.

RCOG. 2005. *Operative vaginal delivery: Guideline No. 26* [Online]. London: Royal College of Obstetricians and Gynaecologists. Available: http://www.rcog.org.uk/womens-health/clinical-guidance/operative-vaginal-delivery-green-top-26 [Accessed August 2010].

RCOG. 2009. *RCOG Statement on later maternal age* [Online]. London: Royal College of Obstetricians and Gynaecologists. Available: http://www.rcog.org.uk/what-we-do/campaigning-and-opinions/statement/rcog-statement-later-maternal-age [Accessed February 2011].

RCOG. 2010. *Classification of urgency of caesarean section - a continuum of risk (Good Practice No. 11)* [Online]. London: Royal College of Obstetricians and Gynaecologists. Available: http://www.rcog.org.uk/classification-of-urgency-of-caesarean-section-good-practice-11 [Accessed August 2010].

READ, A. W., PRENDIVILLE, W. J., DAWES, V. P. & STANLEY, F. J. 1994. Cesarean section and operative vaginal delivery in low-risk primiparous women, Western Australia. *Am J Public Health,* 84**,** 37-42.

REDSHAW, M., ROWE, R., HOCKLEY, C. & BROCKLEHURST, P. 2007. Recorded delivery: a national survey of women's experience of maternity care 2006. Oxford: National Perinatal Epidemiology Unit.

RICE, F., LEWIS, A., HAROLD, G., VAN DEN BREE, M., BOIVIN, J., HAY, D. F., OWEN, M. J. & THAPAR, A. 2007. Agreement between maternal report and antenatal records for a range of pre and peri-natal factors: The influence of maternal and child characteristics. *Early Human Development,* 83**,** 497-504.

RICHARDSON, A. & MMATA, C. 2007. NHS Maternity Statistics, England: 2005-06. London: The Information Centre.

ROBERTS, C. L., ALGERT, C. S., CARNEGIE, M. & PEAT, B. 2002. Operative delivery during labour: trends and predictive factors. *Paediatr Perinat Epidemiol,* 16**,** 115-23.

ROBERTS, C. L., TRACY, S. & PEAT, B. 2000. Rates for obstetric intervention among private and public patients in Australia: population based descriptive study. *BMJ,* 321**,** 137-41.

ROBSON, M. S. 2001. Can we reduce the caesarean section rate? *Best Pract Res Clin Obstet Gynaecol,* 15**,** 179-94.

ROBSON, M. S., SCUDAMORE, I. W. & WALSH, S. M. 1996. Using the medical audit cycle to reduce cesarean section rates. *Am J Obstet Gynecol,* 174**,** 199-205.

ROBSON, S. J., TAN, W. S., ADEYEMI, A. & DEAR, K. B. 2009. Estimating the rate of cesarean section by maternal request: anonymous survey of obstetricians in Australia. *Birth,* 36**,** 208-12.

ROGERS, S. 2009. Caesarean birth statistics, hospital by hospital. The Guardian [Online], 28 October 2009, Available: http://www.guardian.co.uk/news/datablog/2009/oct/28/caesarean-birth-statistics-hospital-england [Accessed November 2009].

ROMUNDSTAD, L. B., ROMUNDSTAD, P. R., SUNDE, A., VON DURING, V., SKJAERVEN, R., GUNNELL, D. & VATTEN, L. J. 2008. Effects of technology or maternal factors on perinatal outcome after assisted fertilisation: a population-based cohort study. *Lancet*, 372**,** 737-43.

ROSENBERG, T. J., GARBERS, S., LIPKIND, H. & CHIASSON, M. A. 2005. Maternal obesity and diabetes as risk factors for adverse pregnancy outcomes: differences among 4 racial/ethnic groups. *Am J Public Health*, 95**,** 1545-51.

ROSS-DAVIE, M. 2011. *Re: Continuous labour support, cochrane and more* [Online]. Oxford: JISCMail.ac.uk. Available: https://www.jiscmail.ac.uk/cgi-bin/webadmin?A0=MIDWIFERY-RESEARCH [Accessed February 2011].

ROTER, D. L. & HALL, J. A. 2006. *Doctors Talking with Patients/Patients Talking with Doctors. Improving Communication in Medical Visits: Second Edition.*, Westport, Praeger Publishers.

ROUSSO, D., PANIDIS, D., GKOUTZIOULIS, F., KOURTIS, A., MAVROMATIDIS, G. & KALAHANIS, I. 2002. Effect of the interval between pregnancies on the health of mother and child. *Eur J Obstet Gynecol Reprod Biol*, 105**,** 4-6.

ROWE, R. E. & GARCIA, J. 2003. Social class, ethnicity and attendance for antenatal care in the United Kingdom: a systematic review. *J Public Health Med*, 25**,** 113-9.

ROWE, R. E., MAGEE, H., QUIGLEY, M. A., HERON, P., ASKHAM, J. & BROCKLEHURST, P. 2008. Social and ethnic differences in attendance for antenatal care in England. *Public Health*, 122**,** 1363-72.

ROYAL COLLEGE OF OBSTETRICIANS AND GYNAECOLOGISTS 2001. *The Use of Electronic Fetal Monitoring: The use and interpretation of cardiotocography in intrapartum fetal surveillance. Evidence-based Clinical Guideline Number 8*, London, RCOG Press.

ROZENHOLC, A. T., AKO, S. N., LEKE, R. J. & BOULVAIN, M. 2007. The diagnostic accuracy of external pelvimetry and maternal height to predict dystocia in nulliparous women: a study in Cameroon. *BJOG*, 114**,** 630-5.

RYDING, E. L., WIJMA, B., WIJMA, K. & RYDHSTROM, H. 1998. Fear of childbirth during pregnancy may increase the risk of emergency cesarean section. *Acta Obstet Gynecol Scand*, 77**,** 542-7.

SAHA, S., BARNETT, A. G., BUKA, S. L. & MCGRATH, J. J. 2009. Maternal age and paternal age are associated with distinct childhood behavioural outcomes in a general population birth cohort. *Schizophr Res,* 115**,** 130-5.

SANDALL, J., DAVIES, J. & WARWICK, C. 2001. Evaluation of the Albany Midwifery Practice. Final Report March 2001. London: Florence Nightingale School of Nursing and Midwifery, King's College, London.

SCOTT, K. D., BERKOWITZ, G. & KLAUS, M. 1999. A comparison of intermittent and continuous support during labor: a meta-analysis. *American Journal of Obstetrics & Gynecology,* 180**,** 1054-9.

SEMBER, B. M. 2007. *The Everything Guide to Pregnancy Over 35,* Avon, USA, Adams Media.

SEYB, S. T., BERKA, R. J., SOCOL, M. L. & DOOLEY, S. L. 1999. Risk of cesarean delivery with elective induction of labor at term in nulliparous women. *Obstet Gynecol,* 94**,** 600-7.

SHAW, A. & CALDERWOOD, L. 2004. *Millennium Cohort Study First Survey: Technical Report on Instrument Development and Fieldwork* [Online]. London: National Centre for Social Research. Available: http://www.cls.ioe.ac.uk/studies.asp?section=00010002000100050004 [Accessed August 2010].

SHORTEN, A. & SHORTEN, B. 2007. What happens when a private hospital comes to town? The impact of the 'public' to 'private' hospital shift on regional birthing outcomes. *Women Birth,* 20**,** 49-55.

SIMKIN, P. 1991. Just another day in a woman's life? Women's long-term perceptions of their first birth experience. Part I. *Birth,* 18**,** 203-10.

SIMOES, E., KUNZ, S., BOSING-SCHWENKGLENKS, M. & SCHMAHL, F. W. 2005. Occupation and risk of cesarean section: study based on the perinatal survey of Baden-Wurttemberg, Germany. *Arch Gynecol Obstet,* 271**,** 338-42.

SIMONSEN, S. M., LYON, J. L., ALDER, S. C. & VARNER, M. W. 2005. Effect of grand multiparity on intrapartum and newborn complications in young women. *Obstet Gynecol,* 106**,** 454-60.

SMITH, G. C., CORDEAUX, Y., WHITE, I. R., PASUPATHY, D., MISSFELDER-LOBOS, H., PELL, J. P., CHARNOCK-JONES, D. S. & FLEMING, M. 2008a. The effect of delaying childbirth on primary cesarean section rates. *PLoS Med,* 5**,** e144.

SMITH, J., PLAAT, F. & FISK, N. M. 2008b. The natural caesarean: a woman-centred technique. *BJOG,* 115**,** 1037-42; discussion 1042.

SMITH, L. F. & JEWELL, D. 1991. Contribution of general practitioners to hospital intrapartum care in maternity units in England and Wales in 1988. *Bmj,* 302**,** 13-6.

SMITH, L. F. & SMITH, C. P. 2005. UK childbirth delivery options in 2001-2002: alternatives to consultant unit booking and delivery. *Br J Gen Pract,* 55**,** 292-7.

SMITH, L. J. 2007. Impact of birthing practices on the breastfeeding dyad. *J Midwifery Womens Health,* 52**,** 621-30.

SMITH, P., JAMES, T., LORENTZON, M. & POPE, R. 2004. *Shaping the Facts: Evidence-based Nursing and Health Care,* Edinburgh, Churchill Livingstone.

SMYTH, R. M., ALLDRED, S. K. & MARKHAM, C. 2007. Amniotomy for shortening spontaneous labour. *Cochrane Database Syst Rev***,** CD006167.

SOMERS-SMITH, M. J. 1999. A place for the partner? Expectations and experiences of support during childbirth. *Midwifery,* 15**,** 101-8.

SOSA, R., KENNELL, J., KLAUS, M., ROBERTSON, S. & URRUTIA, J. 1980. The effect of a supportive companion on perinatal problems, length of labor, and mother-infant interaction. *The New England Journal of Medicine,* 303**,** 597-600.

SPENCE, N. J. & EBERSTEIN, I. W. 2009. Age at first birth, parity, and post-reproductive mortality among white and black women in the US, 1982-2002. *Soc Sci Med,* 68**,** 1625-32.

SPIBY, H., GREEN, J., HUCKNALL, C., FOSTER, H. & ANDREWS, A. 2007. *Labouring to better effect: studies of services for women in early labour. The OPAL study (OPtions for Assessment in early Labour),* London, National Coordinating Centre for the Service Delivery and Organisation.

SPROSTON, K. & MINDELL, J. (eds.) 2006. *Health Survey for England 2004: The health of minority ethnic groups. Summary of key findings,* Leeds: The Information Centre.

STEPHANSSON, O., DICKMAN, P. W. & CNATTINGIUS, S. 2003. The influence of interpregnancy interval on the subsequent risk of stillbirth and early neonatal death. *Obstet Gynecol,* 102**,** 101-8.

STURROCK, W. A. & JOHNSON, J. A. 1990. The relationship between childbirth education classes and obstetric outcome. *Birth,* 17**,** 82-5.

SZKLO, M. & NIETO, F. J. 2007. Epidemiology: Beyond the Basics: Second Edition. Jones and Bartlett Massachusetts.

TANG, C. H., WU, M. P., LIU, J. T., LIN, H. C. & HSU, C. C. 2006. Delayed parenthood and the risk of cesarean delivery--is paternal age an independent risk factor? *Birth,* 33**,** 18-26.

TARKKA, M. T. & PAUNONEN, M. 1996. Social support and its impact on mothers' experiences of childbirth. *Journal of Advanced Nursing,* 23**,** 70-5.

TEIXEIRA, J. M. A., FISK, N. M. & GLOVER, V. 1999. Association between maternal anxiety in pregnancy and increased uterine artery resistance index: cohort based study. *BMJ,* 318**,** 153-157.

TEW, M. 1990. *Safer Childbirth? A Critical History of Maternity Care,* London, Chapman and Hall.

THACKER, S. B., STROUP, D. F. & PETERSON, H. B. 1995. Efficacy and safety of intrapartum electronic fetal monitoring: an update. *Obstet Gynecol,* 86**,** 613-20.

THE INFORMATION CENTRE. 2009a. *Table 7: Method of onset of labour, 1980 to 2008-09* [Online]. London: The Health and Social Care Information Centre. Available: http://www.hesonline.nhs.uk/Ease/servlet/ContentServer?siteID=1937&categoryID=1021 [Accessed July 2011].

THE INFORMATION CENTRE. 2009b. *Table 9: Method of delivery, 1980 to 2008-09* [Online]. London: The Health and Social Care Information Centre. Available: http://www.hesonline.nhs.uk/Ease/servlet/ContentServer?siteID=1937&categoryID=1021 [Accessed June 2010].

THE NHS INFORMATION CENTRE. 2008. *Health Survey for England 2007: Latest Trends* [Online]. London: The Health and Social Care Information Centre. Available: http://www.ic.nhs.uk/statistics-and-data-collections/health-and-lifestyles-related-surveys/health-survey-for-england/health-survey-for-england-2007-latest-trends-%5Bns%5D [Accessed January 2010].

THE ROYAL COLLEGE OF MIDWIVES 2007. *Evidence to the NHS Pay Review Body* London, The Royal College of Midwives.

THOMAS, B. H., CILISKA, D., DOBBINS, M. & MICUCCI, S. 2004. A process for systematically reviewing the literature: providing the research evidence for public health nursing interventions. *Worldviews Evid Based Nurs*, 1**,** 176-84.

THOMAS, H. 1998. *Quality assessment tool for quantitative studies* [Online]. Toronto: Effective Public Health Practice Project. McMaster University. Available: http://www.ephpp.ca/Tools.html [Accessed 2011 July].

THOMAS, J. & PARANJOTHY, S. 2001. The National Sentinel Caesarean Section Audit Report. London: Royal College of Obstetricians and Gynaecologists Clinical Effectiveness Support Unit.

THORNTON, J. G. & LILFORD, R. J. 1994. Active management of labour: current knowledge and research issues. *BMJ*, 309**,** 366-9.

THULIER, D. & MERCER, J. 2009. Variables associated with breastfeeding duration. *J Obstet Gynecol Neonatal Nurs*, 38**,** 259-68.

TIRAN, D. 2008. *Bailliere's Midwives' Dictionary: 11th Edition*, Edinburgh, Bailliere Tindall.

TOMEO, C. A., RICH-EDWARDS, J. W., MICHELS, K. B., BERKEY, C. S., HUNTER, D. J., FRAZIER, A. L., WILLETT, W. C. & BUKA, S. L. 1999. Reproducibility and Validity of Maternal Recall of Pregnancy-Related Events. *Epidemiology*, 10**,** 774-777.

TORVALDSEN, S., ROBERTS, C. L., BELL, J. C. & RAYNES-GREENOW, C. H. 2004. Discontinuation of epidural analgesia late in labour for reducing the adverse delivery outcomes associated with epidural analgesia. *Cochrane Database Syst Rev***,** CD004457.

TRACY, S. K., SULLIVAN, E., WANG, Y. A., BLACK, D. & TRACY, M. 2007. Birth outcomes associated with interventions in labour amongst low risk women: a population-based study. *Women Birth,* 20**,** 41-8.

TRAINOR, C. L. 2002. Valuing labor support. A doula's perspective. *AWHONN Lifelines,* 6**,** 387-9.

TROUDE, P., L'HÉLIAS, L., RAISON-BOULLEY, A.-M., CASTEL, C., PICHON, C., BOUYER, J. & DE LA ROCHEBROCHARD, E. 2008. Perinatal factors reported by mothers: do they agree with medical records? *European Journal of Epidemiology,* 23**,** 557-564.

TUDOR HART, J. 1971. The inverse care law. *Lancet,* 297**,** 405-412.

TUNSTALL, H., PICKETT, K. & JOHNSEN, S. 2010. Residential mobility in the UK during pregnancy and infancy: are pregnant women, new mothers and infants 'unhealthy migrants'? *Soc Sci Med,* 71**,** 786-98.

UNIVERSITY OF BRISTOL. 2008. Avon Longitudinal Study of Parents and Children: Representativeness. Available: http://www.bristol.ac.uk/alspac/sci-com/resource/represent/ [Accessed August 2010].

VAN BOGAERT, L. J. 1999. The relation between height, foot length, pelvic adequacy and mode of delivery. *Eur J Obstet Gynecol Reprod Biol,* 82**,** 195-9.

VAN DE POL, G., DE LEEUW, J. R., VAN BRUMMEN, H. J., BRUINSE, H. W., HEINTZ, A. P. & VAN DER VAART, C. H. 2006. Psychosocial factors and mode of delivery. *J Psychosom Obstet Gynaecol,* 27**,** 231-6.

VAN DER HULST, L. A., VAN TEIJLINGEN, E. R., BONSEL, G. J., ESKES, M. & BLEKER, O. P. 2004. Does a pregnant woman's intended place of birth influence her attitudes toward and occurrence of obstetric interventions? *Birth,* 31**,** 28-33.

VIEGAS, O. A., LEE, P. S., LIM, K. J. & RAVICHANDRAN, J. 2008. Male fetuses are associated with increased risk for cesarean delivery in Malaysian nulliparae. *Medscape J Med,* 10**,** 276.

VILLAR, J., CARROLI, G., KHAN-NEELOFUR, D., PIAGGIO, G. & GULMEZOGLU, M. 2001. Patterns of routine antenatal care for low-risk pregnancy. *Cochrane Database Syst Rev***,** CD000934.

WAGNER, M. 2001. Fish can't see water: the need to humanize birth. *Int J Gynaecol Obstet,* 75 Suppl 1**,** S25-37.

WAITZKIN, H. 1985. Information giving in medical care. *J Health Soc Behav,* 26**,** 81-101.

WALDENSTROM, U., HILDINGSSON, I. & RYDING, E. L. 2006. Antenatal fear of childbirth and its association with subsequent caesarean section and experience of childbirth. *BJOG,* 113**,** 638-46.

WALSH, D. 2006. Subverting the assembly-line: childbirth in a free-standing birth centre. *Soc Sci Med,* 62**,** 1330-40.

WALSH, D. & DOWNE, S. M. 2004. Outcomes of free-standing, midwife-led birth centers: a structured review. *Birth,* 31**,** 222-9.

WARD, C., LEWIS, S. & COLEMAN, T. 2007. Prevalence of maternal smoking and environmental tobacco smoke exposure during pregnancy and impact on birth weight: retrospective study using Millennium Cohort. *BMC Public Health,* 7**,** 81.

WATT, G. 2002. The inverse care law today. *Lancet,* 360**,** 252-4.

WEAVER, J. J., STATHAM, H. & RICHARDS, M. 2007. Are there "unnecessary" cesarean sections? Perceptions of women and obstetricians about cesarean sections for nonclinical indications. *Birth,* 34**,** 32-41.

WEI, S., WO, B. L., XU, H., LUO, Z. C., ROY, C. & FRASER, W. D. 2009. Early amniotomy and early oxytocin for prevention of, or therapy for, delay in first stage spontaneous labour compared with routine care. *Cochrane Database Syst Rev***,** CD006794.

WEISS, J. L., MALONE, F. D., EMIG, D., BALL, R. H., NYBERG, D. A., COMSTOCK, C. H., SAADE, G., EDDLEMAN, K., CARTER, S. M., CRAIGO, S. D., CARR, S. R. & D'ALTON, M. E. 2004. Obesity, obstetric complications and cesarean delivery rate--a population-based screening study. *Am J Obstet Gynecol,* 190**,** 1091-7.

WENDLAND, C. L. 2007. The vanishing mother: Cesarean section and "evidence-based obstetrics". *Med Anthropol Q,* 21**,** 218-33.

WHO. 2009. *Monitoring emergency obstetric care: A handbook* [Online]. Geneva: World Health Organization. Available: http://whqlibdoc.who.int/publications/2009/9789241547734_eng.pdf [Accessed August 2010].

WIEGERS, T. A., VAN DER ZEE, J. & KEIRSE, M. J. 1998. Maternity care in The Netherlands: the changing home birth rate. *Birth,* 25**,** 190-7.

WILDSMITH, E. M. 2002. Testing the weathering hypothesis among Mexican-origin women. *Ethn Dis,* 12**,** 470-9.

WILKINSON, C., MCILWAINE, G., BOULTON-JONES, C. & COLE, S. 1998. Is a rising caesarean section rate inevitable? *Br J Obstet Gynaecol,* 105**,** 45-52.

WILKINSON, R. & MARMOT, M. (eds.) 2003. *Social determinants of health: the solid facts. 2nd edition.,* Copenhagen: World Health Organization.

WONGCHAROENKIAT, N. & BORIBOONHIRUNSARN, D. 2006. Maternal height and the risk of cesarean delivery in nulliparous women. *J Med Assoc Thai,* 89 Suppl 4**,** S65-9.

WORLD HEALTH ORGANIZATION. 2006. *BMI Classification* [Online]. Geneva World Health Organization. Available: http://apps.who.int/bmi/index.jsp?introPage=intro_3.html [Accessed January 2010].

WRIGHT, J. B., WRIGHT, A. L., SIMPSON, N. A. & BRYCE, F. C. 2001. A survey of trainee obstetricians preferences for childbirth. *Eur J Obstet Gynecol Reprod Biol,* 97**,** 23-5.

WU, J., VIGUERA, A., RILEY, L., COHEN, L. & ECKER, J. 2002. Mood disturbance in pregnancy and the mode of delivery. *Am J Obstet Gynecol,* 187**,** 864-7.

YEAST, J. D., JONES, A. & POSKIN, M. 1999. Induction of labor and the relationship to cesarean delivery: A review of 7001 consecutive inductions. *Am J Obstet Gynecol,* 180**,** 628-33.

YOUNG, D. 2010. Childbirth education, the internet, and reality television: Challenges ahead. *Birth,* 37**,** 87-89.

ZAHNISER, S. C., KENDRICK, J. S., FRANKS, A. L. & SAFTLAS, A. F. 1992. Trends in obstetric operative procedures, 1980 to 1987. *Am J Public Health,* 82**,** 1340-4.

ZHANG, J., BERNASKO, J. W., LEYBOVICH, E., FAHS, M. & HATCH, M. C. 1996. Continuous labor support from labor attendant for primiparous women: a meta-analysis. *Obstetrics and Gynecology,* 88**,** 739-44.