DOES TEENAGE PREGNANCY AND CHILDBIRTH REALLY INCREASE RISK?: EXPLORING OUTCOMES THROUGH SECONDARY ANALYSIS OF NHS DATA.

By Kim Watts

MSc RGN RM PGCAP

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ABSTRACT

This retrospective cohort study, examined pregnancy and birth related outcomes for 32,895 births between 1st January 1992 and 31st December 2001 in two maternity units in the East Midlands.

The study compared seven outcomes in younger teenagers (≤16 year), older teenagers (17-19 years) and a comparison group (20-25 year olds). The sample included 1105 births to younger teenagers, 6923 to older teenagers and 24867 to the comparative group. 14824 were to primiparous women and 18071 were to multiparous women of which 1711 births to multiparous women were rapid repeat births (≤18 months of a previous birth).

Results showed that compared to those in their early 20s, primiparous teenagers had an increased risk of antepartum haemorrhage (APH) (≤16, OR=1.67, 95% CI 1.262 to 2.227; 17-19, OR=1.48, 95% CI 1.253 to 1.751) and low Apgar score (≤16, OR=1.36, 95% CI 1.102 to 1.669; 17-19, OR=1.15, 95% CI 1.023 to 1.297) but were less likely to have an instrumental birth (≤16, OR=0.64, 95% CI 0.499 to 0.819; 17-19, OR=0.708, 95% CI 0.622 to 0.807) or perineal trauma (≤16, OR=0.63, 95% CI 0.534 to 0.745; 17-19, OR=0.667, 95% CI 0.608 to 0.734). Teenagers had a similar statistical risk as the comparative group for lower segment Caesarean section (LSCS), low birth weight (LBW) and premature birth.

Compared to those in their early 20s multiparous older teenagers had a reduced risk of both instrumental (OR= 0.711, 95% CI 0.555 to 0.912) and perineal trauma (OR=0.863, 95% CI 0.752 to 0.991) but in younger teenagers there was a similar risk. Multiparous teenagers were at an increased risk of premature birth (≤16, OR=1.934, 95% CI 1.153 to 3.243; 17-19, OR=1.227, 95% CI 1.043 to 1.442) but for LSCS, low Apgar score and low birth weight a similar statistical risk was found as the comparative group.

When comparing multiparous teenagers with primiparous teenagers, multiparous teenagers had a reduced risk of instrumental birth (OR=0.429, 95% CI 0.339 to 0.541), perineal trauma (OR=0.668, 95% CI 0.595 to 0.750), low Apgar score (OR=0.782, 95% CI 0.664 to 0.921) and LBW (OR=0.760, 95% CI 0.587 to 0.982) but an increased risk of premature birth (OR=1.269, 95% CI 1.061 to 1.517). For the remaining outcomes both primiparous and multiparous teenagers had a similar statistical risk.

Teenagers having a rapid repeat birth had a reduced risk of instrumental birth (OR=0.32, 0.110 to 0.931) but an increased risk for premature birth (OR=1.617 95% CI 1.150 to 2.272). For APH, Apgar score and LBW teenagers having a rapid repeat birth had a similar statistical risk to those who had not.

In conclusions teenagers should not be treated as a homogenous group and outcomes should be investigated separately for age groupings and parity as teenagers birth well and only APH and neonatal complications are worse in some groups of teenagers.

DEDICATION

I would like to dedicate this thesis to the memory of my late parents; Allan and Eileen. Throughout their lives they were always there as a source of encouragement and support. My mother encouraged me through the start of this study and I made a promise to her that it would be completed; I have now fulfilled that promise.

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ABBREVIATIONS USED IN THE THESIS

APH	Antepartum Haemorrhage
CESDI	Confidential Enquiry into Stillbirths and Deaths in Infancy
CEMD	Confidential Enquiry into Maternal Deaths
CEMACH	Confidential Enquiry into Maternal and Child Health
CMACE	Centre for Maternal and Child Enquires
DfES	Department of Education and Skills
DPA	Data Protection Act
EMPHO	East Midlands Public Health Observatory
FPSC	Family Policy Studies Centre
GDP	Gross Domestic Profit
HES	Hospital Episode Statistics
HIS	Hospital Inpatient System
ICD	International Classification of Diseases
IM&T	Information Management and Technology
LBW	Low Birth Weight
LSCS	Lower Segment Caesarean Section
NICE	National Institute for Clinical Excellence
NSC	National Screening Committee
OECD	Organisation for Economic Co-operation and Development
ONS	Office of National Statistics
OR	Odds Ratio
PSS	Prolonged Second Stage
RR	Relative Risk
SEU	Social Exclusion Unit
SGA	Small for Gestations Age
SPSS	Statistical Package for Social Sciences
SRE	Sex and Relationships Education
STI	Sexually Transmitted Infection
UA	Unitary Authority
UK	United Kingdom
UNICEF	United National Children's Fund
USA	United States of America

CHAPTER 1 INTRODUCTION AND LITERATURE REVIEW

1.1 Introduction

The focus of this thesis is to examine maternal and neonatal birth outcomes in teenagers. Throughout this thesis teenagers have been defined by their chronological age, being a woman aged nineteen years or under at the time of giving birth. Although in many texts the alternative descriptor of 'adolescent' is used to describe these young women, this is less pertinent to this thesis as it is the age parameters that define the cohort of interest rather than their stage in human development.

Teenage conceptions resulting in births are not a new phenomenon in the history of childbearing [1, p.1]. From the historical perspective getting pregnant or giving birth to a child during the teenage years was viewed positively and as a natural occurrence [2]. Socio-politically this was not seen at the time as being negative, but during the latter part of the twentieth century and continuing into the twenty-first century this view has changed.

Since the 1980s the opinion expressed in published literature has been one of negativity, associating teenage pregnancies with poor outcomes for both the mother [3] and child [4, 5]. This literature has been superseded by a vast array of publications from varied disciplines discussing all aspects of teenage pregnancy. These studies have examined the causative factors of teenage pregnancies [6-9], the social outcomes of teenage pregnancy [10-13], and the physical outcomes of teenage births [14-16]. Teenage births have also been highlighted in two United Kingdom (UK) health enquires [17, 18] as being associated with poor maternal and neonatal outcomes. The result of all these publications has culminated in teenage conceptions and births being relabelled as a 'problem' by modern day governments and society as a whole [19, p.1].

Although there is a general consensus within the literature regarding the negative social implications of giving birth as a teenager, this is not the case for birth outcomes. In a review undertaken by Hoffman [20] the conclusion reached was one of uncertainty stating that *'the evidence is not yet solid enough'* (p. 243) to conclude that all aspects of teenage childbearing are negative. This view is supported in more recent evidence as researchers present conflicting findings regarding birth outcomes for teenagers [21-26]. However, the majority of governmental concerns seem to centre on the prevention of conceptions and the social and long term complications of teenage pregnancies, rather than the outcomes surrounding birth [27-29]. The negative views of teenage conceptions and births remain dominant and have been used as the basis for governmental strategies in the UK over the past decade.

Against this background there has been an overall decline in the number of teenage conceptions [29, 30] but this has not affected the proportion that result in births. In 2008 over half of teenage pregnancies in England and Wales resulted in a birth [31] equating to six percent of all live birth registrations in

England and Wales in that year [32]. This continued level of births to teenagers indicates that a substantial number of teenagers do decide to birth, and this choice has been acknowledged by the latest policy documents which now focus on service provision for parenting teenagers [28, 33-35]. However, none of these policies contain specific recommendations regarding the care of teenagers during pregnancy and birth.

This lack of service guidance may in part be due to the uncertainty of whether all teenagers are at an increased risk of poor birth outcomes. As stated by Hoffman [20]: '*teenage mothers are individuals, so they naturally vary in their circumstances, their behavior and their well-being...consequently, there can be no one size fits all*' (p. 236). It is the differing circumstances in which teenagers give birth that will be the focus of this thesis.

In this chapter a brief background will be provided of teenage pregnancy from both an international and national perspective, including a summary of key policy documents produced in England and Wales. This will be followed by an overview of common characteristics of teenagers who go on to give birth. Having provided this background the literature review will then concentrate on maternal and neonatal birth outcomes in teenage women.

1.2 Background

1.2.1 Teenage Pregnancy: An International Comparison

Numerous health organisations in developed countries have identified teenage pregnancy as an area of concern from a public health perspective [36]. A report on teenage pregnancy published in 2001 by the United National Children's Fund [37] provided data on 28 of the 30 countries that were members of the Organisation for Economic Co-operation and Development (OECD). These member countries are all from the developed world and in total produce two-thirds of the world's goods and services (GDP) that are consumed. In total 1.25 million pregnancies were notified for teenage women during 1998 in these 28 countries, of which 500,000 resulted in an abortion and the remaining 750,000 in maternities (ibid).

The UNICEF report placed the UK at the top of the league table having the highest rate of teenage births in Western Europe, and second only in the 28 OECD countries to the United States (USA) [37]. A summary table has been reproduced from the report (Figure 1.1) showing the birth rates for 15 -19 year olds, per 1,000 in the population. The situation portrayed in Figure 1.1 has not changed drastically in the intervening years since its publication and the UK maintains its top position for teenage births in Western Europe [38, 39].

The UNICEF report [37] highlighted the high prevalence of teenage births in countries where English was the main language. In addition while rates of teenage pregnancy in non-English speaking countries had fallen, rates had remained static in English speaking countries. Within the league table six of the top eleven countries as highlighted in Table 1.1, had a first or main language of English and accounted for three quarters of the total teenage births [37].

1.2.1.1 English Speaking Countries

Two studies undertaken by Chandola *et al* [40, 41] one predating the UNICEF report and one following, examined fertility rates in English speaking countries. In both studies similar high levels of early childbearing were observed and a suggested reason was the ethnic and cultural diversity of English speaking countries.

Figure 1.1 The Teenage Birth League

The rates presented are calculated per 1,000 women aged 15-19 years in the population of each country and are for the year 1998 with the age in full years used at the time of the event. (Source- UNICEF 2001 p.4).

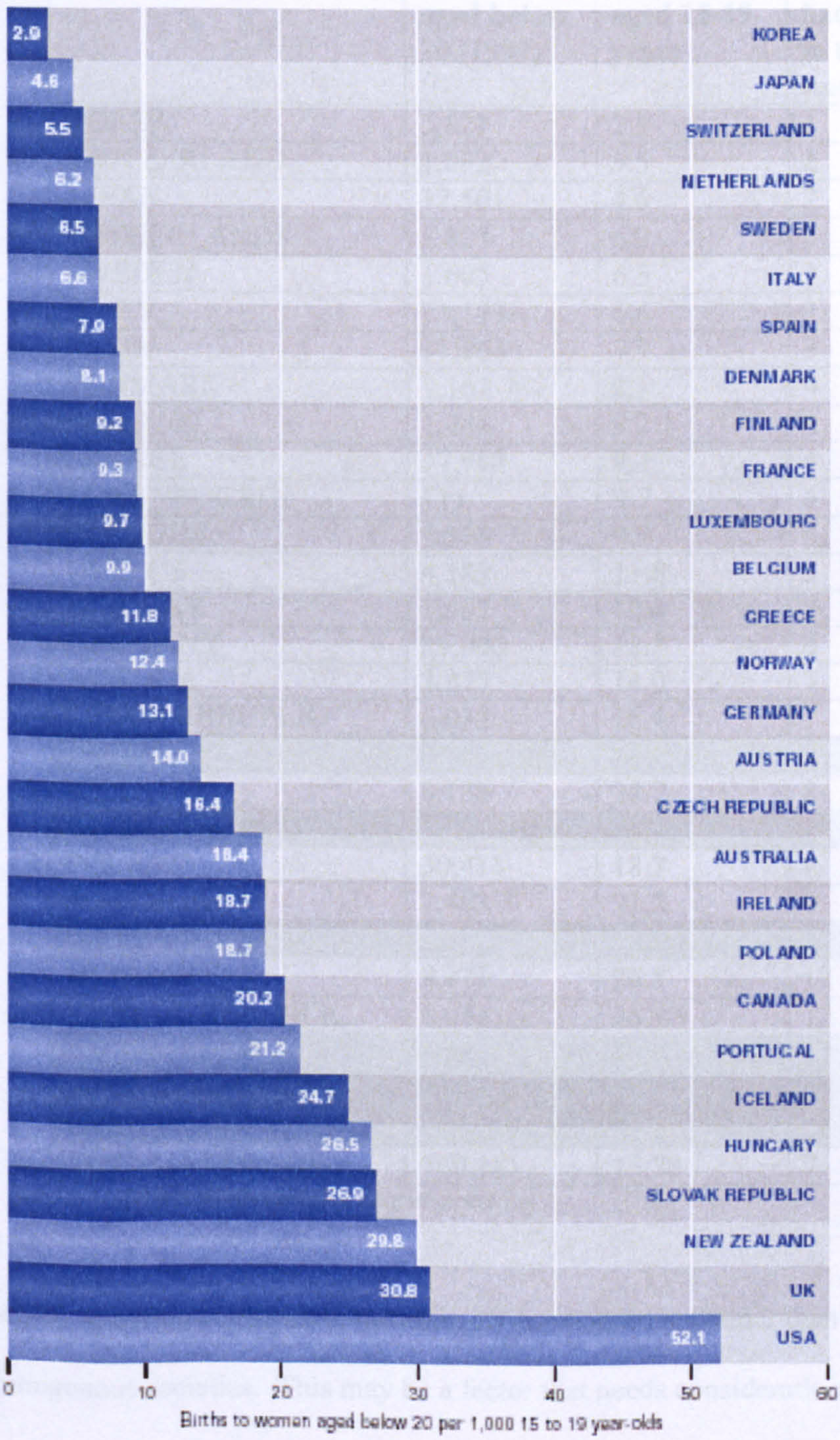


Table 1.1 Number of Teenage Births, Rates and Percentage of Teenage Mothers in a Population. Source (UNICEF 2001 p. 4&6)

	No of Births to women aged below 20 (1999)	Rates per 1,000 women aged 15-19 years	Estimated % of 20 year olds who had a child in their teens
KOREA	5,621	2.9	1
SWITZERLAND	1,092	5.5	2
JAPAN	17,501	4.6	2
NETHERLANDS	2,823	6.2	3
SWEDEN	1,605	6.5	3
ITALY	11,153	6.6	3
SPAIN	11,264	7.9	3
DENMARK	1,161	8.1	4
FINLAND	1,485	9.2	4
FRANCE	17,985	9.3	4
LUXENBOURG	111	9.7	4
BELGUIM	2,975	9.9	4
GREECE	4,183	11.8	5
NORWAY	1,607	12.4	5
GERMANY	29,000	13.1	6
AUSTRIA	3,275	14.0	7
CZECH REBUPLIC	6,035	16.4	7
IRELAND	**3,138**	**18.7**	**8**
ICELAND	3,138	24.7	8
AUSTRALIA	**11,849**	**18.4**	**9**
POLAND	30,413	18.7	9
PORTUGAL	7,403	21.2	9
CANADA	**19,920**	**20.2**	**10**
HUNGARY	9,175	26.5	12
SLOVAK REPUBLIC	6,044	26.9	12
UK	**54,822**	**30.8**	**13**
NEW ZEALAND	**3,924**	**29.8**	**14**
USA	**494,357**	**52.1**	**22**
TOTAL/AVERAGE	760,185	15.78	7

Highlighted countries English speaking

English speaking countries in the main are heterogeneous rather than homogenous societies. This may be a factor that needs consideration when undertaking international comparisons. Variations in the timing of childbearing and pregnancy outcomes are often attributed to culture differences and ethnicity [12, 42] and this area has been researched in several heterogeneous countries.

In America, Maynard [43] and Geronimus [12] have produced discussion papers highlighting possible reasons for higher levels of teenage pregnancies amongst Hispanic and Black populations when compared to Caucasian teenagers. They propose that the influence of cultural acceptance and social influences on these subgroups, within the population appeared to be the main factor for early childbearing. In Hamilton *et als* [44] secondary analysis of nationally collected data in America, higher levels of both conceptions and births were found in Black and Hispanic populations, while a higher proportion of Caucasian pregnancies resulted in terminations.

In Australia two large qualitative studies undertaken on multiple sites focused on teenage health. The first by Smith and Grenyer [45] explored psychological issues of teenage pregnancy and the second by Quine *et al* [46] investigated access to health care for adolescents. In both studies higher rates of teenage pregnancies and births were found in aboriginal populations. In New Zealand a series of large national studies undertaking secondary analysis of national birth notification data, reported similar findings to the Australian studies, again with a higher prevalence of teenage births in Aboriginal and Maori teenagers compared to the white population [47-49].

In Berthoud *et als* [22] UK study variations were noted in the patterns of teenage childbearing between ethnic groups during the 1990s. Caribbean, Pakistani and Bangladeshi women were more likely to have a teenage birth than their white peers and they had more children than white women in the UK. Towards the end of the data collection period in the study, there was a downward trend developing in the South Asian communities that was not present in the two other communities, so the balance was changing.

Further UK studies have focused on aspects of maternal health and parenting in minority ethnic groups. Research by Hawkins *et al* [50] investigated the influence of moving to the UK on maternal health behavior in ethnic minority women, while Higginbottom *et als* [51] qualitative study examined parenting issues of young people from minority ethnic groups. Higginbottom *et als* study found timing of parenting in ethnic minorities was influenced strongly by cultural factors similar to that found by Maynard [43] and Geronimus [12] in the USA.

The variations in the timing of childbearing in minority populations in English speaking countries may, in part, account for higher rates of reported teenage pregnancies and births in these societies. The consensus found in studies undertaken in these countries adds to the weight of this argument but also highlights limitations when drawing international comparisons. Multicultural societies are becoming more of a 'norm' in the western world and as migration increases, especially in younger women, this issue may become more influential in the future [52]. The multicultural phenomenon should not be underestimated when drawing international comparisons and should be taken into consideration when developing national policy or undertaking research into childbearing patterns [21].

Having established that cultural and ethnic differences may impact on teenage conceptions and birth rates within populations, it is also important to consider what impact societal change may have had on teenage childbearing [53].

1.2.1.2 Societal Change

Changes in modern day society have affected the circumstances in which teenagers give birth. These changes have been suggested as first, accounting for differences in rates of teenage pregnancy found between countries and second, on the political views regarding teenage conceptions and births within those countries.

1.2.1.2.1 Co-habitation and Marriage

The change in the pattern of marriage and co-habiting within populations has impacted on the circumstances in which women experience their childbearing. Prior to the 1970s very few teenagers gave birth outside marriage, as a majority of couples conformed with societies views and married after having the pregnancy confirmed, resulting in the birth being registered within marriage [2]. National data sources show a shift in this behavior by the early 1990s, with only a sixth of those teenagers conceiving outside marriage, getting married prior to the birth. This did not mean that all these births were to lone parents, as approximately two thirds of these births were registered to both parents at the same address [54]. This trend has continued throughout the early part of the 21st century, with an increasing number of births registered to couples co-habiting, rather than being married, regardless of age [54-57].

By 2002 in the UK live birth registrations outside marriage were 504 per 1,000 and this rate continues to rise [58]. Although a similar pattern is found throughout Europe, there appears to be a stronger movement in the UK to sole motherhood [59]. As more people choose not to marry and instead co-habit there will consequently be an increase in the number of births registered outside marriage. This is not unique to teenagers and is a trend affecting the whole population not just in the UK but throughout Europe [59-62]. However, the number of sole registrants is higher in younger women than older women in the UK and has been associated with reduced support during pregnancy and early parenting [62].

By the early 1990s the proportion of UK households with a mother as the head of household had risen from 8 percent in 1972 to 22 percent in 1993. Evidence from national data, cites teenage women as being the main reasons for these increases during the 1990s [63]. By 2007 the proportion of children living in a single parent household in the UK was 24% and in majority of cases a woman was the head of these household [64, 65]. In contrast in the USA there has been little change in single parent households, remaining around 9 percent since 1994 [66]. However, in Europe the situation is similar to that found in the UK at 22% [59]. These practices of childbearing outside marriage have had an impact on the support mechanisms drawn on previously to help young mothers and are thought to contribute to the poor outcomes associated with teenage parenting. The literature published on the subject of support for teenagers is vast and could not be included within this thesis but is acknowledged by the researcher as having an impact on the outcomes of birth in teenagers. The more liberal approaches to relationships within societies have been accompanied by an increased openness about sex itself. This has been reflected by the enhancement of sex and relationship education within national curriculums.

1.2.1.2.2 Sex and Relationship Education

The openness of a society as a whole and the extent to which school age children are educated about sex and relationships education (SRE) varies between countries [60]. In some Scandinavian countries this has been offered as a possible explanation for their low teenage birth rates [37] while others conclude after reviewing the evidence that the introduction of SRE has had little impact on teenage pregnancy rates [67].

Any differences in SRE programmes in European countries have narrowed over the last decade, with SRE now part of the curriculum in most European countries. At first some countries avoided SRE as it was felt that to increase the knowledge about sex would lead to increased sexual activity at an earlier age [68-70]. However, in Swann *et als* [71] systematic review the contrary was found and teenagers not receiving SRE while in school, still initiate sex at or before the age of those receiving SRE.

In the UK a 'blanket cover' approach has been adopted to SRE in schools and although national guidelines from the Department for Education and Skills (DfES) were issued in the UK [72] there have still been criticisms in the way SRE is delivered. The Sex Education Forum criticised the use of poorly trained teachers to deliver SRE and identified this as a barrier to the programmes success [73]. Flowerdew [73] went on to suggest the use of school nurses and external input from peer advisors as being more effective than using teachers alone [74]. Swann *et als* review [71] stated that SRE in schools was more effective if it was linked closely with contraceptive services in the local area. In America the picture is similar, Hacker *et al* [6] surveyed 25% of pupils in the 10th and 11th grades in six Boston schools. The researchers found that nearly two thirds of students were sexually active but 65% of these students were not regular users of contraception, even though they had attending SRE in the state system. The main reason provided for none use of contraception was *'they had not considered it'* (p. 285). It was suggested that if the students had been introduced to what local services were available this issue could have been addressed. While the impact of SRE in schools is debated within the published literature [74] the impact of parental support and education is still lacking.

Teenagers repeatedly cite parents as poor providers of information about sex and contraception [75]. A national study undertaken by the Kaiser Family

Foundation [70] found that 50% of teenagers had never talked to their parents about contraception. For girls this mainly occurred after a pregnancy had taken place. If parents were more proactive in talking to teenagers about sex and relationships in general, this would support the actions taken by education. Although the British public are now generally more tolerant of sex, contraception and single parenting they still lag behind the outlook of their European peers in discussing these issues with their children [75]. With this situation still not resolved the SRE is failing to make a substantial impact on the teenage pregnancy rates in the UK. Although educational programmes and parental sources have raised the issue of safe sex and contraceptive use for teenagers, the adoption of using contraception appears to be more dependent on the teenager's individual choice. Teenagers' access to contraception services has been highlighted as an issue of concern, which is thought to contribute to variations in the rates of teenage births between countries.

1.2.1.2.3 Contraception and Abortion

Changes in modern society have included the introduction of more choice over the timing and number of children that women have during their lifetimes. This has mainly been achieved by increased contraception and abortion services being made available to all women. The increased access to these services by teenagers has emerged as a common theme in policy documents in the UK forming the basis for the strategy to reduce teenage conceptions and births [24, 27-30, 76-78]. The driving force behind this approach is the evidence from countries achieving a lower rate of teenage births than found in the UK.

Both the Family Policy Studies Centre (FPSC) [79] and UNICEF [37] state that variations in teenage births may be accounted for by the use of abortion rather than differences in conception rates per se between countries. Singh and Darroch's [42] study used secondary analysis of birth, abortion and population data from 46 countries over a period of 25 years between 1970 and 1995. The study investigated variations in teenage conception outcomes and found that abortion rates were available for only 33 of the 46 countries and abortion rates were varied. In Sweden a country always portrayed within the literature as a success story, achieving the lowest teenage birth rates in Europe also has one of the highest abortion rates when compared to other countries. In 1995 nearly 70% of teenage pregnancies in Sweden ended in abortion in comparison to approximately 40% in England and Wales (ibid). The rates in Sweden were double those found in the USA (34.9%). This illustrates that to compare birth rates alone for different countries may not provide an accurate view of the circumstances and true picture of teenage conceptions and their outcomes in countries. In all three of these countries (Sweden, UK and USA) abortion services are relatively easy to access and a suggested reason for differences in uptake is that the woman's knowledge of the subject varies in the different countries.

Several policy documents in the UK [27-29, 37, 78] and evidence from a review [71] suggest that the lack of access to suitable contraceptive services as being one of the key areas to be tackled, if a reduction in the rates of teenage conceptions is to be achieved. The rationale behind this stems from the quantity of abortions accessed, which is accepted as an indicator that many pregnancies are unplanned and could have been prevented with reliable contraception [60, 80, 81]. Evidence from a number of countries suggests that it is the lack of access to contraceptive services that is the main problem [6, 82-84]. A variety of reasons have been put forward for this, inappropriate opening times of family planning clinics [85], clinics not being in close proximity to local communities and requiring transport to reach [29], lack of confidentiality when accessing GP practices [86], poor publicity of services and information giving [6] and the assumption by some teenagers that certain forms of prescribed contraceptives are harmful [84]. While this information is important in developing service provision, and has been the subject of several research studies [68, 83, 84, 87-89] aimed at evaluating changes to service and personnel who deliver that service, it does not address non-compliance with contraceptive methods.

Non-compliance or lack of use is positively associated with levels of teenage pregnancies. Two papers have been published from the same research team [84, 90], based on a survey of teenagers aged 13-18 years attending a maternity program in America. The research found that regular contraceptive use was associated with a negative attitude to babies rather than a negative attitude to contraception itself. A review undertaken by Cramer [68] in the same year in the UK, compared compliance with prescribed medications and that of prescribed contraceptives. The review found, low compliance with contraceptive prescriptions but this was no different from other medical prescriptions. The deciding factor on whether prescriptions were complied with was how serious the individual viewed the consequences of non-compliance. Cramer (ibid) also found non-compliance more common in younger women than older women, and related this to the stage in development and rebellion traits of teenagers. From the discussion here it is clear that the underlying attitude towards pregnancy may be a key factor not only for teenagers but for most women when examining compliance or use of contraceptives.

1.2.1.3 Summary

The findings of the UNICEF report highlighted increased rates of teenage conceptions and births in English speaking countries with heterogeneous societies rather than homogenous non-English speaking countries. Cultural and societal factors are thought to be the main reasons for these variations.

An area more favourable for comparison when examining teenage childbearing is that of societal change but the impact on teenage childbearing appears to be uniform in all countries. First, the change in pattern of marriage and co-habiting is thought to affect the support mechanisms available for women, especially young women when parenting. Second, the introduction of SRE in schools has raised awareness in teenagers, even though it has not necessarily had a marked impact on contraception use in the UK when compared to other countries. Third, there is a continued drive to increase teenagers interaction with contraceptive services, in both the primary care setting and specialist clinics but this is common in all countries with national targets for reducing teenage conceptions centered on this.

From the comparisons made with other developed countries the UK still has the highest rate of teenage pregnancies in Western Europe and shares a common characteristic with other English speaking countries, that the rates are remaining static. In addition, the numbers of teenage pregnancies that result in births is also high in the UK. Researchers have offered explanations for these findings; differences in sex education, social circumstances and abortion services in countries, with the above findings informing the process of policy formation in the UK. However, the accuracy and consistency of data used to inform policy in the UK is questionable as is the case in other developed countries.

Drawing comparisons between data sourced from different countries has been criticised by some authors [21, 57]. The main reasons given are that the data presented are often collected using different methods and the definitions used to collect the data may vary. Arai [21] in particular draws attention to the inappropriate nature of rates being compared when reproductive behaviour and outcomes of pregnancy in European countries are so varied. The evidence presented so far has made little reference to the occurrence of miscarriage and what impact this may have on the comparisons being drawn.

Some datasets collect data on conception rates and the accuracies of these has already been questioned as to their completeness [91] while others collect data on actual births. This second method is viewed as more accurate but fails to take into consideration variations in contraception and abortion service available within countries.

1.2.2 Teenage Pregnancy: The National Picture

Moving on from this international comparison with its identified difficulties, the national context of teenage pregnancy in England and Wales will now be considered but limited to the demographic and policy aspects of teenage pregnancy within the UK.

The rates of teenage pregnancy and their reduction have been central to UK governmental policy since the early 1990s [29, 92]. Although the 'Health of the Nation' document [92] set many targets for improving public health, it provided the first specific target for the reduction of teenage conceptions in women under 16 but did not include targets for older teenagers. The target set was to reduce conceptions in younger teenagers by 50%, from a rate of 9.6 per 1000 in 1989 to 4.8 per 1000 by the year 2000. Before the end of the target period the reductions in teenage conceptions had not fallen as expected [93] and clear links were made between teenage conceptions and social inequalities [94]. This was summarised in a press release from the then Minister for Health, Tessa Jowell in which she stated:

'Teenage conceptions tend to be both a symptom and a cause of social inequality. They can become a cycle of deprivation' [95].

The extract, taken from a speech on current inequalities in health, indicated that the drive to reduce teenage pregnancies and births was central to the government's policy of reducing health inequalities. Pregnancies and births in the teenage years had been linked with long term implications for the health and socio-economic wellbeing of the mother and child [96-100]. With the realisation that the Health of the Nation target would not be achieved the UK government renewed its drive to tackle this problem.

The Social Exclusion Unit (SEU), established in 1997, was a specially formed unit, part of the Labour government's strategic approach to tackling inequalities. It continues to undertake projects in specific areas and attempts to identify solutions to preventing social exclusion, ensuring mainstream services are accessible for all in the population [101]. Teenagers who become pregnant are often described as socially excluded [21] and exhibit characteristics that fit the remit that the SEU was established to address. Therefore, it was no surprise that it produced one of the most influential documents on the subject, a 'Teenage Pregnancy Strategy' [29].

The strategy highlighted the negative consequences of teenage pregnancies and births and reiterated the negative comparisons with other countries in Europe. The SEU document set targets that both changed the context and widened the parameters of teenage childbearing. For England and Wales new targets concentrated on reducing 'unwanted' conceptions not specified in previous documents but appearing to acknowledge the findings of researchers that some teenagers choose to become parents [90, 102, 103]. The targets set by the SEU addressed two aspects of teenage pregnancy. The first, to halve the number of conceptions in teenagers aged 18 years and under, while maintaining a downward trend in teenager conceptions in under 16 year olds by 2010. The second, to achieve a 60% participation of teenage mothers aged 16-19 in education or employment training to reduce the risk of long term social exclusion by 2010. These ambitious targets were to be achieved by adopting *'a co-ordinated approach to tackling the problem'* and acknowledged that *'governmental measures alone would not succeed'* [76, p.4]. The recommendations of the report follow the ethos of the 'New Public Health' agenda, with 'joined up' approaches and multi-disciplinary working for professionals from a variety of disciplines and backgrounds [104, p.35, 105, p.viii]. This co-ordinated approach, like other policy documents of the time, [77, 106, 107] highlighted the role that health professionals could play in tackling this 'problem'.

1.2.2.1 Achievement of National Targets for Teenage Pregnancy

The overall figures quoted in national reports do show a marked reduction in teenage conceptions since the introduction of the strategy [30, 76, 78]. In 1990 teenage births accounted for 7.86% of all births in the UK [108] and although fluctuations are evident during the intervening time period (7.2% in 1997 and 7.6% in 2000) in 2007 teenagers accounted for only 6.2% of the births in the

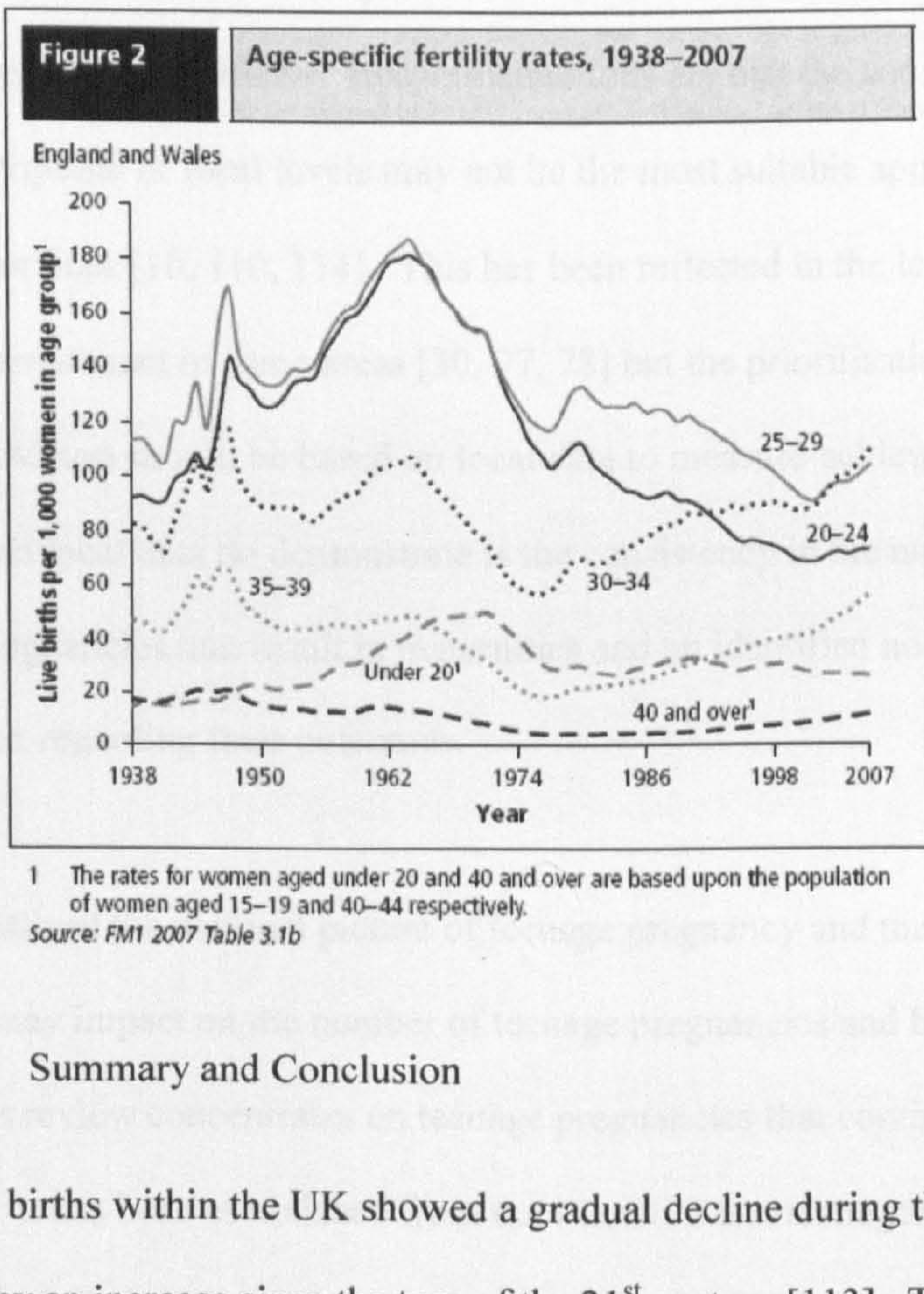
UK [39]. Latest figures from the Office of National Statistics and the Teenage Pregnancy Unit [109] show a reduction in the rate of conceptions in both under 18 year olds and under 16 year olds between 1998 and 2008. The rates for under 18 year olds had fallen from 46.6 per 1,000 in 1998 to 40.4 per 1,000 in 2008, a reduction of 13.3%. For the corresponding years the rates in under 16 year olds have fallen from 8.8 per 1,000 to 7.8 per 1,000. Although this reduction shows progress towards the targets set by the government, the data indicates that the targets set in the SEU strategy for halving the number of under 18 conceptions will not be met across England by 2010 [67].

A criticism of quoting national statistics is that they mask variations that are present between geographical areas [110]. The latest data produced by the Office of National Statistics and the Teenage Pregnancy Unit [31] illustrates this point with marked differences in teenage pregnancies at a local level. Within England and Wales there was an 8.8% fall in teenage conceptions between 1998 and 2007 but when examining the data by district or unitary authority (UA) level the results are very different. For example in Stafford there was a 29.6% increase in teenage conceptions while a 41.9% reduction was recorded in Ryedale [31]. These variations between districts indicate that care is needed when considering measurements against national targets and that local statistics are more useful when planning service provision than overall national data. A secondary caution is that interchangeable terms are used to measure progress, in this case 'percentage reductions' and 'rates of occurrence' and this adds to the difficulty when interpreting findings.

For the area in which this study has been conducted the rate of teenage conceptions has only fallen by 3.3% between 1998 and 2007 (74 to 71.6 rounded) far less than that required by the national target [29]. This rate (71.6 per 1000) is the third highest in the country (71.6 per 1000 aged 15-17 years) and in addition the local abortion rate is in the bottom seven in the country at 35% (rate for England and Wales 48%) [31]. The combination of these two characteristics locally, have resulted in a large proportion of teenage conceptions resulting in births.

The consideration of teenage birth rates should not be viewed in isolation from that of the general population and this issue has been raised by other researchers. Lawlor and Shaw [25] in their paper highlight that progress against set targets for teenage pregnancy rates are often viewed in isolation from trends in national birth rates. When this is considered the reality is that previously, teenage births rates have followed a similar trend to those found nationally. During the 1990s live birth rates in the overall population fell from 648,138 in 1995 to 604,441 in 2000 in the UK [111], a similar trend was found in teenage rates and corresponded with the initiation of the national targets [112]. With the turn of the 21st century overall birth rates increased, reaching the highest levels in 2008 (708,711) since 1972 (725,440) with a total fertility rate of 1.97 [113, p.86]. This latter upward trend is not as marked in teenagers and between 2007 and 2008 the fertility rate increased in all age groups except the under 20s. These trends are illustrated in Figure 1.2. taken from the ONS data [113, p.86]. From the data presented above it is difficult to conclude whether trends in teenage conceptions can be purely attributed to the teenage strategy implementation or whether the rates would have declined with the general trend of the population anyway.

Figure 1.2 Live Births to Women in England and Wales (Source ONS 2008, p.86)



1.2.2.2 Summary and Conclusion

Generally births within the UK showed a gradual decline during the 1990s followed by an increase since the turn of the 21st century [113]. This later upward trend has not been as marked in teenagers, who now account for 6.5% of births [32] in comparison to 7.86% in 1990 [108]. The impact of the governmental strategy on this fall is not conclusive and it is unclear whether through natural variations these current rates may have been achieved [67].

However, the reduction achieved since setting the targets does not follow the trajectory success by the strategies deadline, this year (2010).

The presentation of national data masks the true picture of teenage pregnancy on a local level in the UK. There are marked variations in teenage pregnancy rates between local areas and deprivation is associated with higher levels of teenage pregnancy and births. Recommendations are that the use of national targets at regional or local levels may not be the most suitable approach when planning services [10, 110, 114]. This has been reflected in the levels of financial investment in some areas [30, 77, 78] but the prioritisation stage of service provision should be based on local data to measure achievement. What national and local data do demonstrate is the consistency in the number of teenage pregnancies that result in maternities and an identified need for information regarding their outcomes.

Having outlined the national picture of teenage pregnancy and that local variation may impact on the number of teenage pregnancies and births, the last part of this review concentrates on teenage pregnancies that continue and result in a birth. It has been established from the literature that teenagers who continue with their pregnancies may be at an increased risk of poor outcome due to their social circumstances but whether teenagers are at risk from a biological perspective has yet to be determined.

1.3 Teenagers Giving Birth

1.3.1 Identification of the Literature

The literature reviewed in the remainder of this chapter is not a systematic review; it is a review of published papers providing an insight into teenagers who choose to birth and the resulting maternal and neonatal birth outcomes in those teenagers. A systematic review was not considered appropriate for three reasons. First, the published literature was diverse in terms of methodologies employed and the populations included in the studies were varied, as a result these did not loan themselves to comparison when adhering to a systematic review process. Second, recommendations from other systematic reviews included in this literature review indicated the need for further primary research taking into consideration appropriate associated risk factors examining birth outcomes in teenagers. Lastly, for some of the outcomes examined within this study there was no published literature that specifically presented findings for teenagers.

The literature presented has been identified by conducting electronic searches of databases and on-line journal sites. The electronic databases accessed were: OVID, EMBASE, MEDLINE, MIDIRS, COCHRANE, Web of Science, PUBMED and CINAHL, the search of electronic journals were numerous but concentrated on the disciplines of Obstetrics, Midwifery and Social Sciences.

With all literature reviews it is important to identify appropriate search terms to increase the rigour of the papers identified. As stated by Jones the undertaking of *'keyword searching may not retrieve results because different authors may assign different words for the same phenomena'* [115, p.41] and this is particularly relevant to teenage pregnancy. Within the literature various terms have been used by authors to describe women who birth during their earlier reproductive years. These terms include 'young mothers' [116], 'adolescent mothers' [117, 118], 'schoolgirl mothers' [119] and 'teenage mothers' [23, 120-122]. It was therefore important to include all these terms when searching the literature. The search terms used were: teenage(r), teenage(r) pregnancy(ies), teenage(r) birth(s), teenage(r) birth outcomes, adolescent, adolescence, adolescent pregnancy(ies), adolescent birth(s), adolescent birth outcomes, young mothers, school girl mothers. These terms were also combined with additional specific terms such as first or initial births, primiparity, primiparous, second or subsequent births, repeat births, rapid repeat births, multiparity, multiparous, antenatal complications, intrapartum complications, birth complications, postpartum complications, deprivation, social exclusion, smoking, late booking, antepartum haemorrhage(APH), premature birth, instrumental birth, forceps, forceps birth, ventouse, ventouse birth, vacuum, vacuum birth, Lower Segment Caesarean Section (LSCS), perineal trauma, Apgar score, and low birth weight (LBW).

The electronic searches were supplemented by hand searching relevant journals and contacting authors for specific publications from grey literature and thesis sources. Secondary references in identified papers also provided additional articles for inclusion in the review.

It is important when undertaking a literature review to set parameters when searching the literature to ensure the review remains focused and pertinent to the area of enquiry [115, p.37]. The subject of teenage pregnancy and birth has been acknowledged as being complex and multifaceted [19] and as a result a vast amount of literature has been published. While it is acknowledged by the author that all aspects are of equal importance for a clear and indepth understanding of teenage childbearing, only literature pertinent to the undertaking of this study has been included. In addition to this two further limitations have been applied to this review. Only literature published since 1980 has been included and only literature published in English. There has been no limitation applied to the type of evidence included in this review although it is acknowledges that certain sources are viewed as a higher quality than others [123].

The literature has been presented first concentrating on characteristics of teenagers who choose to birth and second maternal and neonatal outcomes of those teenagers. The last section of this review will examine repeat pregnancies and timing between pregnancies and whether these factors have an impact on maternal and neonatal outcomes.

1.3.2 Characteristics of Teenagers Who Birth

It has been noted by previous researchers that teenagers who continue their pregnancies often share common characteristics with each other and these will now be described and relevance to birth outcomes will be discussed.

1.3.2.1 Impact of Deprivation and Social Exclusion on Teenage Pregnancy Rates

Numerous researchers [124-126] have offered varying explanations for fluctuations in teenage pregnancy and birth rates but most draw the conclusion that social influences are responsible for these differences. Variations in rates of pregnancies and births are linked closely to levels of deprivation, with the highest rates of teenage conceptions and maternities occurring in the most deprived districts and lower rates in the most affluent areas [24]. The levels of deprivation are classified using established deprivation indices [127-130] which have been widely used to measure the impact of deprivation on health outcomes.

In a study by McLeod [131] using Scottish hospital episode data, deprivation levels and the timing of maternities for young women were compared between the 1980s and the 1990s. McLeod included all teenagers within the study but subdivided the teenagers into three groups to present the results. The study [131] found that the yearly pregnancy rates in the most deprived areas increased from 7.0 to 12.5 per 1,000 in 13-15 year olds and from 67.6 to 84.6 per 1,000 in 16-17 year olds, whilst for the same period in the most affluent areas the rates were static at 3.8 for 13-15 year olds and 28.9 per 1,000 for 16-17 year olds. For 18-19 year olds for the same time period there was a fall in conceptions in the most affluent areas and a rise in deprived areas, with a positive association with maternities in deprived areas in comparison to abortions for the more affluent.

In a similar study undertaken in England, Smith [114] analysed hospital episode data for young women accessing maternity and abortion services and compared postcode deprivation indices for birth outcome. Smith (ibid) found pregnancy rates were six times higher in more deprived areas and of those pregnancies occurring in affluent areas, two thirds ended in abortion, in comparison to only a quarter in the deprived areas. There are several factors that are thought to cause these differences in conception and birth rates in teenagers from differing social backgrounds.

1.3.2.2 Early Commencement of Sexual Activity

The level of sexual activity amongst teenagers has increased since the 1960s and this is closely linked with an increase in the number of teenage births at that time [126]. Although generally this increase is seen in all populations the commencement of sexual activity varies with deprivation. Smith and Eleander [110] reported in a study carried out with 201 young women aged 13-15 years, that teenagers from deprived areas were sexually active at an earlier age than those from a more affluent area. This commencement of early sexual activity combined with a low use of contraception, increasing the risk of teenage pregnancies in these teenagers [132]. In addition to the above findings, the method of contraception used by these youngsters initiating sex early is often not the most effective method available [133]. In parallel to this increased earlier sexual activity is the increased risk of sexually transmitted infections (STIs) [78]. Within the teenage population there has been an increased prevalence of Chlamydia infections, gonorrhoea, genital herpes and genital warts over the past decade and all these infections can complicate pregnancies and future childbearing [134].

1.3.2.3 Poor Educational Attainment

One of the main drivers for governmental policy is to encourage young women who parent to engage with educational or vocational activities, as many teenagers who parent leave school at an early age [29]. Whether this is as a result of the pregnancy occurring by chance or whether the teenagers plan the pregnancy has been investigated by researchers. In Bonell *et als* [10] study they examined external causative factors that may increase the risk of teenage conceptions. Two main risk factors identified were that of deprivation and a dislike for school often resulting in exclusion from school. Although the authors acknowledged that deprivation and dislike for school were independent risk factors, both increased the young woman's risk of a conception. Within the study young women who disliked school were at the highest risk and viewed a pregnancy as being 'inevitable' or a 'positive' outcome.

The value that a teenager places on school attendance is often influenced by home life and parental influence [135]. Lee *et al* [136] found that teenagers who gave birth were more likely to have uneducated parents who showed little interest in school work. Specifically, it is the teenagers' low expectations about education and employment opportunities that increase the risk of having a pregnancy coupled with the perceived reduced choices for young women [137]. From these studies it can be concluded that having negative role models and poor education attainment are common characteristics' in high teenage pregnancy rates.

1.3.2.4 Family influences

The childbearing patterns of close family members have been linked with a teenager's risk of a conception and subsequent birth. Teenagers who have mothers, who experienced a teenage birth, are more likely to go on and have a teenage birth themselves and this is often referred to as 'self-perpetuating' in the literature [138]. Rendall [57] describes this pattern of childbearing in subsequent generations as *'cyclical in nature'* (p.27). The influence of other family members should also not be discounted when examining teenagers who choose to birth. Geronimus [12] found that family patterns of childbearing in older siblings also increased the risk for younger teenagers and referred to this behavior as *'fertility timing norms...'* (p. 885). This familial influence is not unique to the USA and is found in most countries both developed and undeveloped throughout the world.

1.3.2.5 Lone parenting

Within a previous section of this chapter (p.10) the influence of changing relationships in society and its impact on childbearing circumstances has been discussed. However, this did not consider the impact of changing family circumstances on teenagers childbearing. The increasing number of lone parent households with the mother as the head of household has increased [139] and these have been linked with increased teenage pregnancies [140].

The influence of a father being present in the family home reduces the risk of early sexual activity [140, 141] and also the risk of teenage pregnancy [142]. These findings were confirmed in a longitudinal cohort study by Ellis *et al* [143] undertaken in the USA and New Zealand. In both cohorts biological father absence was a high risk factor for both early sexual activity and teenage pregnancy. However, the presence of a two parent family alone did not reduce the risk, as stepfathers and multiple father figures were associated with an increased risk of teenage pregnancies [144]. The presence of two biological parents in a household has been linked with better communication regarding relationships and also is thought to set a positive example to parenting within marriage [145].

The impact that family influence can have on teenagers is not limited to pregnancy alone but also the acquisition of other harmful lifestyle choices many of which young pregnant teenagers exhibit. These will be discussed in the following section.

1.3.2.6 Health Related Behaviour in Teenagers

The teenage years are a time of experimentation and a time when many harmful lifestyle practices are first experienced such as smoking, substance misuse and alcohol. Teenagers who become pregnant often experiment with these lifestyle choices at an early age, with similar social class variations as seen in the adult populations [146].

1.3.2.6.1 Alcohol consumption

The general household survey completed in 2005 [147] found that 36% of young women aged 16-24 consumed more than the national guidelines for alcohol in a week and 22% consumed twice the national guidelines in a week. When examining younger teenagers aged 11 to 15 years 22% had consumed alcohol during a week and this percentage rose to nearly half (45%) of 15 year olds girls when considered alone. The recommendations for alcohol consumption in pregnancy are currently to avoid alcohol but if the woman does continue to drink in pregnancy a maximum should be 1-2 units twice weekly [148]. Stromland [149] ranks excessive alcohol consumption during pregnancy as the most serious of all substance abuse due to the frequency of the disorder and the damage it can do to the fetus. The effects on the fetus are wide ranging from organ damage in the first trimester to growth restriction and neurological complications in the second and third trimesters. In several cases the symptoms manifested in the neonate are labelled as 'fetal alcohol syndrome', first described by Jones *et al* [150] in 1973. Although higher levels of alcohol affect all pregnancies the levels of alcohol highlighted in the general household survey for teenagers exceeds safe levels stated in the NICE guidelines. This would place teenagers who continue to drink while pregnant at an increased risk of fetal and neonatal complications.

1.3.2.6.2 Smoking

Rates for smoking have fallen in the general population but areas of deprivation still have a higher prevalence than affluent areas. In 2005 only 23% of women smoked in comparison to 41% in 1974 [133] but higher rates are still found in younger women under the age of 24 in comparison to older women. In 2007 at age 11 years, eight percent of girls reported themselves as regular smokers in comparison to only five percent of boys [151]. This is probably caused by the acquisition behaviour being higher amongst girls than boys [152, 153]. and that girls were more likely to continue to smoke due to peer pressure [153, 154].

The national infant feeding survey undertaken in 1995, found that half of teenage smokers continued to smoke throughout pregnancy compared with only a third of women in other age groups [155]. Smoking is associated with preterm birth, low birth weight, miscarriage, stillbirths, sudden infant death and respiratory conditions in women of all ages [156-159]. In addition research has consistently linked teenagers who smoke during pregnancy with poor outcomes [152, 160-162]. The impact of smoking during pregnancy is well established and should be considered when investigating birth outcomes in teenagers.

1.3.2.6.3 Substance Misuse.

Substance misuse is still a high priority from a public health perspective among young people but national data is showing a decline in overall drug use in teenagers [163]. Data from 2007 collected from surveying 8,000, 11 to 15 year olds found that 25% of teenagers had tried an illegal substance in the past year compared with 29% in 2001 and this is similar amongst girls as boys.

Cannabis still remains the drug most frequently used by younger teenagers, followed by solvents but many teenagers take a combination of substances [151]. Teenagers that have experimented with drugs report having done so on a casual basis and as a result are not classified as 'addicts' but early use can lead to a progression onto hard drugs at a later age [163].

Teenagers who become pregnant tend to exhibit a higher risk taking behaviour than their peers and may be smokers, drink alcohol or take non-prescribed substances or multiples of these before and while pregnant [164]. In one Australian study [164] teenagers between the ages of 12 and 17 years, attending for pregnancy care at three obstetric hospitals were invited to take part in a study of illegal drug use. Findings from the study were that a fifth of the teenagers reported using marijuana during pregnancy and a third of these used a combination of different substances while pregnant. Of the remaining four fifths of teenagers, half had been users prior to having the pregnancy confirmed. In teenagers that had been or continued to use drugs there was an increased incidence of concurrent cigarette or alcohol use. Although the study does portray an exceptionally high rate of substance misuse both before and during pregnancy the authors do not state that the areas in which the study was conducted were atypical demographically to other districts. These high rates of substance misuse have not been reported in the UK [163, 165] but do provide an indication of the level of risk taking behavior in some teenage populations.

The general risk taking behaviour appears to be higher among those teenagers that become pregnant and although prevalence data is not widely available for pregnant teenagers, many of these young women experiment with more than one risk taking behavior besides unprotected sex. In the mother herself there are higher levels of STIs recorded in pregnancy [164] which often are associated with premature births and neonatal infections [166, 167].

1.3.2.7 Summary

More teenagers that become pregnant and go onto give birth are from deprived backgrounds. Many initiate early sexual activity and as result are more at risk of teenage conceptions. Teenagers that initiate having sex earlier are also less likely to use contraception or a reliable form of contraception. Low educational attainment and low expectations of future employment are associated with an increased risk of teenage pregnancy and teenagers who dislike school or feel socially excluded appear to view a pregnancy as a positive outcome rather than being a negative event.

Certain family characteristics are associated with an increased risk of teenage conceptions. More teenagers become pregnant and give birth if their mother had a teenage pregnancy or their older siblings gave birth as teenagers. Also, young women who give birth during their teenage years are more likely to come from a single parent family, where the biological father is no longer in contact.

Teenagers who become pregnant are also more likely to engage in 'risky' health related behaviours, which may have long term consequences for their own and their children's health. These behaviours are often not curtailed during pregnancy which is in contrast to other women and are associated with increased risk of poor outcomes at birth.

1.3.3 Maternal Outcomes in Teenagers

Within the literature maternal outcomes in teenagers have been examined from two separate stances that of social and physical consequences. Some authors have attempted a more experimental approach to researching this group of women to provide closer comparisons for outcomes, including studying sisters [168], comparing twins [169], and comparing teenagers of the same age who had a birth with those who had a termination [98]. These studies have been designed to reduce variations in social circumstances and measure differences in longer term social outcomes, not variations in birth outcomes in these women. Studies that examine the pregnancy and birth outcomes are mainly retrospective in nature as they require the collection of data over a long period of time. Studies using this methodology provide the majority of the evidence reviewed in the following sections.

1.3.3.1 Accessing Antenatal Care

Routine antenatal care for low risk pregnancies has been revisited in the UK and minimum standards of care have been issued as a guideline by the National Institute for Clinical Excellence (NICE) [148]. The main focus of these guidelines remains the same as for previous antenatal care, to prevent and detect complications that could affect maternal or fetal wellbeing. The guidelines are designed to set a minimum standard for care and promote equity in access to care for all women. Women are advised to book for care before 10 weeks gestation but many teenagers do not achieve this.

The pattern that teenagers adopt for care often differs from that seen in other groups of women. Konje *et al* [170] examined booking and antenatal attendance in 3,000 women using a retrospective case study approach. The study examined patterns of care and obstetric outcomes in young teenagers ($\leq$16) compared with women in their early twenties. Twice as many teenagers booked after 25 weeks gestation when compared to the control group but patterns of attendance in follow-up antenatal care were similar in both groups. It was suggested by the researchers that majority of teenagers were still at school and had not planned to become pregnant, therefore, may have failed to recognise the signs of pregnancy which may explain the later bookings.

Teenagers' pregnancy intention can impact on the timing of presenting for care. In Arudu *et als* study [171] 625 teenagers presenting for diagnosis of pregnancy, before 22 weeks gestation, were identified from hospital records in a specialist clinic for teenagers. Of these teenagers 48.2% of teenagers continued with the pregnancy, 45% had a termination and the remaining teenagers had a miscarriage. Teenagers who were requesting termination presented earlier for diagnosis than teenagers who continue with the pregnancy, with nearly half (45%) presenting after 12 weeks gestation.

In a separate study [172] examining antenatal care among 533 pregnant teenagers (<18 years) 47% entered antenatal care post 12 weeks gestation. Young women were 4.2 times more likely to book late if they no longer had a partner and 3.2 times more likely if they had not had a previous abortion. Late entry was also more likely if the women were unemployed (OR=1.9), either white or black (non Hispanic) (OR=1.9 and 1.7 respectively) and less educated (OR=1.2). In contrast women who had not consumed alcohol in the past month and had only one partner in the last 12 months were more likely to present earlier for care. Wiemann *et al* propose that pregnancy intention is the key underlying factor that affects timing of booking in teenagers.

When drawing conclusions from American studies it should be noted that access and type of prenatal care varies according to ability to pay. Hueston *et al* [173] in a longitudinal study focused on changes in the initiation of prenatal care in teenagers and found that although teenagers were booking earlier in more recent times, this was linked with expansion of Medicaid coverage. Thus suggesting this may have been a barrier prior to this initiative, rather than teenagers choosing not to book at an earlier gestation.

A review examining social class, ethnicity and access to antenatal care found links between booking late and poor subsequent attendance with deprivation [174]. Rowe *et als* review included papers examining antenatal attendance of women in the UK. Variations in attendance for antenatal care were compared between social class and ethnic group. This review found that teenagers on the whole do book later for care and their attendance for routine visits may be more sporadic. This behavior can impact on pregnancy outcomes, as late booking removes the opportunity for routine antenatal screening tests. Antenatal screening programmes are designed to increase the early detection of fetal anomalies and reduce the number of affected pregnancies that continue to term [175].

1.3.3.2 Fetal Anomalies

A higher prevalence of specific anomalies are reported in teenagers when compared to the general population, these affect the central nervous system, alimentary tract and musculoskeletal systems [23]. The majority of these anomalies would be detected through routine screening with resulting options being offered of termination, planned treatment or continuation of the pregnancy.

The circumstances surrounding conceptions may influence the outcome of the pregnancy. Neurological and alimentary tract anomalies may be reduced if folic acid intake has been increased prior to conception and continued during the first 12 weeks of gestation but this requires planning of a pregnancy [176, 177]. The aetiology of the other anomalies affecting teenagers is less well known but data from the ONS National Congenital Anomaly System shows that women aged under twenty have the highest prevalence of abdominal wall defects at 9 per 10,000 births [178].

All the above listed anomalies would be detected at the 18-20 week anomaly scan, if the woman has booked early enough for this to take place. The lack of planned pregnancies and the late booking found in teenagers may account for an increased prevalence of these complications and the lower detection rate in teenagers. The continuation of these pregnancies may impact on the neonatal outcomes at birth.

1.3.3.3 Anaemia

Antenatally teenagers are reported to have a higher incidence of anaemia in pregnancy than women from other age groups. A diagnosis of anaemia is made, if at booking, the haemaglobin level is less than 11g/dl or has fallen to below 10.5g/dl in the third trimester of pregnancy [179, p.88]. Anaemia diagnosed in pregnancy before the 21st week of gestation has been associated with an increased incidence of premature birth [180] and should be treated if diagnosed.

In a large UK study [181] that analysed hospital episode data on approximately 340,000 women in the south of England, young women under the age of 18 years were 1.82 times more likely to be anaemic than women aged 18-34 years. Diagnosis of anaemia was at the 10 g/dl level which is lower than used in other studies. However, this study did not adjust for social class during the analysis, which is associated with poor dietary intake, a contributory factor to developing anemia.

A retrospective chart review undertaken in Israel [182] in a homogenous group of 565 teenagers (13-18 year olds) found that 41% of teenagers had a haemoglobin of less than 11 g/dl at the start of pregnancy. This rate was much higher than in the adult population giving birth. In Berenson *et als* [183] American study of similar size a comparison was made between primiparous teenagers aged 15 years and younger, and their older peers (16-17 and 20-22 year olds). Younger teenagers again were more likely to experience anaemia than their older peers (22% v 16% and 6%). In both studies [182, 183] the researchers offered poor diet due to deprivation, as the main cause of the anaemia rather than age per se.

Studies by Williams *et al* [184] and Wellings *et al* [102] both found that women on state benefits were unable to afford a diet meeting the recommendations of dieticians for a healthy pregnancy. As a large proportion of teenagers are thought to live in poverty [184, 185] and may also receive state benefits this has been suggested as a primary cause of the incidence of anaemia found in teenage pregnancies.

1.3.3.4 Hypertensive Complications and Teenagers

Hypertensive complications during pregnancy are still cited as a major cause of maternal morbidity and mortality [186, 187]. Early studies [3, 188] found that teenagers have a higher incidence of hypertensive disorders in pregnancy than other age groups, but this has been disputed by more recent publications [183, 189, 190]. As a large proportion of women are choosing to delay their childbearing until later, the incidence of hypertensive disorders and other pre-existing medical problems have increased in pregnancy. These conditions affect older women rather than teenagers and this may be the reason for differences found between earlier and more recent studies.

1.3.3.5 Antepartum Haemorrhage

The complication of antepartum haemorrhage (APH) in teenagers has been debated within the literature. APH affects two to five percent of all pregnancies [191] but dependent on the classification of APH it is normally associated with higher parity and increased maternal age [192]. In Ananth *et als* study data was derived from a fourteen year dataset containing over 120,000 women who had birthed in the province of Nova Scotia during the 1980s and early 1990s. Analysis was undertaken on singleton pregnancies to examine the risk of placental abruption, placenta praevia and uterine bleeding of unknown etiology. Multivariate models were used to generate odds ratios after adjusting for confounders. Ananth *et al* found that there was a slight increase (RR 1.3) in the risk of abruption among young women (aged under 20) compared with women aged 25-29 years. However, in direct contrast it was women over the age of 40 who had a nine fold increased risk than women aged under 20 of placenta praevia. When parity was considered the risk of having either a placenta praevia or abruption was only increased in young women with a higher parity. The authors suggested that it may be the closeness of the pregnancies in younger women that increases the risk of placental complications but it was not clear whether this aspect was investigated within this study.

In a commentary by Sinhu and Kuruba [193] additional risk factors for APH were suggested. These include smoking, cocaine use, multiple pregnancy, previous placenta praevia, previous terminations and intrauterine surgery including Lower Segment Caesarean Section (LSCS) some of which teenagers experience.

In a large retrospective cohort study on five million women in America, Yang *et al* [194] found an increased risk in women having a second birth for placenta praevia and abruption following a LSCS. This risk was increased by 47% for praevia and 40% for abruption. Within the analysis age was included as a confounder in the multivariate models but no information was provided of the effect age had on the model outcome.

Although teenagers are reported to have a lower LSCS rate than older women, they do share some of the additional risk factors for APH. The research by Ananth *et al* [192] and the characteristics of having additional risk factors in teenagers highlights the need for further research in this area.

1.3.3.6 Premature Birth

Moser *et al* [195] defines premature birth as a birth occurring before the completion of the 37th week of pregnancy and this definition has been adopted in this thesis. Premature births complicate approximately 7.4% of all pregnancies in England and Wales, with the degree of prematurity being closely linked to the degree of compromise found in the neonate [196].

Policy documents continue to state that all teenagers are at a higher risk of preterm births [27, 28, 35] but the evidence from research is less conclusive with differences found in teenagers of different ages and gravida. Secondary analysis of a large retrospective cohort study [162] found a higher incidence of moderate (33 to 36 weeks gestation) and severe (24 to 32 weeks) preterm births but only in multiparous teenagers; primiparous teenagers were not at an increased risk. Teenagers included in the study were aged 15-19 years and therefore this does not provide any evidence for younger teenagers giving birth. The reverse was found in a smaller study undertaken on 2541 births in Brazil [197]. In this study it was younger (<18 years) primiparous teenagers that were at an increased risk of preterm birth (OR=1.77; 95% CI 1.02 to3.08), when compared to a comparative group of women aged 25 to 29 years. Older

(18-19 years) multiparous teenagers however, were not at an increased risk when compared to the control group. The difference in findings between these two studies [162, 197] may in part be explained by the inclusion of different confounders' during analysis and the populations involved. Two factors may have contributed to the differences observed. In da Silva *et als* study social circumstances were included in the analysis in contrast to Smith and Pell's study and the two study populations varied in ethnicity and age range.

In America a large (n=approx 900,000) cross sectional analysis [198] of national birth certificate data, was used to compare preterm birth in multiparous women aged 10-20 years, with multiparous women aged 25. Throughout the adolescent years multiparous women were at an increased risk of very preterm births (<33 weeks gestation). The adjusted Odd Ratios decreased as the teenagers grew older, ranging from 4.22 (95% CI 2.26 to 7.88) at age 10-14, to 1.33 (95% CI 1.24 to 1.41) at aged 20 years. Similar patterns were found in all ethnic groups but there were disparities present. During modeling smoking and short interpregnancy interval were adjusted for but this did not change the findings.

Differences in the incidence of premature birth have also been reported in earlier studies [199-201] indicating that teenagers should not be treated as a homogenous group. Alternative explanations have been suggested by some researchers for the higher incidence of premature birth in teenagers. Fraser *et al* [200] identified a link between preterm birth and pregnancies occurring within two years of menarche. The young gynaecological age of the teenager, and the fact that the teenager is still growing herself, are thought to contribute to the risk of premature birth. A systematic review [202] endorses some of the views of Fraser *et al*, suggesting the continued growth of the teenager may have a negative impact on the nutrition available to the growing fetus, and as a result impair the placental functions of 'stabilising the pregnancy', resulting in premature birth. An alternative more simple explanation for this high incidence of preterm births in teenagers is one of simple miscalculation. da Silva *et al* [197] offers the explanation that incorrect calculation of dates due to poor history and late bookings, preventing accurate dating scan information, may result in the misclassification of teenage births as being premature.

The links between teenagers and premature birth have been identified by previous researchers but there is inconsistency in the evidence presented. There appears to be differences in outcome for teenagers having an initial or subsequent birth and there are more variations when considering the age of the teenager and the time elapsed between births. It is difficult to draw any strong conclusions from the evidence presented here and further research is required.

1.3.3.7 Mode of Delivery in Teenagers

One of the main causes of adverse outcomes for both the mother and the neonate is the process of birth itself, but whether some women as a result of their age, are at an increased risk of adverse outcomes is still an area of debate. The promotion of normality and minimal intervention are the aims of modern maternity services [33, 34, 203] but this is in conjunction with the appropriate use of intervention when clinically indicated. The main indicators for such interventions are maternal and neonatal compromise, which often result in operative birth [204].

Researchers often use the type of birth a woman experiences to compare how women 'perform' during childbirth and these comparisons include whether any differences in a woman's characteristics, such as age, increase an individual's risk of complications. This is the approach adopted when examining teenage birth outcomes. The majority of studies identified in the literature have used data that is routinely collected in maternity hospital episode systems and researchers have completed retrospective secondary analysis on the data available.

1.3.3.7.1 Mixed Parity Studies

In a large American study undertaken by Amini *et al* [36] computerised data for a nineteen year period between 1975 and 1993 was used to examine obstetric outcomes in teenagers. Data were available for 69,096 births of which 19,234 were to teenagers aged 12 to 19 years. The researchers divided the teenagers into two groups, younger teenagers aged 12-15 years and older teenagers aged 16-19 years. Both groups of teenagers were compared with the remainder of the adult population (20 years and over). In primiparous teenagers, LSCS was higher in younger than older teenagers (12.1% and 11.7%; $p=0.57$) but the rates were nearly half that found in the adult population (20.1%; $p<0.001$). All teenagers in this study had higher rates of vaginal births than older women (86.6% and 88% versus 81.5%) but the researchers did not indicate what proportion of these vaginal births were assisted or unassisted. Except for the analysis on primary LSCS the researchers do not identify what proportions of the births were to women having a first or subsequent birth, in other studies this has been reported as affecting the birth outcomes.

Geist *et als* [182] study in Israel, included women who were either Jewish or Muslim, both cultures that in Israel marry earlier and where pregnancy is desired and planned at an early age. Although this study was relatively small in comparison to other studies reviewed (n=565), the authors describe this group of women as 'clean' (p.190) unique as a cohort and lacking in confounding variables experienced elsewhere in other countries such as deprivation. As a result the impact of age alone could be assessed on birth outcome. Young women aged 19 years and younger were compared for birth outcome with the remaining women birthing at the hospital. Rates for instrumental births were much higher in the teenage group than the control (17.4% v 4.25%). These authors suggested this may be explained by having more primiparous teenagers in comparison to the older women.

There are some limitations of this study, nowhere in the study does it mention the size or characteristics of the comparative group and this population is very different from other studies undertaken on teenagers. The pregnancies in teenagers are planned and as a result the teenagers access antenatal care from early in pregnancy, which is contrary to that observed elsewhere [172]. Over a quarter of the teenagers included in this study were married at the time of birth, which again is very different to other populations. In contrast where other authors have struggled to control for confounders or have been critised for doing so, this is not the case in this study. However, whether the results of this study are as generalisable has to be questioned as the population is not representative of those found in most other countries.

A study that is more generalisable, is one undertaken in the South of England which involved the secondary analysis of the St Mary's Maternity Information System database which contained data on over 340,000 women giving birth in North West Thames [181]. The study included all women aged under 35 at the time of birth regardless of their parity. Teenagers aged 17 years and younger were compared with women aged 18 – 34 years for pregnancy complications and birth outcomes. Conclusions from the study were that the teenage group had fewer inductions, operative vaginal births and LSCSs than the comparative group and a higher incidence of normal births. The authors acknowledged that socio-economic variations were not adjusted for within the analysis and this may have had a bearing on the results. Although parity was included in the logistic regression models no separate results were presented for first and subsequent births.

1.3.3.7.2 Primiparous Teenagers

A small study (n=382) undertaken in Hong Kong [205] including only primiparous singleton births, used a retrospective case control method to compare birth outcomes. Primiparous teenagers aged 19 years and younger were identified as the study group and the first woman aged 20-34 years who birthed after the study participant, on the same day was selected as a control. Maternal demographics, labour, birth and perinatal outcomes were compared between the study and control groups. The teenagers in the study had a higher term normal birth rate (85.3% v 82.3% NS), fewer instrumental (18.5% v 42.9%, p<0.001) and LSCS births (3.8% v 9.4, p<0.001) than women aged 20-34 years. Lao and Ho [205] study completed a subset analysis comparing younger teenagers (<17 years) with their older peers (17-19 years) but found no significant differences between the two groups. The researchers concluded that for teenagers in a relatively affluent society, who received adequate antenatal care, they had reached physical maturity as far as reproduction was concerned and were comparable to the control group.

A UK study undertaken in South Glamorgan [189] compared birth outcome data using secondary analysis on 66,271 primigravid women aged 34 years and under at the time of giving birth. Women aged under 20 were compared with 20-34 year olds for pregnancy and intrapartum outcomes. Teenagers were twice as likely (OR=2.1, 95% CI 2.0- 2.3) to have a normal birth and were at a reduced risk of both instrumental (OR=0.5, 95% CI 0.5-0.6) and LSCS births (OR=0.4, 95% CI 0.4-0.5) when compared with older women. Comparisons again were repeated for teenagers under 17 and those aged 17-19 years but no statistically significant differences were found. This was in contrast to the findings of Amini *et al* [36] who found differences between younger and older teenagers for LSCS rates.

1.3.3.7.3 Multiparous Teenagers

Only one study was identified that provided separate data on multiparous teenagers and made comparisons between multiparous teenagers and older multiparous women. Mahfouz *et al* [190] conducted a study in Saudi Arabia comparing teenage women under 20 years with women aged 20-35 years. The study included both primiparous and multiparous women and for analysis the two categories of women were analysed separately by parity. Stratified random sampling was used to identify a cohort of 1938 pregnant women, screened during pregnancy for anaemia and hypertensive disorders, and followed through to birth to observe mode of delivery. In multiparous teenagers the rate of abnormal deliveries (6.9%) was significantly lower (x^2=16.9, $p<0.05$) than older multiparous women (13.2%). The definition of abnormal deliveries in the study included, forceps, breech and LSCS combined together which is very different to the categorization adhered to in the primiparous studies. However, as no other studies were found for comparison it is difficult to make a judgment of the study's validity.

1.3.3.8 Summary

Amini *et al* found a slight difference between younger and older teenagers regarding LSCS but this has not been reported in any other studies in this review. All of the studies [36, 181, 182, 205] found that teenagers were less likely to have a LSCS. However, within these studies differences in the type of LSCS included in the analysis varied so the overall picture remains inconclusive. There is also some criticisms of the failure to include consistent associated risk factors when completing analysis especially socio-economic measures [206], as this has been linked with higher levels of LSCS [207] in the general population.

Only one study [182] found that teenagers were at an increased risk of instrumental birth but the limitations of this study have already been discussed. Five of the studies [36, 181, 189, 190, 205] drew the conclusions that teenagers perform well when giving birth regardless of parity but these studies did not provide any evidence of whether there are differences in outcomes between first and subsequent births in teenagers. In summary a full comparison of birth outcomes in teenagers has not been achieved within the literature and research is required to address these shortfalls.

1.3.4 Perinatal Outcomes for Teenagers

This section of the literature review will be limited to discussing outcomes in the initial neonatal period surrounding birth, that are outcomes assessed immediately at the time of birth and during the initial examination of the neonate following birth.

1.3.4.1 Neonatal Apgar Scores in Teenage Births

The initial assessment of neonatal wellbeing is conducted by the person attending the birth. This assessment takes the form of the Apgar Score [208] which is an integral part of neonatal assessment in practice. The Apgar score is a scale of 0 to 10 and if low (below 7) triggers the need for further resuscitation and aids the planning of care to achieve optimal neonatal outcome (further details can be found on page 308). This assessment has been used by researchers as an indicator of neonatal wellbeing when comparing birth outcomes but its use in studies focusing on teenagers is limited.

Only three studies were identified that used Apgar score as an indication of neonatal wellbeing in teenagers and their findings were inconclusive [14, 16, 183]. Berenson *et als* small American study included only 147 nulliparous teenagers aged 15 and under and used Apgar score as an indicator of neonatal wellbeing. Apgar scores were recorded at the five minute post delivery mark and no statistically significant differences were found between these young teenagers and the comparative groups of older teenagers (16-17 years) and young adults (20-22 years). These findings were similar to a further small study undertaken by Usta *et al* [16] in the Middle East.

A large American study [14] included data on nearly four million nulliparous pregnant women aged under 25 years found lower Apgar scores in younger teenagers. The women in the study were split into four age groups, < 16, 16-17, 18-19 and 20-24 years. Apgar scores were categorized as very low Apgar (<4) or low Apgar (<7) recorded at five minutes. Teenagers aged <16 had a higher relative risk (RR) for both very low Apgar score (RR=1.2 9, 95% CI 1.20 to 1.39) and low Apgar score (RR=1.24, 95% CI 1.19 to 1.29) in comparison to all other age groups. The authors repeated the analysis on white married women only (excluding those under 16) and adjusting for socioeconomic factors, status and alcohol use during pregnancy but the results remained the same. The authors proposed that the differences in outcomes between the present study and previous studies may be due to sample size issues and selection bias.

All three of these studies have been undertaken on nulliparous teenagers and no studies were identified examining data for multiparous teenagers. In order to inform service provision it is important to have a complete picture of possible compromise in all teenagers therefore further research is required to address this gap in the evidence.

1.3.4.2 Low Birth Weight and Teenagers

All babies are weighed at birth by the health professional attending the birth and dependent on the findings may trigger additional care if the neonate is thought to be compromised. Data are then recorded in Hospital Episode Data Systems and on birth notifications that can then be used to formulate national statistics.

Neonates who are born prematurely are often categorized as low birth weight (LBW) [209]. Care must be taken in clarifying the difference between a neonate born prematurely and also being low weight and a neonate born prematurely and being an appropriate weight. For this review it is the compromised neonate born with a weight that is lighter than expected at term that will be focused on.

1.3.4.2.1 Difficulties with National Categories of Low Birth Weight

In the general population the proportion of neonates born with a LBW in England and Wales is seven percent [210] but for teenagers this proportion is increased to nine percent of births [23]. An anomaly with national statistics is that they do not take into consideration the influence that ethnicity has on birth weight [211, 212]. There is an established association between women from some minority ethnic groups having smaller neonates but this does not always equate to the neonate being compromised. Findings of a study [211] developing customized growth charts plotted variations of growth between different ethnic groups. This demonstrated that it was important to use individual charts tailored to ethnic populations when assessing fetal growth [211].

Parental characteristics are also influential when considering LBW and should always be taken into consideration if the population is diverse [211, 212]. Wilcox *et al* found that paternal stature influenced the weight of the neonate even if the mother was of average stature, the difference in birth weight was nearly a fifth of a kilogram (183g) but on completion of regression analysis it was paternal height that was the key indicator. The multicultural nature of UK society has already been established within this review but this is not reflected when producing national norms for birth weight used for comparison purposes.

1.3.4.2.2 Ethnicity/Deprivation and Low Birth Weight in Teenagers

When considering the impact of ethnicity on LBW in America a study by Reichman and Pagnini [201] compared birth weight between teenagers and older women. When adjusting for socio-economic indicators and educational attainment, younger black adolescents (less than 15 years) were more likely to have a low birth weight neonate than other groups. In contrast, when white teenagers were compared with older white women, other groups as well as teenagers were at risk of LBW. Younger teenagers under 15 had the highest risk compared to 25-29 year olds, but older women over 40 years, were very close to younger teenagers in risk. The authors also concluded that if appropriate adjustments were made during multivariate analysis, then not all teenagers were at an increased risk of LBW and majority of the risk was explained by socio-economic circumstances. However, this paper [201] did not take into consideration the parity of women when drawing conclusions, which may impact on the levels and rate of LBW observed in teenagers.

Several studies have identified a link between LBW and ethnic differences in neonates in deprived populations [47, 48, 199]. In all three of these studies teenage women from minority ethnic groups, that had a LBW neonate, were also from deprived backgrounds. These close links between ethnicity, deprivation and young childbearing, are all key when trying to gain an insight into this complication in teenagers.

However, the increased prevalence of LBW infants in women from more deprived areas suggests that the link may be more a social and ethnicity problem, than purely a complication of age alone [94, 198, 213]. As social class and ethnicity appear to be contributing factors to the occurrence of LBW, it is important to adjust for these factors when designing and analysing any further studies.

1.3.4.2.3 Influence of Social Support and Low Birth Weight in Teenagers

Lone parenting as a teenager has been presented as having a negative effect on neonatal outcomes including LBW [141, 214] but Botting *et al* [23] found the converse of this when completing secondary analysis of national data. Although teenagers overall had neonates with lower birth weights in comparison to the average for the general population within marriage (3145 v 3321 grams), neonates born to teenagers outside marriage and living with both parents had heavier neonates (3224 grams). Support mechanisms and improved nutritional intake for teenagers who lived at home with their parents, were suggested as possible explanations for these differences.

1.3.4.3 Neonatal Mortality Rates and Teenagers

The infant mortality rates in the UK have consistently improved over the last three decades across all age groups and many now consider the rate to be the lowest achievable [104, 215]. Variations in infant mortality rates have been associated with differences in marital status, social class and infant birth weight. In repeated Infant Feeding Surveys [155, 216] teenage mothers were seen to experience a higher infant mortality rate than other women across all social groups. The picture is particularly marked in lower 'socio-economic groups', as more teenagers are present in this group than any other.

The infant mortality rates include the incidence of stillbirth, which has also been reported as being higher in younger women [217]. There are dangers when drawing comparisons of stillbirth rates in different age groups due to the differing rates of termination for abnormality. Older women are provided with enhanced early antenatal screening when compared to teenagers [175]. This allows abnormalities that may result in a stillbirth to be detected earlier and the pregnancy may as a result be terminated. In many cases this is not true in teenagers as they book later for care and teenage pregnancies may have progressed to a later stage, beyond the gestation for legal abortion to take place. As a result, the outcome of the pregnancy may be a fetus incompatible with life that will be recorded as a stillbirth. It is for this reason that some conclusions drawn regarding increased rates in some age groups must be treated with a degree of caution. Although new recommendations and guidelines for screening for anomalies will address some of these differences [175] the papers on which policy is based will not have taken this into consideration.

1.3.4.4 Summary

The discussion above clearly indicates that there are several questions still to be clarified on the direct influence age alone has on neonatal outcomes. There is a debate in the literature as to whether teenagers are at an increased risk of having a neonate who is compromised at birth measured by low Apgar score. Suggested differences in findings have been that some studies [16, 183] are underpowered but all studies have provided only evidence for nulliparous women or have not differentiated between parity in women included.

All of the studies examining Apgar score have included women who had assisted births. As a result it is difficult to establish whether it is an underlying complication that has caused the low Apgar or whether it is the birth process itself. Therefore, it is difficult to establish whether all teenagers are at risk of low Apgar in all birthing situations.

LBW in teenagers appears to have a higher prevalence than that found in older women but it is difficult to determine whether it is age alone that is a risk factor, or whether ethnic and social circumstances are the main cause. As a high proportion of teenagers who birth are from deprived areas and are also from minority ethnic groups in multicultural societies, they exhibit increased risk factors for LBW than older women in the same populations. Taking this into consideration there is a need for further research to be undertaken in this area, adjusting for the risk factors of ethnicity and deprivation to inform clinical practice for teenagers.

Although neonatal and infant mortality rates are higher in teenagers there are anomalies in the care that has been accessed by different age groups. This should be taken into consideration when drawing comparisons using crude data. Age specific screening services may disadvantage teenagers and younger women as diagnosis of abnormality may not be achieved. Teenagers often book later for care and as a result miss the opportunity for early screening to detect risk of anomalies. This may increase the number of births to teenagers that would otherwise have been terminated, and as a result increase the perinatal mortality rate recorded for teenagers.

1.3.5 Initial and Repeat Births in Teenagers

Within England and Wales around 20% of births that occur in under 18 year olds are to teenagers who are already mothers [76]. This equates to some 8,504 births based on 2008 figures in the UK [113]. So far the literature that has been reviewed has examined maternal and neonatal outcomes in either first birth, or has not differentiated between first or subsequent births within the findings with the exception of one small study [190] which concentrated on multiparous teenager outcomes. None of these studies have examined differences in outcomes between first and repeat births in teenagers. Within this next section this aspect will be explored.

In Smith and Pell's study [162] separate analysis for first and second births was completed when examining birth outcomes in teenagers. In this retrospective cohort study birth outcomes were compared between teenagers (15-19 years) and a comparative group (20-29 year olds). Over 110,000 births in Scotland were identified and stratified for first and second births in non-smoking women. There were only three intrapartum outcome measures included in the study; stillbirth, preterm delivery and emergency LSCS (see page 46 of thesis for findings regarding preterm).

For first births in teenagers the risk of having an emergency LSCS was half that of the comparative group (OR=0.5; 95% CI 0.5 to 0.6) and these odds remained lower for second births in teenagers (OR=0.7; 95% CI 0.5 to 1.0). In second births to women aged 15-19 the risk of stillbirth was increased (OR=2.6, 95% CI 1.3 to 5.3) but not in first births. The authors did not report on any other modes of birth, therefore it is still uncertain whether there are any differences in other birth outcomes in first and repeat births in teenagers.

Mortality rates for neonates were examined in one American study [218] where parity and infant mortality were tracked for 46,985 teenage mothers. The teenagers were aged 11 to 19 years and only singleton births with a newborn weight of over 500 grams were included in the study. Deaths were identified through death certificates linked to birth certificates and cause of death was classified using International Classification of Diseases (ICD) codes. Parity in the study was classified as the number of live births including the study neonate. Hellerstedt *et al* found that higher order neonates of teenagers were at an increased risk of mortality in comparison to firstborns. For all multiparous teenagers the risk of having a neonatal mortality was twofold even after adjusting for confounders. These differences were greater in the post neonatal period, rather than in the immediate period following birth. The authors concluded that the higher levels of neonatal mortality in multiparous teenagers was due to environmental, rather than physical causes and suggested further research in the direction of social and economic investigation. Although this study provides information about mortality in neonates, it does not provide any information regarding neonatal outcomes immediately following birth.

Four further studies [11, 219-221] were identified in the search but these concentrated on the risk factors of repeat pregnancies rather than examining maternal and neonatal birth outcomes. A further three studies examined risk factors [222] and attitudes [90, 223] towards repeat pregnancies but introduced the term of rapid repeat births in teenagers.

1.3.5.1 Rapid Repeat Births in Teenagers

The amount of time that lapses between pregnancies has been noted as having adverse effects on birth outcomes in women generally [224, 225]. In Rawlings *et als* study neonatal birth outcomes in America were examined in white and black women. A short interpregnancy interval was defined as a subsequent conception occurring less than 6 months following a first birth. Neonatal outcomes of the second births were compared with those of women who had conceived after 6 months of a first birth. Pregnancies following a short interpregnancy interval were at an increased risk of both LBW and preterm birth. The short interval between pregnancies was more common in black rather than white women, and may explain some of the variation reported in neonatal birth outcomes between ethnic groups.

A similar study undertaken in Scotland [225] concurs with the findings of Rawlings *et al* [224]. The same interpregnancy interval definition was used to examine neonatal outcomes of interuterine growth restriction, extreme (24-32 weeks) and moderate (33-36 weeks) preterm birth and perinatal death. Similar exclusion criteria were also applied as in the previous study [224]. The findings of this study were an increased risk of premature birth, increased intrauterine growth restriction and stillbirth in pregnancies with a short interpregnancy interval. The authors concluded that mothers with short interpregnancy interval were more likely to have had a complicated first birth and to have demographic risk factors for birth complications.

In one further study [226] designed to test the optimum time between births to reduce adverse neonatal outcomes, 173,205 singleton neonates were included who were born alive to multiparous women in Utah. The optimum interval to reduce neonatal complications was conceiving between 18-23 months following a first birth. As found previously [224, 225] conception within 6 months of a first birth resulted in the highest neonatal complications.

These three papers provided a strong evidence base that short pregnancy intervals are detrimental for neonatal outcomes in women generally but they do not provide any insight into variations that may occur between different age groups or maternal outcomes following a short interpregnancy interval. This lack of evidence may stem from difficulties in tracking women having subsequent births especially within the UK.

1.3.5.2 Identification of More Than One Birth to the Same Woman

A possible reason for the reduced volume of literature in the area of interpregnancy interval or repeat pregnancies is the inherent problem of tracking women during their whole obstetric history. This is the result of researchers having difficulty identifying and linking women from the data available [227]. This may account for the lack of comparisons between initial and subsequent pregnancies and the resultant limited conclusions that have been drawn about differences in maternal outcomes in this situation.

Some of the difficulty may stem from the epidemiological data collection method used nationally for registration of births in the UK. Currently only past obstetric histories are taken for women who are married when registering a birth, while for single women registering a birth alone, no previous obstetric outcomes and history are recorded [228]. This is particularly pertinent to teenagers as a large number of teenagers are single and do register a birth alone. This shortfall in data collection has resulted in the inability at a national level to track repeat pregnancies in single women, which includes majority of teenagers.

Although these data may not be available at a national level they are available at a local level from hospital episode statistics (HES) [104, p.18]. HES contain both past and current histories for each woman that receives care and provides a potential source of data for analysis linking women who have more than one birth episode in the same dataset.

Although 20% of teenagers do go on to have a further pregnancy during their teenage years, little is known about what happens after the first teenage pregnancy regardless of its outcome. It may be an isolated event or it could be the beginning of a complex reproductive history. Although the above difficulties exist, some researchers [229] concentrating on smaller defined populations have adopted a methodology based on epidemiological methods to gather information for women's obstetric history. Seamark [229] a general practitioner in Devon tracked the reproductive history of women for a specific cohort in his own practice. A comparison group was then identified and reproductive histories compared. Seamack's use of this method of data tracking to compare obstetric outcomes and draw comparisons indicates that this research is possible when using patient episode data as a source. The focus of Seamark's [229] study was to gain an understanding of first births to teenagers and what happened in future reproductive terms, not to examine or compare subsequent birth outcomes with first birth outcomes.

1.3.5.3 Summary

The number of teenagers that have repeat births is substantial and as a result should be researched to examine outcomes. However, currently the studies that have been undertaken are quite limited and have concentrated on isolated maternal and neonatal outcomes rather than providing a comprehensive overview. This does not clarify whether maternal and neonatal outcomes are different in first and repeat births to teenagers.

The three studies that examined timing between pregnancies again only provided evidence for women generally and whether this is applicable to teenagers who do not always have the same characteristics as women who birth later in life has to be questioned.

Finally, the difficulties that researchers have faced when trying to follow women throughout their reproductive life have been presented and alternative methods using Hospital Episode Systems or Patient Episode Data have been highlighted. By using these methods vital answers to possible variations in teenage childbearing could be addressed.

1.4 Conclusions from the Literature Review

Within the UK teenage pregnancy remains high on the agenda for current public health policy. The UK has maintained its top of the league position for teenage births in Western Europe and despite governmental strategies this does not show signs of change. National strategies to reduce the rates of teenage pregnancy within England and Wales have made some progress over the last decade but the achievement of targets set for 2010 now look less likely.

Teenage pregnancy is multifaceted and as a result researchers have explored the subject in many different ways. Research into the social and societal aspects of teenage pregnancy have generated a vast array of literature and have established that many teenagers who get pregnant and become teenage parents have common characteristics. These teenagers are more likely to come from a deprived background and have limited social support. More teenagers than older women continue to engage in risk taking behavior during pregnancy such as smoking, drinking alcohol and substance misuse all of which have negative consequences for birth and longterm outcomes. In addition, teenagers are more likely to come from minority ethnic groups who are associated with increased neonatal complications.

Of those teenagers who become pregnant a substantial number go onto give birth but the evidence regarding birth outcomes is more limited. Studies have investigated outcomes in isolation failing to acknowledge the variations that are present in teenagers. The studies often are one dimensional in that they examine outcomes in one group of teenagers ie primiparous or multiparous teenagers or in a certain age group failing to undertake the same analysis in all teenagers to provide an indepth picture. Some of these studies have been criticised for not including associated risk factors in analysis thus questioning the validity of the findings. This type of research provides limited evidence on which to base practice and inform service provision.

There is a need for an indepth examination of birth outcomes in teenagers, which includes examining outcomes in both primiparous and multiparous teenagers. In addition, comparisons should not just be limited to older women but made between teenagers themselves to establish if there are any differences between age groups or parity in teenagers. Although studies have been undertaken in women in general, no studies have examined initial and repeat births in teenagers in the same cohort or examined whether rapid repeat births in teenagers affect birth outcomes. The last combination that is lacking is comparing both maternal and neonatal outcomes in the same cohort of teenagers. By undertaking this indepth approach of examining teenage birth outcomes, a strong evidence base will be established on which to base practice.

1.5 Aim of Research

The main aim of this research was to examine specific maternal and neonatal birth outcomes in a defined cohort of teenagers.

To meet this aim it would be necessary to track initial and subsequent births to teenagers over a period of time. This would require access to a comprehensive data source in the form of hospital episode data.

It would be necessary to include in the analysis known associated risk factors that could be influential on the birth outcomes being investigated.

CHAPTER 2 METHODOLOGY AND METHODS

2.1 Introduction

This chapter sets out the methodological underpinning of my study. Here I describe why an epidemiological approach has been adopted and why a retrospective cohort study, using secondary analysis, is appropriate to address the aims of this thesis. The final section of this chapter presents the methods used to complete the study.

2.2 Epidemiological Approach

Teenage pregnancy has been labelled by governments and some researchers as a public health 'problem' [37, 99, 125], therefore, it seems reasonable to use an overarching public health methodology to examine the outcomes of teenage births, namely epidemiology. Epidemiology has been described by Donaldson and Donaldson [104] as:

'... one of the population sciences basic to public health. The techniques and methods of epidemiology and its general approach of a population perspective on health, disease, and health services leads it to have a very widespread application throughout the field of public health' (p.35).

The basis of epidemiology is to understand the causal relationships when investigating disease or health outcomes by using a variety of methods [230, p.30]. Pollock [231] summarises this in his description of epidemiology as being a:

'standard tool' in public health which analyses the relationship between disease and ill health on the one hand and the causative factors like exposure on the other' (p.246).

Initially, epidemiological methods were used to identify the aetiology, occurrence and distribution of disease within populations [232, p.1] but more recently epidemiology has diversified to examine broader issues [233] such as social, behavioural, environmental and other factors [234, p.133].

Generally, epidemiology has been used as a tool in modern public health by the medical profession and more recently in a broader multi-disciplinary approach [231, p. 249]. In maternal and neonatal services there are examples of good practice using both retrospective and prospective epidemiological approaches when examining the relatively rare occurrences of maternal and neonatal deaths. In this case data are collected using epidemiological methods and cases are reviewed to inform practice. These methods culminated in the production of first the Confidential Enquiry into Stillbirths and Deaths in Infancy (CESDI) and Confidential Enquiry into Maternal Deaths (CEMD). These were later replaced by the combined Confidential Enquiry into Maternal and Child Health (CEMACH) in April 2003 that was re launched as the Centre for Maternal and Child Enquires (CMACE) in 2009. Reports published by these organisations [186, 187, 235, 236] have used epidemiological methods to investigate maternal, neonatal and child health outcomes. A number of study designs are employed in epidemiology and choosing an appropriate design is a key stage in the process of epidemiological research, incorporating the assessment of strengths and limitations of those designs [237].

2.3 Epidemiological Study Designs

Epidemiology is no different from any other quantitative research in that the research question is a starting point when choosing a research design. This is reiterated by Koepsell and Weiss [238] stating that:

'An epidemiologic study generally begins with a question. Once the research question has been specified, the next step in trying to answer it is to choose a study design' (p. 93).

Epidemiological study designs are varied and have evolved with the changing research questions posed, influenced by health services or policy documents [231, p. 247]. As a result there has been a shift from earlier descriptive studies and case reports to the emergence of studies using experimental or observational approaches, adding to the complexities of modern day studies [231, p.251]. Experimental studies involve the manipulation of study factors and the resulting study conditions are controlled. The researcher establishes a degree of control and data collection as a result, is prospective. An example of experimental studies is the randomised controlled trial that is used to evaluate different treatment methods or interventions [239, p.229]. There are ethical considerations to be made when undertaking experimental studies and often the subject areas that are investigated in public health do not loan themselves to this type of study. In contrast an observational study does not manipulate the study factors and the conditions are not created but more observed as a natural phenomenon with little or no interference from the researcher. Koepsell and Weiss [238, p.100] suggest that observational studies allow the researcher to test a wider range of hypotheses at the same time allowing greater flexibility for the researcher. Ethically observational studies do not have the same implications as experimental studies but there are additional ethical considerations to be considered. These will be discussed in more detail on page 91. As the focus of this thesis is teenage birth outcomes these are a natural occurrence and observational studies are adjudged more appropriate for this subject area.

2.3.1 Observational Studies

In epidemiological research the observational study is the most frequently used design and involves the researcher being an external observer [240, p.247]. When observing at the individual level, three main study designs are used; case control studies, cross-sectional studies and cohort studies [232, 238, 241], which will now be briefly described and compared.

2.3.1.1 Case-Control Studies

Case control studies were first developed in the 1950s and Saks and Allsop [240] describe them as:

'*using a descriptive method to compare the characteristics of a particular phenomenon or group of interest to a control or reference group*' (p.409).

Case-control studies are often the first step when testing hypotheses and are defined by the outcome being identified and not by the 'exposure'. 'Cases' are individuals within a population and all must have the outcome of interest, which has been clearly defined by set inclusion and exclusion criteria. In contrast 'controls' are individuals who often share similar characteristics as the 'case' but do not have the outcome of interest, therefore can be used for comparative purposes [232, p.74]. To illustrate Zeitlin *et als* case-control study [209] tested whether having a small for gestational age neonate was a risk factor for singleton preterm live births. The 'cases' were defined as neonates born between 22 and 36 completed week's gestation and the 'controls' were neonates born between 37 and 40 weeks gestation. The outcome was defined as having a neonate that was below the 10^{th} percentile of intrauterine growth reference. For the case, control and outcome, clear definitions were applied for identification of study participants.

Case-control studies have two main advantages over cohort studies; they can be completed in a short period of time and do not require a large population when a rare disease or phenomenon is the focus of the study [232, p.74]. Case-control studies are useful when studying diseases with long latent periods and in cases of multiple exposures. The main weakness of case-control studies is one of bias especially when selecting controls. It is often difficult to establish if exposure has occurred [238, p.375] and in consequence causal relationships are difficult to establish as data for exposure and outcome are recorded at the same time [232, p.80]. Case-control studies cannot be used to estimate disease incidence or prevalence because of the lack of a 'denominator' population.

2.3.1.2 Cross-Sectional Study

Cross-sectional studies differ from cohort and case-controlled studies as they survey a population at a particular point in time and as a result are often described as 'prevalence' studies [104, p.57]. In contrast to the other two designs, cross-sectional studies identify exposure and outcome data together, which prevents the design being used to predict incidence of a disease or event [238, p.109]. Cross-sectional studies are either a descriptive or analytical study. Descriptive studies collect information on the frequency of the 'exposure' or outcome in the population, allowing the prediction of the prevalence, alternatively, analytical studies measure the association between the 'exposure' and the risk of having the outcome [232, p.51]. To achieve this data must be collected at the same time in all participants in the study. The annual Health Survey completed in England is an example of this design. Participants are selected via postcode sectors and to aid maximum representation the sample is stratified. Health related measurements and information are collected and recorded and then used as indicators for population health status. These health measures are often focused on sections of the population [242] so may not provide an accurate overview of health for all sections of the population.

The main advantages of cross-sectional studies are quick completion, ease of administration and provide prevalence for both cases and risk factors in a population, useful for health service planning. Repeating these studies on a regular basis provides an opportunity to establish trends in health status within the population included. A weakness of cross-sectional studies is that as data on outcome and 'exposure' are collected at the same time there is no opportunity to identify relationships between the two. Cross-sectional studies are more suitable for researching chronic illnesses rather than acute illnesses, as cases can be lost before survey data are collected; this is in contrast to cohort or case control studies.

2.3.1.3 Cohort Studies

Cohort studies are often used to examine disease or phenomenon that occur commonly not rarely [238, p.346] and have the additional advantage of allowing the identification and investigation of multiple outcomes from a single 'exposure' [241, p.22]. Cohort studies also termed 'follow-up studies', compare the occurrence of an event of interest after an initial 'exposure' over a period of time by tracking the participants. Therefore, 'exposure' information must be available to the researcher for a cohort study to be considered [238, p.349]. The word 'cohort' originates from Latin and describes '*a body of soldiers*' and the analogy of the soldiers marching in a straight line, is drawn with participants passing through time in a study [243, p.107]. A cohort contains people who share a common characteristic, often the presence of a particular outcome of interest [243-245]. Dublin *et als* [246] cohort study examined outcomes in women following induction of labour and compared them with birth outcomes in women following spontaneous onset of labour. The common factor between the groups was pregnancy and the passage through time was the duration of the pregnancy followed by birth. The 'exposure' data was that generated and recorded in hospital episode data regarding the occurrence of induction or not and allowed the testing of associations between induction and birth outcomes in women.

Cohort studies have the additional advantage of examining multiple outcomes at the same time with the flexibility of the design enabling additional outcomes to be identified as the study progresses. In addition, as data are available before the outcome they have the advantage over cross-sectional and case-control studies of being able to test causality. There are disadvantages to using cohort studies. These are; rare conditions need a large sample size which has financial implications, the study period is protracted to allow follow-up data collection and there can be a issue with loss to follow up. Some of these disadvantages can be addressed by using a combination of prospective and retrospective data collection.

2.3.1.4 Prospective Cohort Studies

Cohort studies that are prospective in nature are used when a sample population is identified for study prior to the development of a condition of interest. Cohort studies are used for the following purposes,

- to clarify the causative factors in disease development,
- to identify long term adverse events following treatment or care
- tracking subsequent health care usage

Adopting a prospective approach allows the researcher the opportunity to decide the type of data required and to define the method of data collection including timing of data collection. A major issue when conducting prospective studies is the amount of time needed to collect the data [104, p.67]. First, this is costly from the perspective of the researchers time and for the sponsors of the research as it has financial implications [247, p.5]. Second, there is the potential for loss to follow-up to occur, when the sample population used may be transient in nature or participants stop co-operating because they no longer consider the study relevant [248, p.253]. Loss to follow-up is a potential limitation of this type of study design but can be prevented if data are sourced from hospital episode data as the outcome is recorded prior to the participant leaving hospital. Finally, a prospective approach has the additional risk of introducing bias during data collection as episodes of care may be affected. Although the use of hospital episode data has been encouraged by previous researchers [249]concerns have been expressed regarding the use of data not collected specifically for research purposes [250, 251].

2.3.1.5 Retrospective Cohort Studies

Retrospective cohort studies have been widely undertaken when examining birth outcomes in women [23, 60, 162, 252]. Stewart and Kamins [247, p.5] discuss at length the benefits and disadvantages of undertaking a prospective versus a retrospective study and these have been summarised.

The data used in retrospective cohort studies can be extensive and in majority of cases provides data on large sample sizes that may include a whole population rather than just a sample of the population. In contrast prospective data collection is specific and collected in addition to that already available. A strength of retrospective studies is that the data has already been collected and therefore no research bias is introduced at the time of data collection [253] or to the service which is often affected when prospective studies are undertaken [247, p.5]. Retrospective studies reduce the time needed to undertake the study so findings can inform policy or practice more rapidly. A final advantage of retrospective studies over prospective studies is the reduction of possible loss to follow-up, as all data have already been collected [248], although the completeness and accuracy of the data may be an issue and attrition may occur 'along the way'.

When using data that has been collected for other purposes, the quality of the data and the type of data collected may limit further analysis. Complicated procedures may be required to transform the data into a usable format as described by previous researchers [251, 253-256]. However, the transformation of data into a suitable format will not address the issue of missing data. The source data should be assessed prior to the studies commencement for its completeness to reduce the problem of missing data.

In summary prospective data collection provides the researcher with a degree of control over the type, format, quality and quantity of data collected but with the disadvantages of taking a protracted amount of time, increased financial cost and not least a delay in the publication of findings to inform practice.

In the case of retrospective data, the length of time and financial implications of the study are reduced and findings can be used to inform practice at an earlier stage. The main disadvantage is the issue of data quality and availability and whether the data is in a format that can be analysed to address the research question(s) posed. Solutions have been developed to address these concerns and retrospective cohort studies continue to be widely used in healthcare. Therefore, within this thesis retrospective data will be used as a source for secondary analysis to address the study aims.

2.4 Secondary Analysis

Secondary analysis emerged in the post war years (after Second World War) as an established methodology and has been defined by several authors with some variations depending on the source data used. Stewart and Kamins [247] define secondary analysis as:

'... further analysis of information that has already been obtained. Such an analysis may be related to the original purpose for which the data were collected, or it may address an issue quite different from that which prompted the original data-gathering effort' (p.2).

Hyman's [257] definition focuses on survey data and states secondary analysis is *'the extraction of knowledge on topics other than those which were the focus of the original surveys'* (p.1). These definitions are more specific while the following example is more generic. Dale *et al* provides the simplest definition as *'a re-working of data already analysed for other purposes'* [258, p.26].

Taking into consideration the above definitions it is clear that this method can only be employed when data has already been collected or compiled for other reasons. The method was originally adopted by social scientists and favoured more by American rather than British researchers. The initial reluctance by British researchers to adopt this method was linked to their concerns over 'survey data' and indeed as Marsh [259] indicates perhaps an underlying mistrust that surveys can be 'positivisitic' in nature and, as a result, may be epistemologically flawed. In contrast to this Hyman [257] describes the emergence of secondary analysis as a *'major movement within social science'* (p 1). Hyman believed that the collection of large datasets provided a wealth of data that allowed for a more in depth understanding of both the individual and society as a whole. The wider use of secondary analysis was as a direct result of the establishment of accessible storage facilities for large datasets that were subsequently made available to researchers [249]. The majority of these datasets originated from government sources; the general household surveys, UK archive data, census data, health service activity data and alternative sources from industry.

With the emergence of improved technology and the 'computer age' the storage and transfer of data became well established and the development of statistical packages facilitated the handling of large amounts of data in a efficient and more effective manner [249]. Several authors [247, 257, 258, 260, 261] have devoted whole books to secondary analysis identifying issues of concern regarding its use.

2.4.1 Views on Secondary Analysis

The conflicting views about the use of secondary analysis are centred on the use of survey data as a source and not the methodology itself. Goode and Hatt's [262] present the view that:

'from a very 'pure' experimental point of view, such analyses are considered to yield answers which are 'plausible' but not capable of being stated in the customary 'probability' terms of science' (p.343).

The explanation for this view comes from one of 'fit for purpose' and the difference in process of data collection for analysis. These views are reiterated by other authors [258, 260, 263] but have not prevented the continued use of secondary analysis. Data collected following episodes of routine care or from audits examining the quality of health care have been used by several researchers in the area of teenage pregnancy [88] and birth outcomes [14, 207, 225]. These studies have all used a retrospective cohort design to identify data from health related sources and the data has been accepted as being of a high quality.

There are numerous sources for patient data collection, primary care, secondary care, disease registries and cancer registries that are all valuable particularly to epidemiological research, as they provide data stretching over a period of time [264, p.172]. Several researchers [251, 253, 265, 266] found data from these sources were not always accurately recorded and in some instances incomplete having a negative effect on the type of care provided and the quality of the research generated [250]. Initially, the arrival of computerised systems did not improve matters as appropriate training was not always provided for the health professionals who inputted data [256]. With the provision of training for healthcare professionals and the increased use of audit and random sampling of data systems, using inter-rater reliability checks [267], the accuracy of data capture has improved.

Although the accuracy of data and the completeness of the data are important a further barrier is one of volume of data. The data sources that have been identified often provide a large volume of data much of which may not be needed in secondary analysis. As a result relevant variables have to be identified and filtered from the full dataset, this can be a time consuming process for the researcher. However, this barrier is offset by the large number of cases available using this method challenging the views of Goode and Hatt [262] by increasing the generalisability of the findings through the use of statistical robustness [258, p.26].

Much health data is gathered in the secondary care setting. There are two main types of data collection in secondary care 'hospital activity statistics' and 'hospital episode statistics'. Hospital activity statistics record activity and throughput in a unit and are used for management purposes, whilst hospital episode statistics record the whole care of the patient [104, p.18]. It is the latter of these that provide a wealth of information for the researcher [264, p.178].

The value of hospital episode data is that it provides information not only on the care received but also the demographic characteristics of the individual, and when examining a complex area such as teenage pregnancy access to this linked data is very important. Hospital episode data has been collected to record the care provided for legal and care planning purposes and not research. As a result there may be barriers to the use of this data for research purposes.

Access to the data may be limited as the data will be governed by the Data Protection Act and Information Commission who interpret the act for application to Health Settings [268, 269]. Ethical considerations also apply to the use of this data for research purposes and appropriate ethical approval must be sort prior to gaining access to the data [270]. Finally, the format of the data may be a barrier to its use as consistent categorisation of care episodes are required for data extraction and comparison purposes [249, 251].

Having discussed aspects of data sources, limitations of such data and benefits of large volumes of data it is important to consider what factors need to be considered when undertaking secondary analysis. An issue not debated is how the quality of data is assessed. This is an important process to complete and will demonstrate whether the data is *'fit for purpose'* and that the quality of the data is sufficiently robust for analysis purposes.

When using a retrospective design the researcher has not been involved in a vital stage of the research process, that of data collection, where quality of the data is assured [243, p.111]. To address this problem a framework has been developed that assesses the quality of data identified for secondary analysis [247]. Researchers can reduce bias and ensure the quality of a proposed retrospective study overall, if such a framework is used. It is therefore the responsibility of the researcher to adequately scrutinise the original methods used to collect the data. This scrutiny can be aided by the application of a framework as suggested by Stewart and Kamins [247]. The Stewart and Kamins framework consists of six areas for assessment: purpose of original study, who collected the data, original data content, when collected, methodology used and the consistency of information compared to other sources (See Appendix 1). As this is a validated tool for assessing the data used for secondary analysis this framework has been used to assess the quality of the data used as a source for analysis in this thesis.

2.4.2 Conclusions

The justification of applying epidemiological methodologies has been presented in this chapter. Epidemiology allows examination of health related outcomes and is therefore suitable to use when investigating teenage pregnancies and births. Having compared the characteristics of the three observational study designs, the most suitable design is a retrospective cohort study. The proposed study aims to compare the birth outcomes of teenagers to that of women in their early twenties. For this to be achieved the study requires all women included to have been pregnant and given birth during the study time period. In addition women need to be tracked to identify multiple 'exposure' to the outcome of interest in this case teenage births. Exposure data and outcome data are available from hospital episode statistics on which secondary analysis can be completed meeting all of the requirements to undertake a cohort study. Details of the completed study are presented in the following sections.

2.5 Methods

This study was a retrospective cohort study undertaking secondary analysis of hospital episode data for women aged 25 and under giving birth at two large maternity units in the East Midlands between 1st January 1992 and 31st December 2001. The data extracted included complete hospital episode data on all care provided to the women while in the hospital setting.

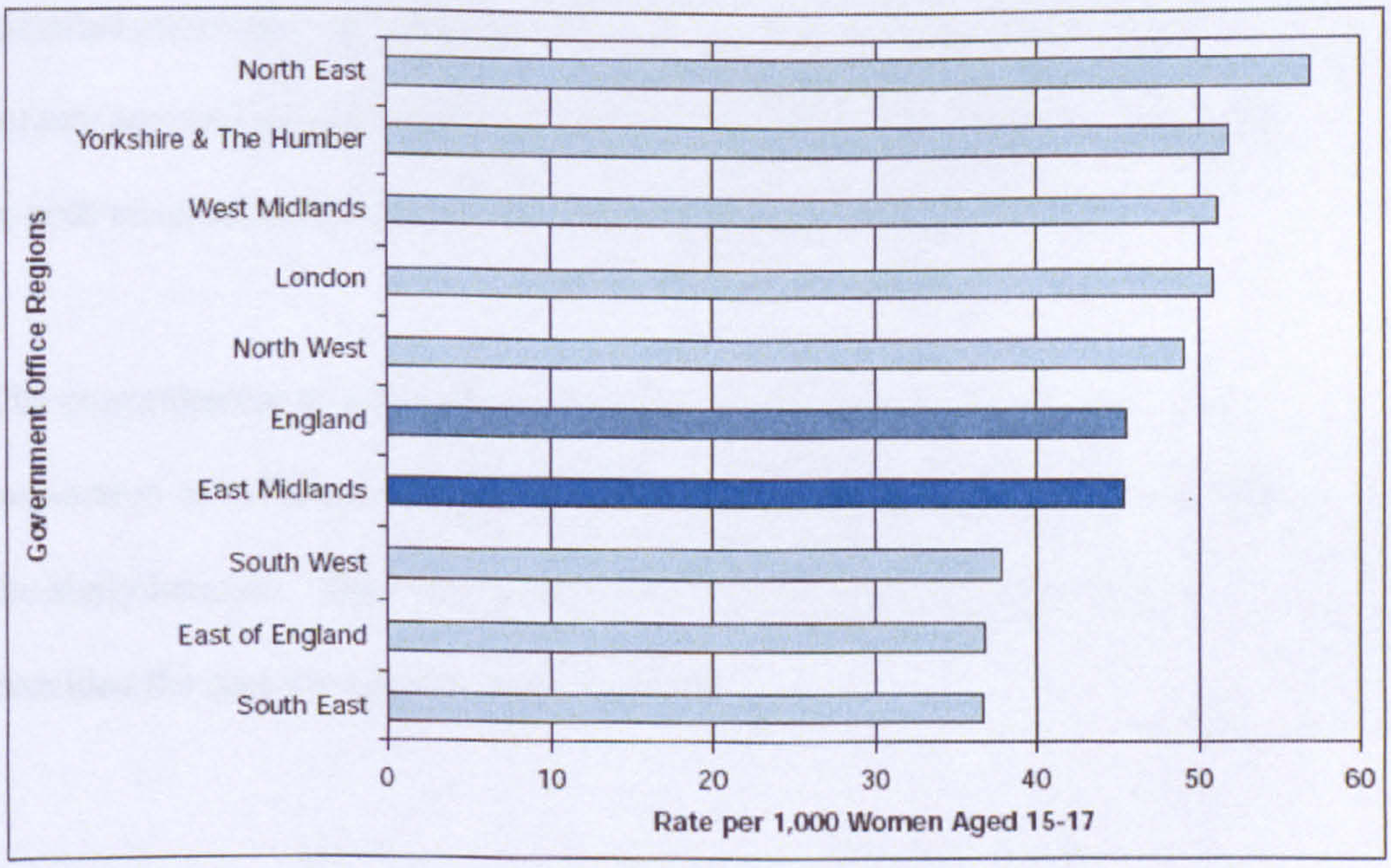
2.5.1 Study Setting

When undertaking a study that involves a specific cohort of individuals it is important to establish that adequate access to the specified population is available in the study setting. Within the next section the suitability of a city in the East Midlands as the chosen setting is presented and data current at the time of data collection has been used to support the selection.

Teenage pregnancy is not only recognised as a priority area for national policy focus, it has been raised as a major social and health issue on a local level within the East Midlands. Figure 2.1 shows the regional picture for rates of teenage conceptions for 1997-1999 in England [271]. The East Midlands region mirrors the national average for teenage conceptions; however, within the region there are wide variations in conceptions rates at a local level [31].

Nationally approximately 50% of teenage pregnancies in the under 16 age group and 33% of the 16 to 17 age group result in terminations, but within the Trent region 62% of teenage pregnancies result in a live or stillbirth rather than abortion [272].

Figure 2.1 Under 18 Pregnancy Rate for 1997-1999



Source: [271]

At a local authority level, conceptions in those under 18 ranged between 16.7 and 74.7 per 1,000 within the East Midlands. In terms of teenage pregnancies, the city's Unitary Authority (UA) has the highest rate with 362 teenagers becoming pregnant each year, of whom 73% continue with their pregnancy with a resulting live or stillbirth outcome [272]. These data demonstrate that local levels are 11% higher than the national average in 1999 as quoted by the Office for National Statistics [273]. Within the city this number accounts for 12% of all pregnancies rather than 9% as seen nationally. This proportion has not reduced whilst in the rest of the UK the rate has fallen [274].

'Viewpoints on Social Exclusion' a document produced by the East Midlands Integrated Regional Strategy [275] identified the high regional rates of teenage pregnancy as an important challenge when trying to reduce social exclusion. Detailed outcomes, for differing age groups of teenage mothers and their infants are not included within the published data and this has been identified at both national and local levels as a need to inform policy.

The concentration of continuing pregnancies within the city provides a large population on which to undertake research and a strong rationale for selecting the study location. The next section describes the maternity units that provided the care for women during the study.

2.5.2 Study Sites

Two maternity units provided care in the city, one providing care for approximately 3,000 pregnant women who are resident in the south of the city and surrounding areas and the second larger unit providing care for approximately 5,000 pregnant women resident in the north of the city and surrounding areas. In addition both units acted as regional referral centres for maternal-fetal medicine. Referral rates during data collection were approximately 1,500 women per year from surrounding counties accounting for approximately 18.75% of the births each year. These additional women were either referred in the antenatal, intrapartum or postnatal periods to the unit that had the specialist service they required.

In total the two units provided intrapartum care for approximately 9,500 women per annum, accounting for between ninety eight and ninety nine percent of all women giving birth in the area, the remainder of women gave birth at home. Home births accounted for between 1-2 per cent of all births (n=190 per annum approximately) at the time of data collection. The exclusion of these women from the study and the loss of the data were deemed acceptable by the study researcher. This decision was influenced by the local clinical guidelines for home births, which excluded primiparous women and those aged under 18 from being offered a home birth. As teenagers were the main groups of interest in the proposed study the data loss from home births would have been minimal but this may have had more of an impact on the comparison group. Over the study period women aged 25 years and under at the time of birth, fitted the inclusion criteria for the study, accounted for approximately 35% of births across the city (n= 3,325 per annum) (data from local units, unpublished).

The casemix of women receiving care at the two units was also diverse both obstetrically and socially. Being regional referral units impacted on the number of complicated pregnancies and births supported in the units and local population had a social indices ranging from inner city deprivation with a Jarman score of (64.64), to suburban affluence and a score of (-45.51). The Jarman index was first developed in 1983 as a measure of primary care need by local populations [127]. Although it is not a direct deprivation score it has been used by researchers as a proxy for material deprivation comparable with other widely used deprivation scores [129, 130]. Therefore, the Jarman index was used in this research as an indicator of deprivation, as Jarman index was available at the enumeration level for the population included in the study. The Jarman index is interpreted on a scale ranging from deprived, as a high positive score to affluent, as a high negative score [127].

2.5.3 Ethical Considerations

Before undertaking any research it is important to consider the ethical implications of the proposed research as this is an integral aspect of the methodology [276, p.285]. The United Kingdom's (UK) Research Governance Framework [277] provides researchers with a clear outline of what is expected whilst conducting research. Although ethical considerations can be complex in research, four areas have been considered when conducting the research presented here. These are the inclusion of teenagers in the study, protecting confidentiality/anonymity, gaining access to data, and the issue of consent.

When a study is conducted that includes children or teenagers there are additional ethical considerations that need to be considered. Children and teenagers are viewed as a 'vulnerable group' for research purposes and it is recommended that children and teenagers should only be included if a suitable adult population will not meet the needs of the research. These recommendations are for general application to all research undertaken regardless of data source or analysis strategy [278]. The data collection for this thesis did not involve direct contact with participants by the research team so the vulnerability aspect is not one of powerlessness as described by Alderson [276, p.286] but more of maintaining confidentiality or anonymity [279].

The issues of maintaining confidentiality and anonymity are more problematic in epidemiological studies if individuals need to be identified and episodes of care linked [270, 280]. This can be achieved by a process described by Strobl *et al* [270] as 'Pseudonymising data' which although cannot completely anonymise data does not contravene the Act's [269] controlling access to patient information. 'Pseudonymising' the data involves altering a key or unique identifier so that people external to the study are unable to link the data to an individual thus only allowing the researcher this ability.

In this thesis the researcher was required to identify women who had more than one index birth within the dataset and for this purpose a hospital number and unique identifier were used. Pseudonymity was achieved by using a mathematical formula to convert the hospital number for each woman from both study sites. The unique identifier was multiplied by 2,000,000 for study site one and 3,000,000 for study site two to prevent duplication of the identifier number when data were merged from the two study sites. All names, addresses (except postcodes which were used to identify Jarman indices), and general practice details were removed from the dataset to protect anonymity.

A second database was created that contained individual demographic data to track women and link unique identification variables between the two study sites. These data were separated from the main dataset and used to create a 'tracking' variable to identify women who had an index birth at both study sites during the study time frame. When complete this one variable was then later merged back into the main dataset. All other identifying data were permanently removed and not linked to the main dataset used for analysis.

2.5.4 Access to Data and Consent

A succession of Parliamentary Acts starting with the Data Protection Act 1998 (DPA) [269, 281, 282] have impacted on the researcher having access to medical records and the data they contain. This has been particularly relevant to studies in the field of epidemiology [270, 280, 283].

Most Codes of Conduct [284, 285] recommend informed consent should be obtained for all medical research whether this is for direct contact or to access records [280]. This is not always feasible in epidemiological studies as the participants may not be contactable and in some cases may be deceased [270]. The publication of the Human Rights Act in 1998 and the Health and Social

Care Act 2001 did assist researchers as they clarified that if research was of an historical or statistical nature then 'fair processing' could be relaxed and consent was not needed as long as three stipulations were met. First, that the results of the research would not have a direct impact on an individual, second, that persons could not be identified and third, that no damage or distress (to individuals) was caused from conducting the research. Walley [283] and Iversen *et al* [280] both state that the undertaking of secondary analysis in epidemiological studies has less of an impact on participants than undertaking primary research, due to the high standards of data handling and techniques used to preserve confidentiality and anonymity. Therefore, the current researcher could be confident that the secondary analysis completed in this study met the standards set as described above.

Consent was not gained from individuals either in writing or verbally for the secondary analysis completed in this study however; the recommendations stated above were adhered to. All analysis was undertaken at a population level removing the possibility of any direct impact on individuals. Data was pseudonomysed and individuals could not be identified from the data presented, resulting in no stress being caused. All data used in this thesis was inputted at the time of care and women were entitled to full access to their records. It is ethically sound to gather and record the care received so these records may be used at a later date for practice or legal requirements. The local hospitals' policy at the time of data collection was to inform patients that their records could and may be used for research purposes that may have been communicated either verbally to the patient or by posters in the clinical areas.

Although this does not equate to gaining consent as interpreted by the Data Protection Act (DPA) it does indicate that the data collected was in an environment that valued ethical principles. Ethical approval was sought and gained from the Local Research Ethics Committee at the two units prior to data extraction for use in this thesis (see Appendix 2).

2.5.5 Background of the Maternity Dataset

The hospitals providing care for women at the two study sites used Clinical Computing Limited (established in 1979) to provide clinical databases to be used in practice settings. The computerised systems enabled the recording of point of care clinical information on clinical activity through the Hospital Inpatient System (HIS) with the addition of the PROTON language programme. PROTON was originally developed for the management of treatment for renal patient's and enabled clinicians in other disciplines to enter and manage hospital episode data more effectively allowing in depth data collection facilities. These data were then used for generating reports and completing basic analysis on patient outcomes following care. New developments in the mid 1980s, in desktop publishing enhanced the process, with the introduction of an additional computer programming system, allowing data collection to be tailored to meet individual organisational needs. Computerised systems for maternity services commenced in 1989 at unit one and 1988 in unit two and were updated and modified, when additional new data was required to be collected. The system allowed instant access to online patient information for registered users of the system. Each episode of care for a patient was entered into the system at the time of provision and this was then stored with a unique identifier for each patient, (usually the hospital number) that remained constant for each patient throughout all care provided by the unit for the remainder of patients life. In addition to the hospital number, in pregnancy an additional unique identifier from the hospital system was allocated to each index birth on the maternity records system. An index birth for the purpose of this study is defined as:

'a birth to a woman occurring during the study period at either of the study sites. An individual woman may have more than one index birth during the study period but each birth will be identified as a separate index birth'.

Including a hospital unique identifier was a valuable addition to the data: by linking these two identifiers (hospital number and unique identifier) individual women can be located and their number of pregnancies that have occurred during the study time frame can be counted. The key to tracking episodes of care to the same individual over a period of time is the hospital number, as differing pregnancies are identified by a unique identifier.

The maternity activity dataset called the 'Matern System' consists of computerised patient records for all women receiving care at the two maternity units in the City (two study sites). It included data from the booking episode, the antenatal period (if care was received in hospital), intrapartum care and up to and including postnatal transfer of mother and child to the primary care setting. The database did not include data on care provided after transfer only inpatients care. The dataset was routinely checked for completeness by the audit process and through midwifery supervision activities within the units.

2.5.6 Maternity Activity Data

For each episode of care, data were entered into the computerised system by the lead professional providing the care, usually the midwife in 'normal' cases or the doctor in 'complicated' cases. Those data were entered as either free text or using predefined 'drop-down' menus. A coding book was provided for the researcher in this thesis from both units to identify the codes used for individual fields. Although the two sites contained a core of identical data fields each also had additional data collected only at that unit, requiring the two separate coding books to interpret the data. All hospital episode data for maternity services was held separately on its own system at the two units, called the 'Matern System'.

The 'Matern System' at study site 1 consisted of 23 separate screens of which 21 screens contained relevant data for the study. At study site 2 there were 27 screens of which 25 screens contained relevant data. The data screens were grouped into stage of care categories, for ease of use by the health care professional providing the care. The first screens contained data on the unique identifier, hospital number, name, address, postcode, general practitioner details, lead care provider, marital status and next of kin. This was followed by data on the full booking history, including type of antenatal screening, smoking status of mother, partner and household residences, previous or current medical conditions, family medical and genetic history, a summary of previous pregnancies, initial antenatal observations and antenatal admission episodes. The second group of screens contained data on admissions in labour, analgesia used, medical interventions, progress in labour, type of birth, maternal and neonatal condition including initial observations, summary data of length of time in labour, time and date of transfer to postnatal ward for mother and child and details of any complications occurring. The last section of screens involved postnatal care, maternal and neonatal observations, methods of feeding, neonatal screening tests, contraceptive advice and finally transfer data including date of transfer for both mother and neonate.

Having established the screen numbers containing the data required discussions took place with the Information Management and Technology (IM&T) department regarding both the format of the data and how it could be made available to the study. The criteria for inclusion in the study were supplied to the IM&T department and all women aged 25 or under at the time of birth during the study period were identified for transfer by the IM&T department. The data were provided in Excel (version 5.0 for windows) spreadsheets. These data were not presented sequentially on the screens and no explanatory labels were attached to the original coded data. Each field name was given the prefix of item- followed by a number, which then had to be identified from the codebook supplied by the IM & T department.

2.5.7 Process of Data Extraction and Dataset Formation

Prior to transfer into the Statistical Package for Social Science (SPSS) version 15 for windows, several steps were required to transfer the data from Excel. Each screen contained a unique pregnancy ID for each index pregnancy and this was pseudonomysed and used as the key variable to allow linking of the screens.

The following steps were completed in Excel:

- Each screen was saved as a workbook instead of a worksheet to accommodate the large number of cases
- Each was then renamed as new site screen in preparation for merging of data
- All field identifiers were changed from the prefix item- to ite_ which could be recognised by SPSS
- Variables required for analysis on each individual screen were then transferred to SPSS

In SPSS the following steps were undertaken:

- Variables required for analysis were renamed for consistency for both study sites in a format acceptable to SPSS this was necessary because although similar data were entered on both unit systems the field names were not always consistent and data needed to be located and renamed ensuring consistency prior to merger of the datasets
- Each variable was labeled describing the data using and missing values were identified
- Where necessary data were then recoded using syntax (definition for syntax in Appendix 3) into either categorical, numerical, date or string as appropriate for the data and variable names were changed from ite_ to q_. Examples of syntax used can be seen in Appendix 3.

- Some large string variables were recoded
- Data were then cleaned and frequencies were completed on categorical and numerical variables to identify any anomalies in the data which were then addressed
- Screens were then sorted by unique identifier prior to merging to ensure case to case data transfer from both files.
- When all data variables were ready, all screens were amalgamated into the final combined dataset.
- The process of deriving new variables was then undertaken prior to any analysis.

2.5.8 Final Data Description

Screens from study site one had 743 original variables, 387 were excluded as not required for analysis and a total of 356 were retained. It was similar for study site 2 with 399 variables excluded. Of the variables retained at both sites, 100 variables were allowed for the recording of up to 10 previous pregnancy and births summaries. These were present for all women regardless of their parity; therefore, many of these fields did not contain data for women. In total the 356 original unique matched fields, present at both sites were available on the system for transfer from the screens for analysis in this thesis. This process has been summarised in Figure 2.2 and 2.3.

Figure 2.2 Summary of Data Sources Unit 1

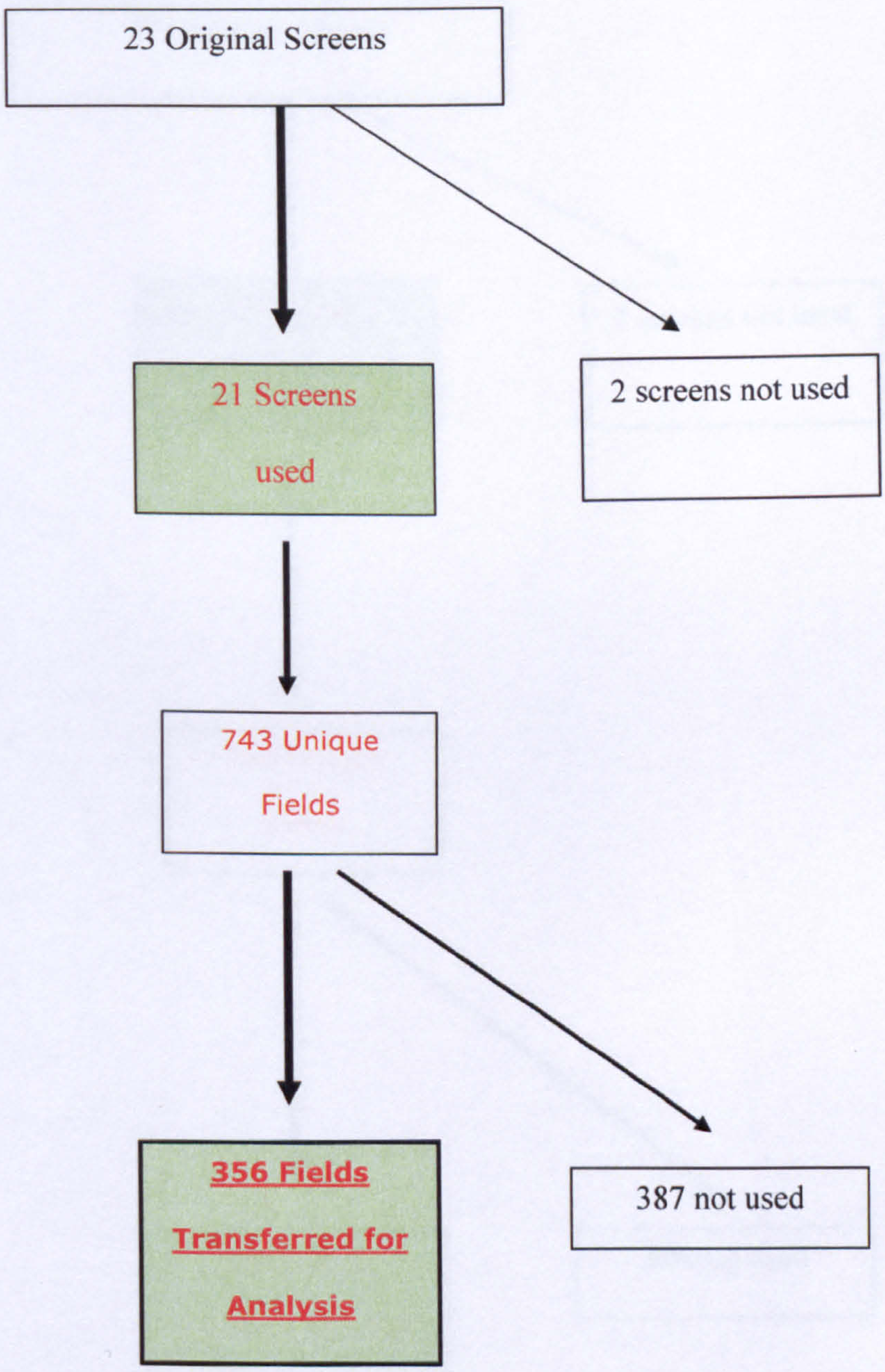
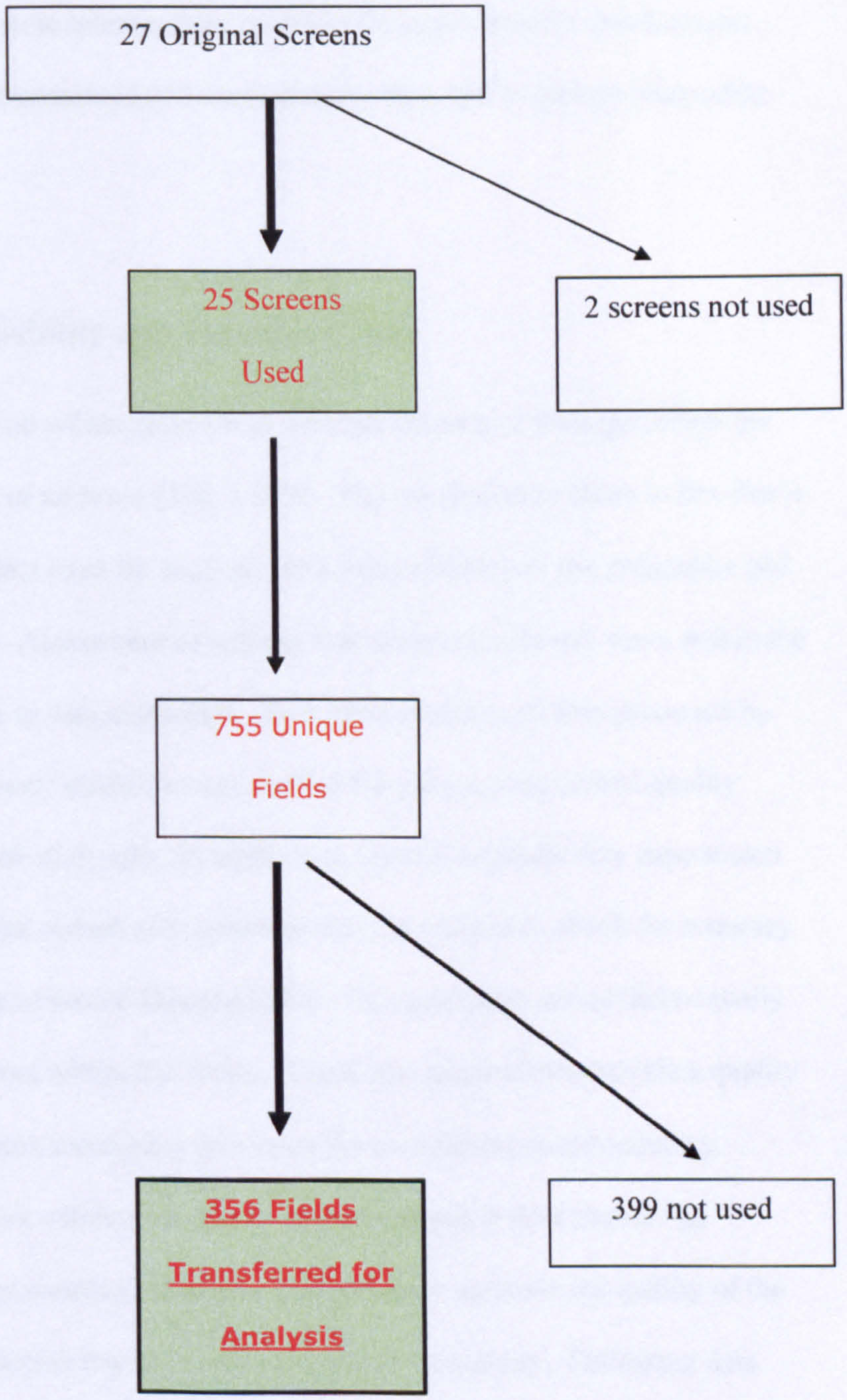


Figure 2.3 Summary of Data Sources Unit 2



In addition to the 356 core variables containing data from both sites a further 157 new variables were derived from original variables, 67 for use in the analysis and 90 were intermediary stages in the new variables development. The final dataset contained 513 variables of which 446 contained analysable data.

2.5.9 Reliability and Validity of Data

Validity is defined within research as whether the data or findings reflect the true occurrence of an event [238, p.223]. The interpretation taken in this thesis is whether the data used for analysis are a true reflection of the pregnancy and birth outcomes. Assessment of validity was undertaken in two ways within the study sites prior to data extraction. As routine practice, all data produced by the hospital episode statistics were audited for accuracy by central quality assurance at each study site. In addition as part of the midwifery supervision process, a random subset of hospital records are audited to check for accuracy and consistency of record keeping [286]. This process is completed annually with all Midwives within the Trusts. These two assessments provide a quality control framework examining data entry for completeness and accuracy. While this cannot validate all data used in this thesis it does provide an indication of the measures that have been taken to maintain the quality of the data collected within the study sites and assess its validity. Following data extraction the assessment of data quality has been described on page 104, a further measure of validity.

When examining reliability within research, this is defined as the agreement of repeated measurements for consistency both internally within the analysis and externally when compared to other sources of evidence [240, p.179]. In this thesis the reliability has been measured by comparing the current findings with other published literature in similar settings and populations. In addition comparisons were made between the incidence of teenage births found in this thesis and those published from national data sources [54, 273, 275]. In both cases there was consistency between findings in this thesis and published literature and between proportions of births recorded in the thesis and those published in national dataset sets. In addition the quality of the data was assessed using the Stewart and Kamins framework [247]and has been presented.

2.5.10 Stewart and Kamins Framework Assessment

The criteria of the framework have been used to assess the suitability and quality of the data used in this thesis and the findings are summarised below.

1. What was the purpose of the study? Why was the information collected?

Primary data collection was completed as part of routine practice and to meet legal requirements. The data collected summarised episodes of care provided in a secondary care setting during childbirth. The data was used to assess and plan care for individual women in the two units and provide data for national statistics.

2. *Who was responsible for collecting the information? What qualifications, resources, and potential biases are represented in the conduct of the study?*

The data collection was the responsibility of the two units providing the patient care. All data were presented as a true and accurate record of the events as records could be used in a legal setting and those inputting data were professionals adhering to a Code of Practice. Data were entered by health care professionals at the time of providing the care to individual women and were mainly midwives and doctors involved in the care. The data collected was routine and as such no potential biases were anticipated.

3. *What information was actually collected? How were units and concepts defined? How direct were the measures used? How complete was the information? Are there any differences in the quality of different variables?*

The information that was collected was a detailed account of all care provided by the units and data were entered using a standardised coding system. The data were entered at the time of providing the care and regularly updated as further care was administered. Data were available for all women having an index birth during the study period, so the dataset was deemed as complete as possible. There were some differences in the coding of data entries between the two units but the data were comparable for linkage. Both sources of data were subject to similar quality assurance processes checking the quality of the primary data collection.

4. When was the information collected? Is the information still current, or have events made the information obsolete? Were there specific events occurring at the time the data were collected that may have produced the particular results obtained?

The information was collected between 1st January 1992 and the 31st of December 2001 and was deemed still current during the completion of this thesis. Comparisons with other data sources for the same period and those occurring after the data collection period demonstrated that the data reflects a true picture of the current situation in the local area. Prior to the end of the data collection period new initiatives from government had identified teenage pregnancy as a focus for future policy strategies but the impact of this policy had not affected local service provision at the point of data collection, so no significant event took place during the study period.

There were some changes in data collection during the study period which impacted on the data used in the thesis these were the classification of stillbirths and data collected on smoking habits of mothers. The stillbirth classification changed on the 1st October 1992 when an amendment to the Births and Deaths Registration Act [287] was made. The definition of stillbirth changed from a dead fetus being expelled from the mother after completion of the 27th week of gestation, to the expulsion of a dead fetus expelled from the mother after completion of the 24th week of pregnancy. This change in definition affected the way in which the outcome of pregnancy was recorded within hospital episode data to either a miscarriage or stillbirth within the dataset. To rectify this change stillbirth data during the first year of the study was reclassified prior to analysis using the new definition. Second, the data on smoking habits was initiated during the data collection for the study. The first introduction of this data collection was as a result of a pilot study undertaken in Nottingham and the amount of data collected increased over time. This resulted in data prior to 1993 being unavailable and an increasing number of variables containing data being available over the time span of the study. Data during the first four years of the study were excluded from any analysis as incomplete.

5. *How was the information obtained? What was the methodology employed in obtaining the data?*

Data was collected as a routine matter on all women receiving care at the two units and not initially for research purposes. The data is detailed and provided by the health professional in attendance at the time care was administered. Details of the data collection method have been presented on page 96 of this thesis.

6. *How consistent is the information with other sources?*

A large proportion of the data entered was by using drop down menus. This standardisation of data aids consistency in the data entry and allows comparison with other data sources. All maternity units in the UK are required to return a core dataset for the purposes of national statistical summaries. This has increased the consistency of data collection in units across the country and made them comparable. In conclusion the data that has been used in this study has been judged as quality data for use in secondary analysis.

2.6 Analysis

This section provides an overview of the analysis undertaken in this thesis. Detailed information on the definition of variables and derivation of new variables has been presented in relevant results chapters. A range of statistical methods were used in the research using the Statistical Package for Social Science (SPSS) version 15.

Adhering to the recommendations of Dale *et al* [258] and Stewart and Kamins [247] when using secondary data, descriptive statistics were completed for all variables to identify any discrepancies in coding, to establish type of distribution and any missing data to complete the data cleaning process.

2.6.1 Univariate Data Analysis

After data cleaning was complete frequencies and descriptive statistics were presented for each of the seven outcomes and associated risk factors used in later analytical chapters. Measures of central tendency and dispersion were summarised using the mean for parametric data and the median for non-parametric data. To compare groups the Chi-squared tests was used for categorical data, if initial associations were identified a series of post-hoc Chi-squared tests were made. For categorical data with multiple categories a Cramer's V test was used as it is more accurate than a chi-squared test [288, p.105]. For continuous data comparisons were made using Kruskal Wallis test for multiple groups and the Mann-Whitney U test when only two groups. If initial Kruskal-Wallis tests found associations between variables then posts-hoc Mann-Whitney U tests were completed.

2.6.1.1 Odds Ratio's (OR)

Odds Ratios (OR) are widely used in epidemiological studies [232, p.45] as they provide an approximate indication of the likelihood of an outcome given certain conditions being present [288, p.283]. In this study univariate ORs were used to examine associations between a study outcome (dependent dichotomised variable), and identified associated risk factors (independent variables), these were categorical, binary or continuous level data. The dependent variables were dichotomised to aid clinical usefulness, for example, the outcome examining birth weight was dichotomised to either LBW (<2500) or not (≥2500) adhering to the standard categorisation used in practice. These univariate OR were completed for each of the outcomes and associated risk factors.

The dependent variables within this study have several associated risk factors that need to be controlled for to address the hypotheses. As all the dependent variables were recoded into dichotomous variables the analysis of choice was multiple logistic regression. When using a large dataset and entering a number of independent variables into models, there was the possibility that a large number of cases would be lost to analysis due to missing data in one of the variables. This problem was addressed by running a backward manual stepwise conditional logistic regression analysis [289, p.174].

2.6.2 Multivariate Analysis

2.6.2.1 Backward Manual Stepwise Conditional Logistic Regression

An automated stepwise conditional model only enters cases that have all of the variables, and does not add any further cases if a variable is removed. If the model is re-run manually after the removal of a variable the analysis begins again and all cases that have all the terms are added to the model, potentially increasing the number of cases included for analysis.

A backward manual stepwise conditional logistic regression analysis involves several stages:

- Entering the dependent dichotomous variable
- Entering all independent variables into the model
- Running the analysis
- After running the analysis the independent variable that has a p value >0.05 and is the least significance is removed from the model*
- The model is then repeated each time removing the least significant independent variable with a p value of >0.05

- When only independent variables that have reached a significance of ≤0.05 remain within the model the stepwise analysis is complete.

*the key explanatory variables remain in the models even if they do not reach the 0.05 significance level and these have been identified in advance in the hypotheses being tested.

All odds ratios are presented using the 95% confidence intervals and the significance value (p value) for each result.

Diagnostic tests were completed for all multivariate logistic regression models included in the analysis. The percentage of variance in the dependent variable that was explained by the independent variables was presented using the Nagelkerke R Square test (0 to 1 range presented as a proportion). The fit of the model was assessed using the Hosmer and Lemeshow Test which indicated whether a model was a good fit. If the p value was <0.05, the model could be accepted as a poor fit and a good fit if the p value ≥ 0.05 [290, p.174].

2.7 Summary

In summary the information provided in this chapter has presented the case for using an epidemiological approach with a retrospective cohort study design. The methodology employed was that of secondary analysis using data from the local hospital episode statistics systems. The rationale for choosing the study setting has also been justified. An overview of the data available for secondary analysis has been described and the quality of that data assessed using the Stewart and Kamins framework. Detailed information of fields used for variable development will be presented as pertinent in the following analysis chapters. Finally, the planned analysis has been presented.

CHAPTER 3 OVERVIEW OF DATASET

3.1 Introduction

This chapter outlines the content of the dataset and provides a background for further indepth analysis in later chapters. First, it will describe the demographic characteristics of women aged 25 years and under giving birth in two maternity units in the Trent region. Second, this will be followed with a summary of the main findings and the identification of the overall hypotheses to be addressed in later chapters.

The aims of the chapter are to:

- examine the characteristics and birth outcomes of women in the dataset
- examine the incidence of associated risk factors for birth outcomes of interest

The objectives are to:

- describe the number of teenage women giving birth in the dataset
- describe the demographic characteristics of women in the dataset
- describe the outcome of births to women in the dataset
- describe the incidence of associated risk factors to be used in later analysis

3.2 Methods

3.2.1 Identification of Variables Used In Analysis

Key variables that have been used for analysis have been listed in Appendix 4. A description of the variable development and derivation of new variables has been presented as they are analysed in the chapter.

3.2.2 Analysis

Data from hospital episode statistics entered by NHS staff as free text or from a 'drop down' menu were recoded into numerical or string variables dependent on data content. Numerical data were examined as described on page 108 & page 109 of this thesis in a series of univariate analyses using SPSS version 15 for Windows.

3.3 Results

3.3.1 Index Births in Comparison to Total Births for Units

Each birth recorded in this study has been termed an 'index birth' for analysis. The definition of an 'index birth' is:

'a live or stillbirth recorded within the dataset to a woman aged 25 years and younger within the 10 year study period'.

During the study period (1st January 1992 to 31st December 2001) there were 94,775 births at the hospital units, which were used for the data extraction in this thesis. Of these births 32,895 met the definition of an index birth and the remaining 61,880 births were to older women and therefore excluded. Tables 3.1 and 3.2 provide a summary of the index births as a percentage of the total births occurring at each unit.

The two units used for data extraction varied in throughput. Unit 1 was larger having 56,448 births in total and averaged 5,650 births per year, accounting for 59.56% of births in the city. Unit 2 had 38,327 births and averaged 3,830 per year accounting for 40.44% of births. No data from home births were recorded in the hospital episode statistics and therefore no home births were included in this analysis. The study dataset contained data on 34.7% (n=32895/94775, 95% CI 34.40 to 35.00) of women giving birth during the 10 year period at the two study sites.

Table 3.1 Total Births at Unit 1 (1992-2001)

Year	Number of births to <26 year olds	Births to ≥ 26 year olds	Total Births	% of total births to <26 year olds births
1992	2213	3458	5671	39.0
1993	2084	3614	5698	36.6
1994	1975	3620	5595	35.3
1995	1969	3672	5641	34.9
1996	1918	3986	5904	32.5
1997	1894	3872	5741	33.0
1998	1826	3847	5673	32.2
1999	1829	3894	5723	32.0
2000	1734	3771	5505	31.5
2001	1664	3633	5297	31.4
Total	**19106**	**37342**	**56448**	**33.8**

Table 3.2 Total Births at Unit 2 (1992-2001)

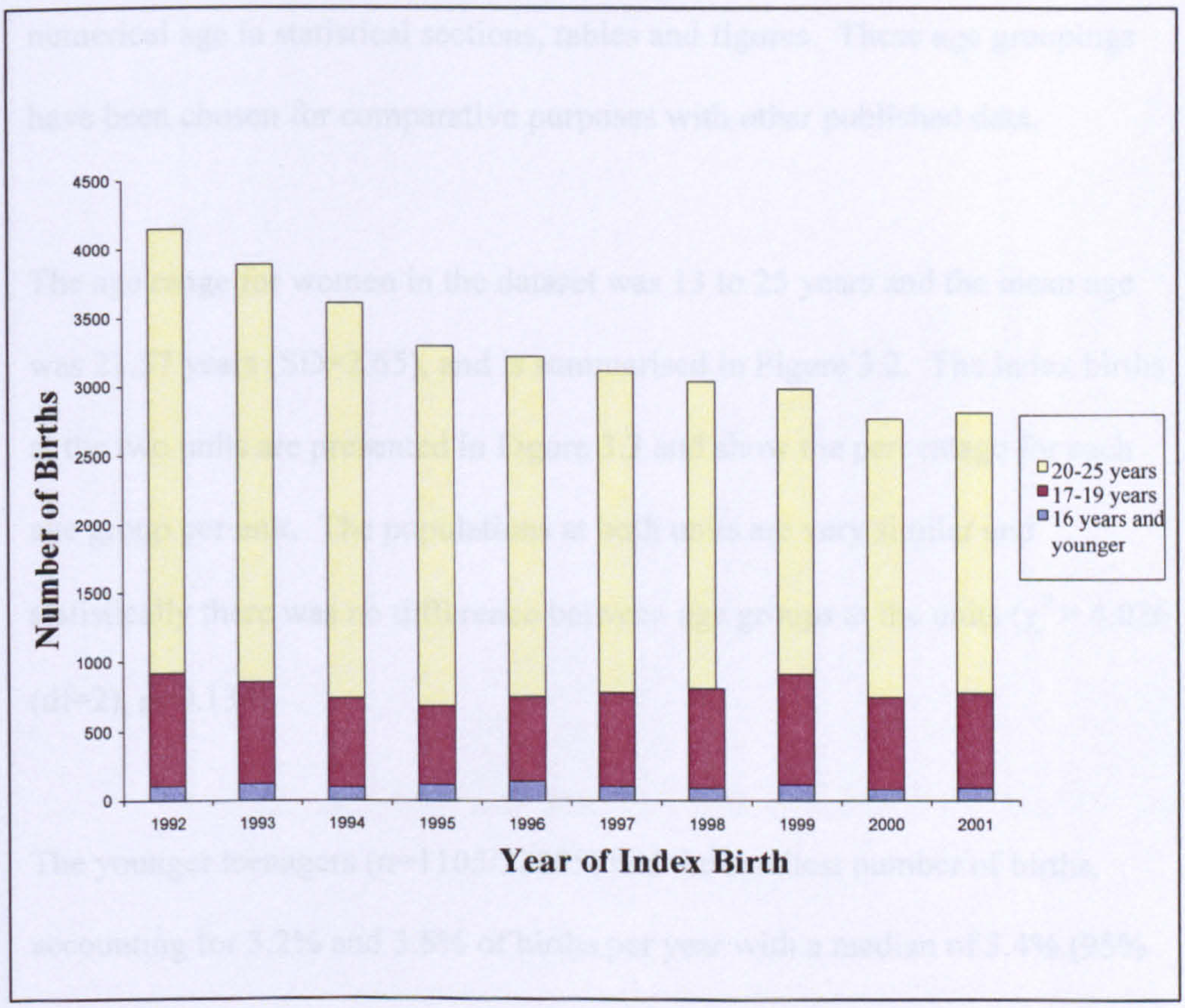
Year	Number of births to <26 year olds	Births to ≥26 year olds	Total Births	% of total births to <26 year olds
1992	1937	2689	4626	41.9
1993	1804	2677	4481	40.3
1994	1636	2419	4055	40.3
1995	1326	2090	3416	38.8
1996	1303	2355	3658	35.6
1997	1225	2466	3691	33.2
1998	1217	2512	3729	32.6
1999	1158	2431	3589	32.3
2000	1032	2412	3444	30.0
2001	1151	2487	3638	31.6
Total	**13789**	**24538**	**38327**	**35.9**

In this thesis analysis will be undertaken on the index births only. Initially, the profile of women in the study will be analysed, then data on maternal and neonatal outcomes followed by analyses of the associated risk factors used in later chapters.

3.3.1.1 Index Births By Age Group

In Figure 3.1 the number of index births by age group per year has been summarised. It can be seen from this bar chart that although the number of births for the study population has fallen over the 10 year period reflecting the national figures [228], the proportion of births to younger teenagers and older teenagers has remained consistent in comparison to a general decline in the comparative group.

Figure 3.1 Number of Index Births by Age Group per Year of Study



3.3.2 Profile of Women

The woman's date of birth and the date of her index birth were used to calculate the woman's age at delivery. The age at delivery was recorded in 'whole completed years' adhering to the approach used by British demographers of rounding down for age classification as described by Rendall [57]. The age variable was also used to derive the age groupings variable. Three age groups were derived for analyses, these were 'younger teenagers' (≤16 years), 'older teenagers' (17-19 years) and a comparative group 'women in their early twenties' (20-25 year olds). Where all women aged 19 years and under were aggregated together they have been described as 'all teenagers'. From this point onwards these descriptors will be used in the text and the numerical age in statistical sections, tables and figures. These age groupings have been chosen for comparative purposes with other published data.

The age range for women in the dataset was 13 to 25 years and the mean age was 21.57 years (SD=2.65), and is summarised in Figure 3.2. The index births at the two units are presented in Figure 3.3 and show the percentage for each age group per unit. The populations at both units are very similar and statistically there was no difference between age groups at the units ($\chi^2 = 4.026$ (df=2), p=0.134).

The younger teenagers (n=1105/32895) had the smallest number of births, accounting for 3.2% and 3.6% of births per year with a median of 3.4% (95% CI 2.33 to 4.47) over the study period; older teenagers (n=6923/32895) account for 21.2% and 20.8% of births with a median of 21% (95% CI 20.04 to 21.96); and the comparative group (n=24867/32895) account for 75.6% of births at both units with a median of 75.6% (95% CI 75.07 to 76.13)

Figure 3.2 Number of Women in Dataset by Age

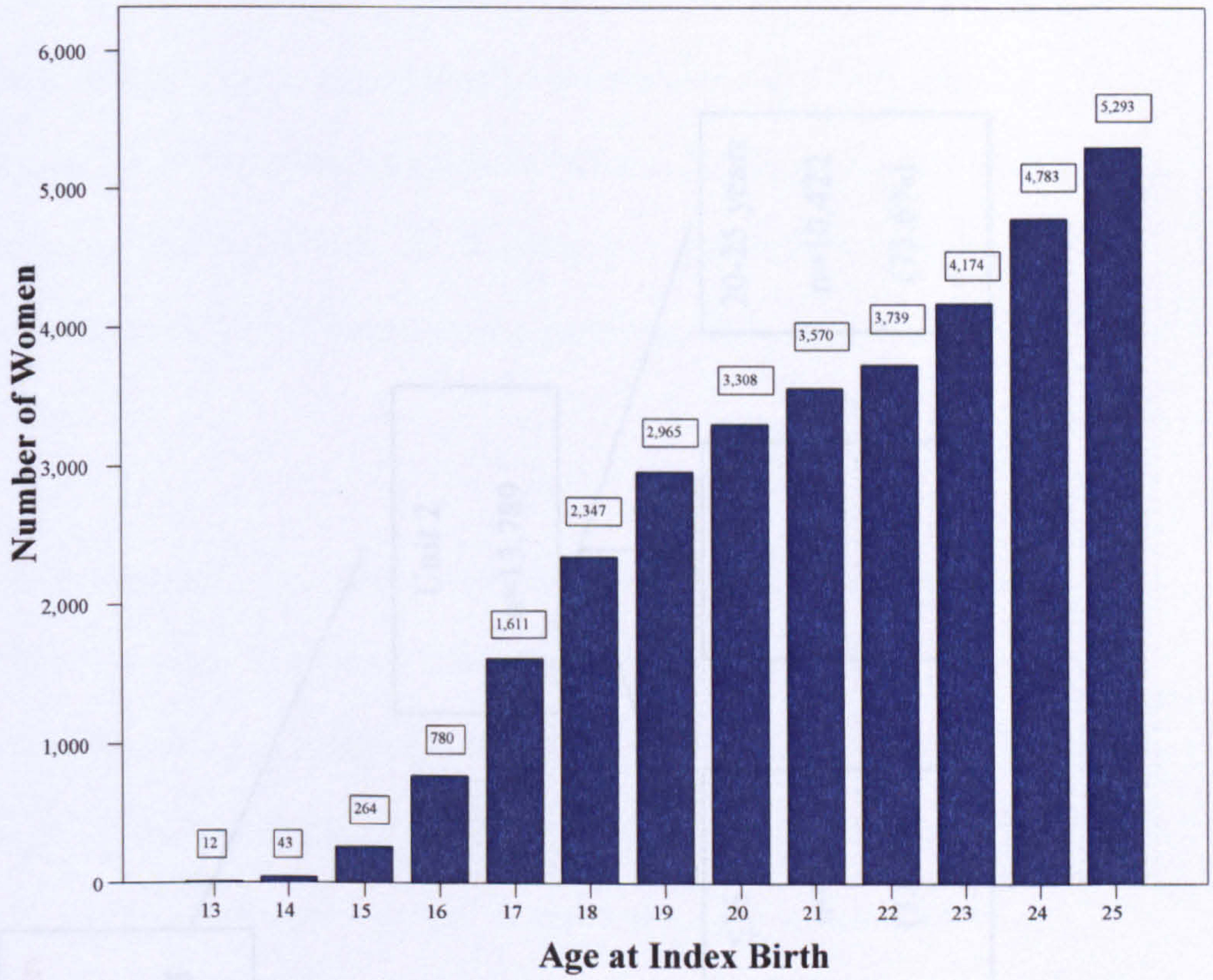
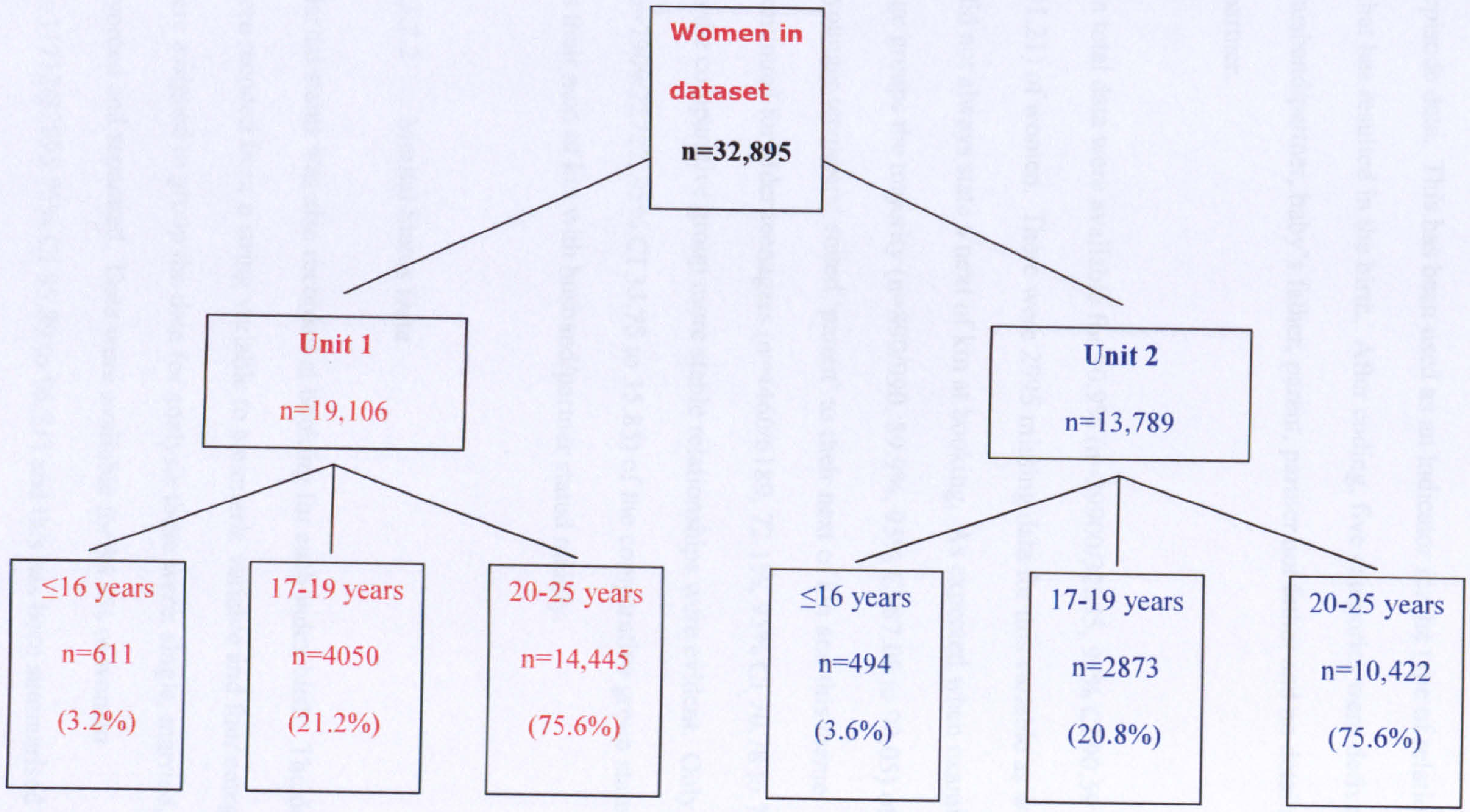


Figure 3.3 Number of Index Births By Unit and Age Group



3.3.2.1 Next of Kin Data

At booking, next of kin details for all women are recorded in the hospital episode data. This has been used as an indicator for the type of relationship that has resulted in the birth. After coding, five categories were derived: husband/partner, baby's father, parent, partner not father and no details/no partner.

In total data were available for 90.9% (n=29900/32895, 95% CI 90.59 to 91.21) of women. There were 2995 missing data for this variable as women did not always state a next of kin at booking. As expected when examining the age groups the majority (n=890/990, 89.9%, 95% CI 87.05 to 90.05) of 'younger teenagers' stated 'parent' as their next of kin and this theme continued for older teenagers (n=4460/6189, 72.1%, 95% CI 70.78 to 73.42), in the comparative group more stable relationships were evident. Only 34.8% (n=7909/22722, 95% CI 33.75 to 35.85) of the comparative group stated parent as their next of kin with husband/partner stated mainly.

3.3.2.2 Marital Status Data

Marital status was also recorded at booking for each index birth. The data were recoded from a string variable to a numeric variable and four categories were assigned to group the data for analysis these were: single, married, divorced and separated. Data were available for 96.1% of women (n=31712/32895 95% CI 95.89 to 96.31) and this has been summarised in

Table 3.3. The majority of women in all age groups described themselves as single when booking, although there was a marked change for the comparative group. Only 1.1% (n=331/31712 95% CI 0.9 to 1.2) of women described themselves as either divorced or separated.

Table 3.3 Marital Status by Age Group

Marital Status	Age Group						Total	
	≤16 years		17-19 years		20-25 years			
	%	n	%	n	%	n	%	n
Single	98.5	1077	90.2	13496	56.4	13496	**65.0**	**20624**
Married	1.5	16	9.6	645	42.2	10096	**33.9**	**10757**
Divorced	0.0	0	.04	3	0.7	172	**0.6**	**175**
Separated	0.0	0	0.1	8	0.6	148	**0.5**	**156**
Total	**100**	**1093**	**100**	**6707**	**100**	**23912**	**100**	**31712**

Data indicating the next of kin and marital status was only available at the start of the pregnancy and so only provides a snapshot of support the woman may have received. Therefore, this data has not been used in any further analysis within this thesis.

3.3.3 Maternal Outcomes

3.3.3.1 Antepartum Haemorrhage

A common antepartum complication in pregnancy is that of antepartum haemorrhage. The definition adhered to within this thesis for APH is that described by Drife and Magowan [291] as:

"as vaginal bleeding from the gential tract after 22nd week of pregnancy" [318, p.228].

This standard definition is used widely within clinical practice. Therefore, it is assumed for the purposes of this study the recording of APH as a complication fits the above criteria. Data were recorded in two separate fields in the hospital episode data both of which contained free text. Source data were manually searched for text recording 'APH'or antepartum haemorrhage and from this a dichotomised variable was derived for analysis. In fields where APH was not recorded these were entered as no APH occurring.

Details for 100% (n=32895) of births were available for analysis. Overall, 5.3% (n=1739/32895, 95% CI 5.06 to 5.54) of index pregnancies were complicated by APH. Teenage women had higher proportions of pregnancies complicated by APH, with 6.6% (n=73/1105 95% CI 5.14 to 8.06) of younger teenagers and 6.3% (n=435/6923 CI 5.73 to 6.87) of older teenagers being affected in comparison to 5.0% (n=1231/31356 CI 4.76 to 5.24) of the comparative group. These findings are summarised in Table 3.4.

Table 3.4 Incidence of Antepartum Haemorrhage by Age Group

Age Groups	APH				
	APH		No APH		Total
	%	n	%	n	n
≤16 years	6.6	73	93.4	1032	1105
17-19 years	6.3	435	93.7	6488	6923
20-25 years	5.0	1231	95.0	23636	31156
Total	**5.3**	**1739**	**94.7**	**31156**	**32895**

A Chi-squared test indicated there was a significant difference in the occurrence of APH between groups ($\chi^2 = 23.198$ (df=2), $p \leq 0.001$). Post-hoc Chi-squared tests indicated this was only significant between the teenage groups and the comparative group (≤16 versus 20-25, $\chi^2 = 6.084$ (df=1), $p=0.014$; 17-19 versus 20-25, $\chi^2 = 19.379$ (df=1), $p \leq 0.001$; ≤16 versus 17-19 ns). This dichotomised variable was later used as a dependent variable when testing hypotheses.

3.3.3.2 Index Birth: Method of Delivery

Differences have been observed by previous researchers in birth outcomes between teenagers and older women [14, 162] and will now be examined in the study population.

One variable was included in the dataset describing the index birth outcome and this variable, after recoding for consistency between units, was used for analysis. There were originally nine categories: normal, breech, Keillands forceps, Neville Barnes forceps, Wrigleys forceps, LSCS, Ventouse, breech and 'other'. These descriptors were recoded into six outcomes by combining forceps and ventouse births into one category labelled 'instrumental births'.

The type of index birth was available for 99.8% (n=32821/32895) of women and has been summarised in Table 3.5. Overall, 70% (n=22994/32821 95% CI 69.5 to 70.5) of index births classified as a normal birth. All age groups had similar proportions of normal births: younger teenagers 71.2% (n=786/1104, 95% CI 68.32 to 73.68); older teenagers 71.1% (n=4913/6913 95% CI 70.03 to 72.17) and the comparative group 69.7% (n=17295/24804, 95% CI 69.13 to 70.27) and there was no statistically significant difference ($\chi^2 = 5.348$ (df=2), p=0.069) between age groups.

Overall, 15.2% (n=4988/32821, 95% CI 14.2 to 16.2) of women had an instrumental birth. Teenage women had higher proportions of instrumental births with 18.3% (n=191/1104, 95% CI 12.82 to 23.78) for younger teenagers and 16.2% (n=1127/6913 95% CI 14.05 to 18.35) for older teenagers compared to 14.8% (n=3670/24804, 95% CI 13.65 to 15.95) for the comparative group. There was a statistically significant difference between age groups ($\chi^2 = 13.443$ (df=2), p=0.001). A post hoc Chi-squared test showed that there was only a statistically significant difference between the teenager groups and the comparative group ($\leq$16 versus 20-25 year olds, χ^2= 5.229 (df=1), p=0.022 and 17-19 versus 20-25 year olds χ^2 = 9.560 (df=1), p=0.002).

Women having a Lower Segment Caesarean Section (LSCS) birth accounted for 13.7% (n=4487/32821, 95% CI 12.69 to 14.71) of births. Teenage women had lower proportions of LSCS births, with 10.7% (n=118/1104, 95% CI 5.12 to 16.28) of younger teenagers and 11.5% (n=797/6913 95% CI 9.29 to 13.71) of older teenagers in comparison to 14.4% (n=3573/24804, 95% CI 13.25 to 15.55) of the comparative group having a LSCS. There was a statistically significant (χ^2= 46.393 (df=2), p$\leq$0.001) difference between age groups. A post hoc Chi-squared test showed that there was only a statistically significant difference between the teenage groups and the comparative group ($\leq$16 versus 20-25 year olds, χ^2 = 11.927 (df=1), p=0.001 and 17-19 versus 20-25 year olds χ^2 = 37.541 (df=1), p$\leq$0.001).

Breech births recorded in the overall dataset accounted for only 0.9% (n=301/32821, 95% CI 0.8 to 1.0) of all births and there was little variance between age groups: younger teenagers 0.6% (n=7/1104, 95%CI 0.14 to 1.06); older teenagers 1.0% (n=71/6913, 95% CI 0.07 to 1.23) and comparative group 0.9% (n=223/24804, 95% CI 0.07 to 1.02) and there was no statistical difference between groups (χ^2= 1.982 (df=2), p=0.371).

Within the dataset there were a total of 51 births (0.2%) that were classified as 'other'. This descriptor was used to classify births where more than one method of delivery had been used ie. a combination of either ventouse followed by forceps, ventouse followed by LSCS, forceps followed by LSCS or assisted breech followed by LSCS. No further analysis was undertaken on this group.

Following this analysis two methods of delivery were used as dependent variables when testing hypotheses in later chapters, these were Instrumental and LSCS birth.

3.3.3.3 Operative Birth

A variable was derived combining instrumental birth and LSCS births and was labelled 'operative birth' and entered as an independent variable to test hypotheses. Overall, 29.2% (n=9475/32469, 95% CI 28.71 to 29.69) of women in the dataset had an operative birth. A slightly lower proportion of teenage women had an operative birth, younger teenagers 28.2% (n=309/1095, 95% CI 25.55 to 30.85) older teenagers 28.1% (n=1924/6837, 95% CI 27.83 to 29.97) compared to the comparative group 29.2% (n=7242/24537, 95% CI 28.93 to 30.07) but there was no statistical difference between age groups (χ^2= 5.390 (df=2), p=0.068).

Table 3.5 Method of Delivery by Age Group

Age	Method of Delivery (% and n)										
	Normal		Instrumental		LSCS		Breech		Other		Total
Group	%	n	%	n	%	n	%	n	%	n	
≤ 16	71.2	786	17.3	191	10.7	118	0.6	7	0.2	2	1104
17-19	71.1	4913	16.3	1127	11.5	797	1.0	71	0.1	5	6913
20-25	69.7	17295	14.8	3670	14.4	3573	0.9	223	0.2	44	24804
Total	70.0	22994	15.2	4988	13.7	4487	0.9	301	0.2	51	32821

3.3.3.4 Perineal Trauma

Data describing the degree of perineal trauma for women varied between the two units. There was no consistency for the categorisation used so; a simple dichotomous variable was derived indicating whether trauma had occurred versus no trauma recorded. The analysis reported here was completed on women having a normal birth only.

Of those women having a normal birth 44.5% (n=29442/, 95% CI 43.93 to 45.07) had some degree of perineal trauma reported. Younger teenagers had the highest proportion of perineal trauma with 45.1% (n=453/1004, 95% CI 42.2 to 48.18) of women being affected. The older teenagers had the lowest proportion of women affected with 43.5% (n=2731/6241, 95% CI 42.27 to 44.73) and 44.8% (n=9936/22197, 95% CI 44.15 to 45.45) of the comparative group had a degree of perineal trauma. Statistically there was no difference between age groups ($\chi^2 = 3.545$ (df=2), p=0.178) and findings have been summarised in Table 3.6. Perineal trauma was used as a dependent variable when testing hypotheses later in this thesis.

Table 3.6 Summary of Perineal Trauma by Age Group

Age Group	Perineal Trauma				
	Trauma		None		Total
	%	n	%	n	
≤16 years	45.1	453	54.9	551	**1004**
17-19	43.5	2713	56.5	3528	**6241**
20-25	44.8	9936	55.2	12261	**22197**
Total	**44.5**	**13102**	**55.5**	**16340**	**29442**

3.3.4 Neonatal Outcomes

3.3.4.1 Live or Stillbirth

Data recording the state of the neonate at birth, was recorded in one variable from which staff entered the outcome of birth as either a live or stillbirth from a 'drop down' menu. There were 50 neonates whose birth outcome was not recorded but using triangulation methods as described by Tritter (2007 p.304) with variables containing data on delivery date, transfer details for mother and baby, 19 of these were identified as live births and recoded, leaving just 31 cases of unknown outcome for index birth, all from unit 2 (0.09%). Data on neonatal outcome of birth were recoded into a dichotomous variable of either live birth or stillbirth in the dataset.

Live births accounted for 99.5% (n=32699/32864) of births at both units and only 0.5% (n=165/32864) of neonates were stillborn. The proportion of live births was similar for all age groups (99.3% and 99.5%) and there was no statistically significant difference between the groups ($\chi^2 = 1.129$ (df=2), p=0.569).

3.3.4.2 Premature Birth

Prematurity is the term used to describe a neonate born before the completion of the 37th week of pregnancy and accounts for approximately 7.4% of all births in England and Wales [195].

The data used to calculate the gestation at the point of birth was the date of delivery and corrected expected date of delivery (EDD) calculated from the dating scan. Date of delivery was subtracted from the expected date of delivery to calculate the gestation at birth. From this data the dichotomised variable of premature birth was derived (defined as $\leq$37 weeks gestation).

Gestational details were available for 99.5% (n=32723/32895, 95% CI 99.42 to 99.58) of women. Overall 8.9% (n=2932/32723, 95% CI 8.59 to 9.21) of index births resulted in a premature birth. Teenage women had higher rates of premature birth, with 10.9% (n=120/1101, 95% CI 9.06 to 12.74) of younger teenagers and 9.9% (n=681/6887, CI 9.19 to 10.61) of older teenagers having a premature birth in comparison to 8.6% (n=2131/24735, CI 8.25 to 8.95) of the comparative group. These findings are summarised in Table 3.7. Having a premature birth was used as a dependent variable when testing hypotheses later in the thesis.

Table 3.7 Incidence of Premature Birth by Age Group

Age groups	Premature Birth or Term				Total
	Premature Birth		Term		
	%	n	%	n	n
≤16 years	10.9	120	89.1	981	1101
17-19 years	9.9	681	90.1	6206	6887
20-25 years	8.6	2131	91.4	22604	24735
Total	8.9	2932	91.1	29791	32723

3.3.4.3 Apgar Score

The Apgar Score was developed in the early 1950s [208] as an initial assessment of neonatal wellbeing. This assessment at the time of birth is an established part of clinical practice and has been used by researchers as an indicator of neonatal wellbeing. Low Apgar score is defined as a score of 6 or less at time of assessment [208].

The data were recorded in three separate fields within the hospital episode statistics. Scores were recorded at the one minute, five minute and ten minute stage after birth. The five minute data has been used to derive a dichotomous variable as either low Apgar score or not, the rationale for this choice has been presented on page 54 of this thesis.

Details for 98.6% (n=32447/32895) of births were available for analysis. Overall 9.6% (n=3104/32447, 95% CI 9.08 to 9.72) of babies had a low Apgar score. A higher proportion of teenagers, 12.4% (n=134/1082 95% CI 10.44 to 14.36) of younger teenagers and 10.5% (n=720/6839 CI 9.77 to 11.23) of older teenagers gave birth to a neonate with a low Apgar score, in comparison to women in the comparative group (9.2%, n=1231 CI 8.84 to 9.56). These findings are summarised in Table 3.8.

Table 3.8 Incidence of Low Apgar Score by Age Group

	Apgar Score				
Age Groups	Low Apgar (≤6)		Normal Apgar (7-10)		Total
	%	n	%	n	n
≤16 years	12.4	134	87.6	948	1082
17-19 years	10.5	720	89.5	6119	6839
20-25 years	9.2	2250	90.8	22276	24526
Total	9.6	3104	90.4	29343	32447

There was a statistically significant ($\chi^2 = 21.607$ (df=2), $p \leq 0.001$) difference between age groups. Post hoc Chi-squared analysis found there was a statistically significant difference between all age groups and this has been summarised in Table 3.9. A neonate having a low Apgar score was used as a dependent variable when testing hypotheses later in the thesis.

Table 3.9 Post hoc Analysis of Apgar Score by Age Group

Age Group	Statistical Test	Results
All groups	Chi-squared	**$\chi^2 = 229.345$ (df=2), $p \leq 0.001$**
≤ 16 v 17-19*	Post Hoc chi-squared	**$\chi^2 = 4.028$ (df=1), $p = 0.045$**
≤ 16 v 20-25*	Post Hoc chi-squared	**$\chi^2 = 23.045$ (df=1), $p \leq 0.001$**
17-19 v 20-25*	Post Hoc chi-squared	**$\chi^2 = 211.192$ (df=1), $p \leq 0.001$**

* indicates age group with fewer lower Apgar Scores   Bold -= significant result in Table

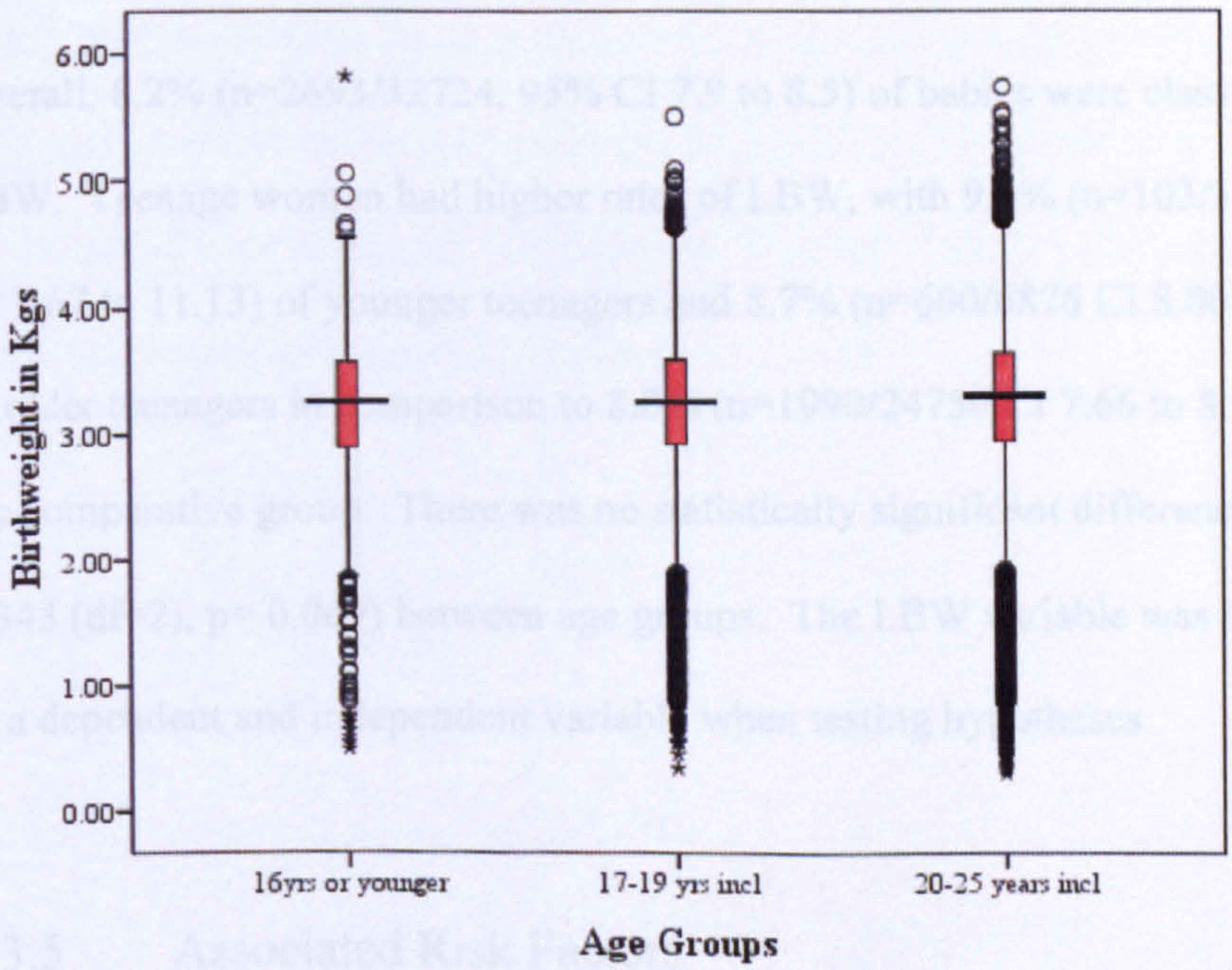
3.3.4.4 Birth Weight in Neonates

Variations between the birth weight of teenagers and older women has been documented in numerous research studies [183, 200, 201, 292, 293] and the following analyses will examine if this was similar in the study population.

Data on birth weight was recorded and recoded into a continuous variable within the dataset. Whilst examining birth weight it is important to consider the incidence of two categories of birth weight: that of Low Birth Weight (LBW) and a macrosomic neonate which have been associated with poorer outcomes for both the mother and neonate. A neonate is classified as a LBW infant if, at term, the neonate weighs 2.5kgs or less and a macrosomic neonate is defined as a neonate weighing over 4kgs at birth.

Within the dataset neonatal birth weight was available for 99.5% of women (n=32730/32895, 95%CI 99.42 to 99.58). The data, when examined, was normally distributed and therefore the mean has been used to compare the birth weight between age groups. Birth weight ranged from 300 grams to 5082 grams, with a mean birth weight overall of 3268 grams (SD =0.613). The comparative group had the highest mean birth weight at 3260 grams (SD 0.614) and the younger teenagers had the lowest mean birth weight at 3193 grams (SD 0.597), while older teenagers had a mean birth weight of 3210 grams (SD 0.59). Figure 3.4 illustrates the birth weight for all age groups.

Figure 3.4 Birth Weight of Neonates by Age Group



When undertaking a Kruskal Wallis test there was a significant difference in birth weight between age groups (χ^2= 56.997 (df=2), p≤0.001). Post hoc Mann Whitney U tests found a significant difference between the teenage groups and comparative group only. These findings have been summarised in Table 3.10.

Table 3.10 Post hoc Analysis for Birth Weight by Age Group

Groups	Statistical Test	Results
All three Age Groups	Kruskal Wallis Test	**χ^2= (2) 56.997, p≤0.001**
≤16 *v 17-19	Mann Whitney U	z= (1) -1.337, p=0.181
≤16* v 20-25	Mann Whitney U	**z =(1) -4.280, p≤0.001**
17-19* v 20-25	Mann Whitney U	**z = (1) -6.600, p≤0.001**

Bold -= significant result in Table *indicates lower birth weight

3.3.4.5 Low BirthWeight

Overall, 8.2% (n=2693/32724, 95% CI 7.9 to 8.5) of babies were classified as LBW. Teenage women had higher rates of LBW, with 9.4% (n=103/1098 95% CI 7.67 to 11.13) of younger teenagers and 8.7% (n=600/6876 CI 8.00 to 9.40) of older teenagers in comparison to 8.0% (n=1990/24750 CI 7.66 to 8.34) of the comparative group. There was no statistically significant difference ($\chi 2$ = 5.343 (df=2), p= 0.069) between age groups. The LBW variable was later used as a dependent and independent variable when testing hypotheses.

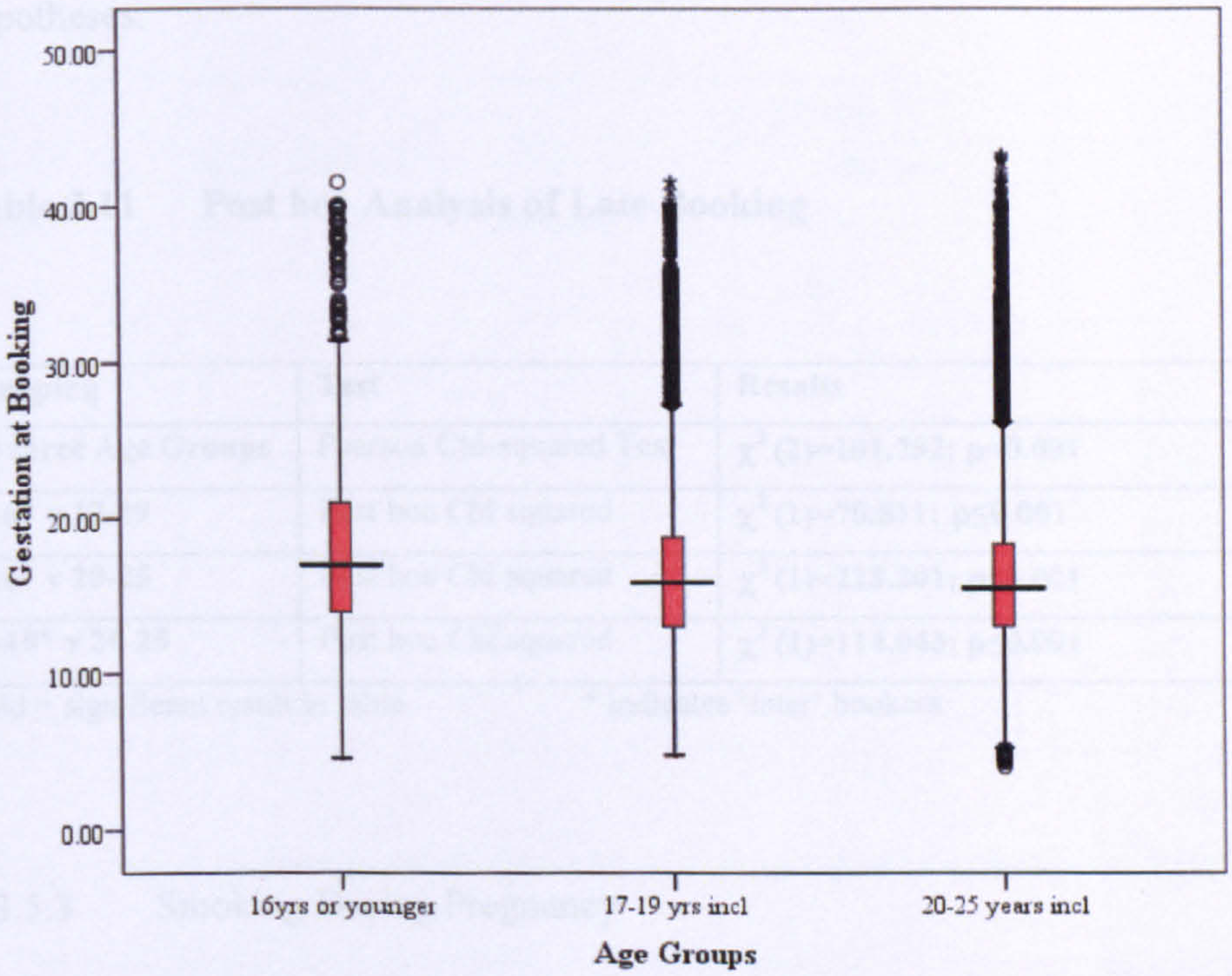
3.3.5 Associated Risk Factors

3.3.5.1 Gestation at booking

Previous researchers [172] found that pregnant teenagers book later for antenatal care than older women generally. The gestation of pregnancy was recorded at the booking visit. To calculate gestation at booking when data was missing, the date of booking was deducted from the expected data of delivery (EDD). Data were available for 98.36% of the population (n=32357/32895).

On examination the data was not normally distributed therefore the median has been used as a measure of central tendancy. From the data women booked between 4 and 43 weeks gestation for care, with a median of 15.5 weeks gestation. Younger teenagers booked later for care with a median of 17 weeks gestation, but older teenagers and the comparative group booked at a similar gestation (15.86 v 15.43, respectively). These findings are illustrated in Figure 5.3. A Kruskal-Wallis test found a statistically significant difference between age groups (χ^2= 55.997 (df=2), p≤0.001) for gestation at booking. Post-hoc Mann-Whitney U tests found a statistically significant difference only between the teenage and comparative groups (≤16 v 20-25; z= -4.28 (df=1), p≤ 0.001, 17-19 v 20-25, z= -6.60 (df=1), p≤0.001). This data was then recoded into a dichotomised variable for 'late booking'.

Figure 3.5 Gestation at Booking by Age Group



3.3.5.2 Late Booking for Antenatal Care

The definition used for classification of late booking was that used by previous researchers *'booking later than 20 weeks gestation' [170, 171, 173, 294, 295]*. The proportion of women booking at or after 20 weeks gestation varied between age groups. Younger teenagers had the highest proportion of late bookers at 30% (n=324/1099; 95% CI 25.01-34.17) followed by older teenagers at 18.9% (n=1289/6818; 95% CI 15.90-20.10) and the comparative had just 13.7% (n=335424462; 95% CI 11.86-14.14) of women booking late.

There was a statistically significant difference between age groups (χ^2 = 295.990 (df=2), p=0.001) for late booking. Post-hoc analysis showed this was significant between all groups and has been summarised in Table 3.11. This dichotomised variable was later used as an independent variable when testing hypotheses.

Table 3.11 Post hoc Analysis of Late Booking

Grouping	**Test**	**Results**
All three Age Groups	Pearson Chi-squared Test	χ^2 **(2)=101.752; p=0.001**
≤ 16* v 17-19	Post hoc Chi squared	χ^2 **(1)=70.811; p≤0.001**
≤ 16* v 20-25	Post hoc Chi squared	χ^2 **(1)=223.201; p≤0.001**
17-19* v 20-25	Post hoc Chi squared	χ^2 **(1)=114.043; p≤0.001**

Bold = significant result in table * indicates 'later' bookers

3.3.5.3 Smoking During Pregnancy

Data on women's smoking status was collected at booking and again on the day after birth. If a woman smoked one cigarette per day she was recorded as a smoker in the dataset. Therefore, the variable derived for smoking was a dichotomous variable of whether a woman smoked at the time of birth but did not provide information on the number of cigarettes an individual smoked. The method of data collection was fully established at different times in the two units and complete data collection was not available until 1996.

Smoking data were available for 97.3% (n=17442) of all index births occurring between 1996 and 2001 (n=17929). In total 6255 (35.9%) women were reported as smokers at the time of giving birth. A summary of these findings are shown in Table 3.12.

Table 3.12 Smoking Status by Year of Delivery

Year of Delivery	Index Births (n)	Smoking Data				
		Non-smoker		Smoker		Total
		%	(n)	%	(n)	
1996	3221	63.7	2025	36.3	1155	**3180**
1997	3117	62.9	1941	37.1	1141	**3085**
1998	3035	63.7	1925	36.3	1097	**3022**
1999	2985	65.6	1927	34.4	1011	**2938**
2000	2761	64.4	1633	35.6	901	**2534**
2001	2810	64.7	1736	35.3	947	**2683**
Total	**17929**	**64.1**	**11187**	**35.9**	**6255**	**17442**

A Chi-squared goodness-of-fit test indicated there was a statistically significant difference between the proportions of smokers identified in the current sample, compared to 23% quoted in a national data source for all ages of women [296] (χ^2= 356.528 (df=1), p≤0.001).

Older teenagers had the highest proportion of smokers at 44.9% (n= 1807/4022, 95% CI 43.36 to 46.44), the younger teenagers had a lower proportion at 38.9% (n= 248/638, 95% CI 35.12 to 42.68) but this was still higher than the comparative group with 32.9% (n= 4200/12782, 95% CI 32.09 to 33.71). A Chi-squared test indicated a significant difference in smoking overall between groups (χ^2 = 283.067 (df=2), p≤0.001). A post-hoc Chi-squared test indicated this remained significant between all groups and results have been summarised in Table 3.13. This dichotomised variable was later used as an independent variable when testing hypotheses.

Table 3.13 Post hoc Analysis for Smoking Status by Age Group

Grouping	**Test**	**Results**
All Age Groups	Chi-squared	$\chi2$ (2)=283.067; p≤0.001
≤ 16 v 17-19*	Post Hoc chi-squared	**$\chi2$ (1)=7.663; p= 0.006**
≤ 16*v 20-25	Post Hoc chi-squared	**$\chi2$ (1)=19.540; p≤0.001**
17-19* v 20-25	Post Hoc chi-squared	**$\chi2$ (1)=277.061; p≤0.001**

Bold = significant result in table   * indicates most smokers

3.3.5.4 Multiple Birth

Whether a birth was a singleton or multiple births was recorded in the hospital episode statistics at the time of birth. These data were recoded as a dichotomous variable within the dataset. Less than 1% (n=318/32822, 95% CI 0.0928 to 0.0992) of women had a multiple index birth, these included 303 sets of twins and 15 sets of triplets. For the purposes of further analysis both twin and triplet births have been combined and termed 'multiple births'. A lower proportion of teenage women had multiple births: younger teenagers 0.3% (n=3/1104, 95% CI 0.20 to 0.62); older teenagers 0.6% (n=44/6913, 95% CI 0.42 to 0.78) when compared to the comparative group 1.1% (n=271/24805, 95% CI 0.97 to 1.23) and this was statistically significant (χ^2 = 17.505 (df=2), p≤0.001). Post hoc analysis found this was only significant between the teenage groups and the comparative group as summarised in Table 3.14. This dichotomised variable was later used as an independent variable when testing hypotheses.

Table 3.14 Post hoc Analysis of Multiple Birth by Age Group

Grouping	Test	Results
All three Age Groups	Chi-squared	**$\chi 2$ (2)=17.505; p≤0.001**
≤ 16 v 17-19*	Post Hoc chi-squared	$\chi 2$ (1)=2.173; p= 0.140
≤ 16 v 20-25*	Post Hoc chi-squared	**$\chi 2$ (1)=6.805; p≤0.001**
17-19 v 20-25*	Post Hoc chi-squared	**$\chi 2$ (1)=14.078; p≤0.001**

Bold = significant result in table * indicates most multiple births

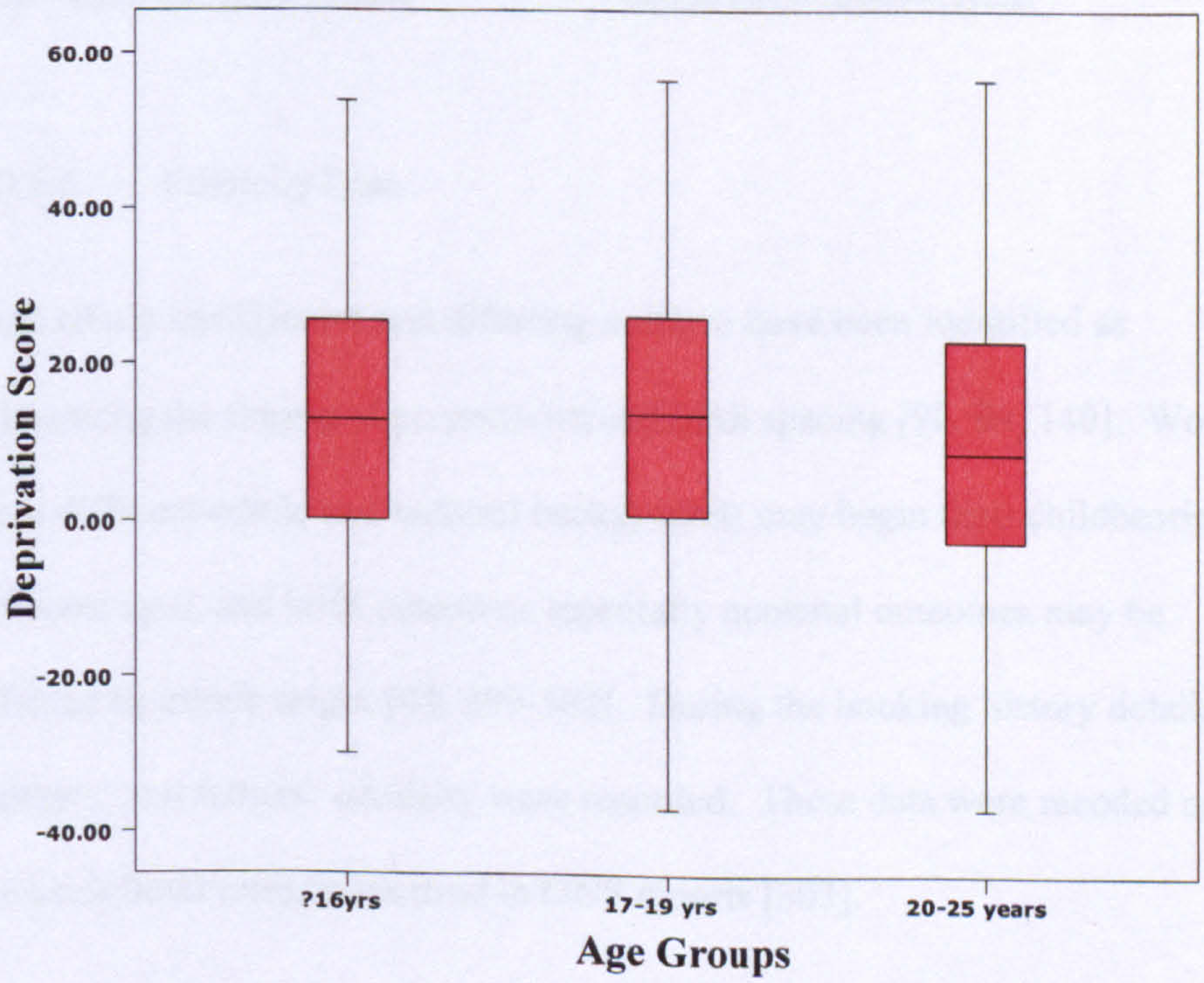
3.3.5.5 Deprivation Score

Deprivation has been positively associated with the occurrence of increased teenage pregnancies and teenage pregnancies resulting in a birth [162]. Deprivation is also positively associated with poorer outcomes in both the mother and baby regardless of age [77, 157, 297, 298]. In this thesis Jarman indices [127] were used to provide information on disadvantage as the researcher had access to these at enumeration level. Enumeration districts contain a smaller population (approx 450 people) than wards (approx 5500).

Deprivation scores for women were derived using the postcode from the address given at the booking interview. Postcodes indicate the enumeration district as well as the ward in which the person is resident. If postcodes were missing but addresses available, these were manually inputted using the post office postcode source manual. These were entered into an Excel spreadsheet and enumeration codes identified from the MIMAS system. From these enumeration codes Jarman indices were identified for each woman. The completed derived variable was then merged into the master dataset for analysis using the unique identifier to link cases.

Jarman indices were available for 95.2% (n=31305/32895, 95% CI 94.76 to 95.44) of women. For the remaining 1590 (4.8%) women a postcode could not be identified. Women's deprivation scores ranged from -37.00 (least deprived) to 56.50 (most deprived) with a mean of 10.5 (SD=16.37). Boxplots have been used to summarise levels of deprivation for the three age groups illustrated in Figure 3.6. Teenage women came from a more deprived background (≤16 mean score=12.5 [SD=16.16], 17-19 mean score= 13 [SD 16.08]) when compared to the comparative group (20-25 mean score = 9.7 [SD=16.37]).

Figure 3.6 Deprivation Score by Age Group



A Kruskal Wallis Test indicated that there was a statistically significant difference for deprivation scores between age groups. A post hoc Mann Whitney U test found that there was a statistically significant difference only between teenagers and the comparative group, these findings have been summarised in Table 3.15. This continuous variable was later used as an independent variable when testing hypotheses.

Table 3.15 Summary of Analysis for Jarman Score

Grouping	**Test**	**Results**
All three	Kruskal Wallis Test	**χ^2 (2)=101.752; p=0.001**
≤ 16 v 17-19*	Mann Whitney U Test	Z = -0.468; p= 0.640
≤ 16* v 20-25	Mann Whitney U Test	**Z = -2.958; p=0.003**
17-19* v 20-25	Mann Whitney U Test	**Z = -7.996; p=0.001**

Bold = significant result in table * indicates most deprived group

3.3.5.6 Ethnicity Data

Both ethnic background and differing cultures have been identified as influencing the timing of pregnancies and birth spacing [90, 99, 140]. Women from different ethnic and cultural backgrounds may begin their childbearing at different ages, and birth outcomes especially neonatal outcomes may be affected by ethnic origin [48, 299-302]. During the booking history details of mothers' and fathers' ethnicity were recorded. These data were recoded using the predefined categorises used in ONS reports [303].

The main ethnic group for women was Caucasian accounting for 87.7% (n=28585/32604, 95% CI 87.34 to 88.06) of the total births with Indian and Pakistani origin the next largest group with 7.0% (n=2288/32604, 95% CI 6.72 to 7.28). For partners this was similar with 85.6% (n=18059/21091, 95% CI 85.13 to 86.07) being Caucasian and the next largest ethnic group again were Indian/Pakistani with 5.4% (n=1149/21091, 95% CI 5.33 to 5.45). The data have been summarised in Table 3.16 and Table 3.17.

Table 3.16 Mother's Ethnicity

Ethnicity	N	%
Caucasian	28585	87.7
Indian/Pakistani	2288	7.0
West Indian	745	2.3
Mixed Race	419	1.3
Other	227	0.6
African	89	0.3
Far Eastern	90	0.3
Middle Eastern	114	0.4
Mediterranean	47	0.1
Total	**32604**	**100**

Table 3.17 Father's Ethnicity

Ethnicity	N	%
Caucasian	18059	85.6
Middle Eastern	42	0.2
Indian/Pakistani	1149	5.4
Other	996	4.7
Mixed Race	497	2.4
African	112	0.6
West Indian	99	0.5
Mediterranean	91	0.4
Far Eastern	46	0.2
Total	**21091**	**100**

These two variables have nine categories for ethnicity; therefore the Cramér's V test was used for analysis as it is more accurate for tables containing data over 2x2 [288 p.105]. When comparing the mothers' ethnicity with the fathers' there is a strong association with births occurring to parents from the same ethnic group (Cramér's V = 0.633; $p \leq 0.001$). There were two exceptions to this where a woman described her ethnicity as 'mixed race' or 'other' she had a greater association with Caucasian partners. A summary of this data is presented in Table 3.18.

Table 3.18 Cross Tabulation of Mother's and Father's Ethnicity

Mothers Ethnicity	Fathers Ethnicity: African	Caucasian	Far East	Indian/Pakistan	Mediterranean	Middle East	Mixed Race	Other	West Indian	Total
African	**20**	4	0	1	0	0	3	0	10	**38**
Caucasian	63	**17569**	9	88	58	11	385	55	513	**18751**
Far East	0	10	**37**	1	0	0	0	1	1	**50**
Indian/Pakistan	3	21	0	**1036**	2	3	3	5	20	**1093**
Mediterranean	0	15	0	0	**25**	0	3	0	2	**45**
Middle East	0	5	0	2	0	**27**	0	3	0	**37**
Mixed Race	11	**188**	0	9	4	1	**75**	0	116	**404**
Other	1	**56**	0	3	0	0	5	**33**	22	**120**
West Indian	13	92	0	6	0	0	21	2	**307**	441
Total	**111**	**17960**	**46**	**1146**	**89**	**495**	**495**	**99**	**991**	**20979**

Figures in shaded cells= matched mother and father for ethnicity

Figures in red and bold= highest prevalence and not matched ethnicity

As the majority of the women were Caucasian a dichotomous variable of Caucasian or not was derived. Overall, using the dichotomised variable 12.2% (3997/32629, 95% CI 11.84 to 12.56) of women in the study were classified as being from a minority ethnic group. Teenagers had lower proportions, with younger teenagers having 9.1% (n=100/1093, 95% CI 7.39 to 10.81) and older teenagers 10.6% (n=728/6894, 95% CI 9.87 to 11.33). For the comparative group 12.8% (3169/24672, 95% CI 12.38 to 13.23) of the women classified themselves as from a minority ethnic group. There was a statistically significant difference between age groups for ethnicity ($\chi^2 = 35.147$ (df=2), $p \leq 0.001$). A post-hoc Chi-squared test found this was only statistically significant between the teenage groups and the comparative group (≤ 16 versus 20-25, $\chi^2 = 12.902$ (df=1), $p \leq 0.001$; 17-19 versus 20-25, $\chi^2 = 24.845$ (df=1), $p \leq 0.001$). This dichotomised variable was later used as an independent variable when testing hypotheses.

3.3.5.7 Epidural Pain Relief

Women in labour have a range of pain relief that can be used that include; non-pharmacological methods such as relaxation, aromatherapy, hydrotherapy and transcutaneous electrical nerve stimulation (TENS) and pharmacological methods such as opiate drugs, inhalation analgesia, and regional anaesthesia. The pharmacological methods have been associated with increased intervention in labour and birth [304-306] and poor neonatal outcomes [307, 308].

Hospital episode statistics on pain relief administered during labour were only available from unit 2 and this only contained data on epidural use. The time of administration was not available from the original data so timing of epidural could not be established. Data were coded as a dichotomous variable.

The proportion of women having an epidural at unit 2 was 40.8% (n=7786, 95% CI 40.1 to 41.5) during childbirth. Teenage women had a higher proportion of epidural use; younger teenagers 55% (n=336/611, 95% CI 51.06 to 58.94); older teenagers 46.1% (n=1869/4050 95% CI 44.56 to 47.64) in comparison to the comparative group of 38.6% (n=5581/14445, 95% CI 37.81 to 39.39). These findings are summarised in Table 3.19.

Table 3.19 Epidural Analgesia Use by Age Group

Age Group	Epidural				
	Epidural		No		Total
	%	n	%	n	
≤16 years	55.0	336	45.0	275	611
17-19	46.1	1869	53.9	2181	4050
20-25	38.6	5581	61.4	8864	14445
Total	40.8	7786	59.2	11320	19106

There was a statistically significant difference ($\chi^2 = 126.938$ (df=2), $p \leq 0.001$) between age groups. Post hoc analysis found there was a statistical difference between all age groups and has been summarised in Table 3.20. This dichotomised variable was later used as an independent variable when testing hypotheses.

Table 3.20 Post hoc Analysis for Epidural Use

Grouping	Test	Results
All three Age Groups	Chi-squared	**$\chi 2$ (2)=126.938; p≤0.001**
≤ 16 *versus 17-19	Post Hoc chi-squared	**$\chi 2$ (1)=16.657; p≤0.001**
≤ 16* versus 20-25	Post Hoc chi-squared	**$\chi 2$ (1)=65.736; p≤0.001**
17-19* versus 20-25	Post Hoc chi-squared	**$\chi 2$ (1)=74.201; p≤0.001**

Bold = significant result in table * indicates highest epidural use

3.3.5.8 Length of Second Stage

An association has been described by previous researchers [309, 310] between the length of second stage and the outcome of operative birth. Commencement of the second stage of labour was recorded in the hospital episode statistics for the majority of women except for some LSCS cases where this may not have been applicable. Time of full dilation and time of birth were recorded in four variables in hours and minutes. Data in the hour variable for time of full dilation and time of birth were converted into minutes. The two variables for time of full dilation were then added together and this was repeated for the two variables for time of birth. The time in minutes for full dilation was deducted from the time in minutes for the time of birth for the neonate and this calculated the total length of second stage of labour in minutes. Definitions for prolonged second stage of labour have been provided by National Institute for Clinical Excellence (NICE) [204] and distinguish between primiparous and multiparous women. For the purposes of this study a definition of a second stage lasting longer than 120 minutes has been used as a descriptor for prolonged second stage and been applied to both primiparous and multiparous women.

Overall 10.2% (n=2894/28236, 95% CI 9.85 to 10.55) of women had a prolonged second stage of labour. The older teenagers and the comparative group had similar proportions of women having a prolonged second stage: older teenagers 10.2% (n=621/6076, 95% CI 9.44 to 10.96); comparative group 10.3% (n=2182/21184, 95% CI 9.89 to 10.71). The proportion was lower in the younger teenagers 9.3% (n=91/976 95% CI 9.14 to 9.46) and there was no statistically significant difference between age groups ($\chi^2 = 0.974$ (df=2), p=0.614). Findings have been summarised in Table 3.21. This dichotomised variable was later used as an independent variable when testing hypotheses.

Table 3.21 Prolonged Second Stage by Age Group

Age Group	Prolonged Second Stage				
	Prolonged		Normal		Total
	%	n	%	n	
≤16 years	9.3	91	90.7	885	976
17-19	10.2	621	89.8	5455	6076
20-25	10.3	2182	89.7	19002	21184
Total	**10.2**	**2894**	**0.5**	**25342**	**28236**

3.3.5.9 Number of Pregnancies to Individuals

At booking women provided data on previous obstetric history. This data included summaries of all previous pregnancy outcomes that the woman disclosed, including live births, stillbirths and miscarriages/abortions. For each previous pregnancy, 10 separate variables were allocated to record data on pregnancy outcome. If data were recorded in these variables, syntax was used to add all previous pregnancies together plus one, to calculate the total number of pregnancies to each individual. This process derived the gravida for individuals summarised in Table 3.22.

The number of pregnancies was varied within and between age groups, one younger teenager had a total of eight pregnancies, thirteen older teenagers had nine pregnancies and one woman in the comparative group had a total of 11 pregnancies. Only summary details were available for these pregnancies and not all resulted in a term pregnancy or live birth.

3.3.5.10 Initial and Repeat Birth

Differences in outcomes between first and subsequent births in teenagers have been reported in several studies [36, 182]. The gravida variable was used to derive a dichotomous variable, which categorised women as being either primiparous or not in the dataset.

Overall, 45.1% (n=14824/32895, 95% CI 44.56 to 46.64) of women were primiparous and teenagers had a higher proportion of primiparous births than the comparative group. 87.3% (n=965/1105, 95% CI 85.3 to 89.3) of younger teenagers and 63.2% (n=4376/6923, 95% CI 62.1 to 64.3) of older teenagers were primiparous, whilst only 38.1% (n=9483/24867, 95% CI 37.5 to 38.7) of the comparative group were primiparous. A summary of these findings has been presented in Figure 3.7. This dichotomised variable was later used as an independent variable when testing hypotheses

Figure 3.7 Initial and Repeat Births by Age Group

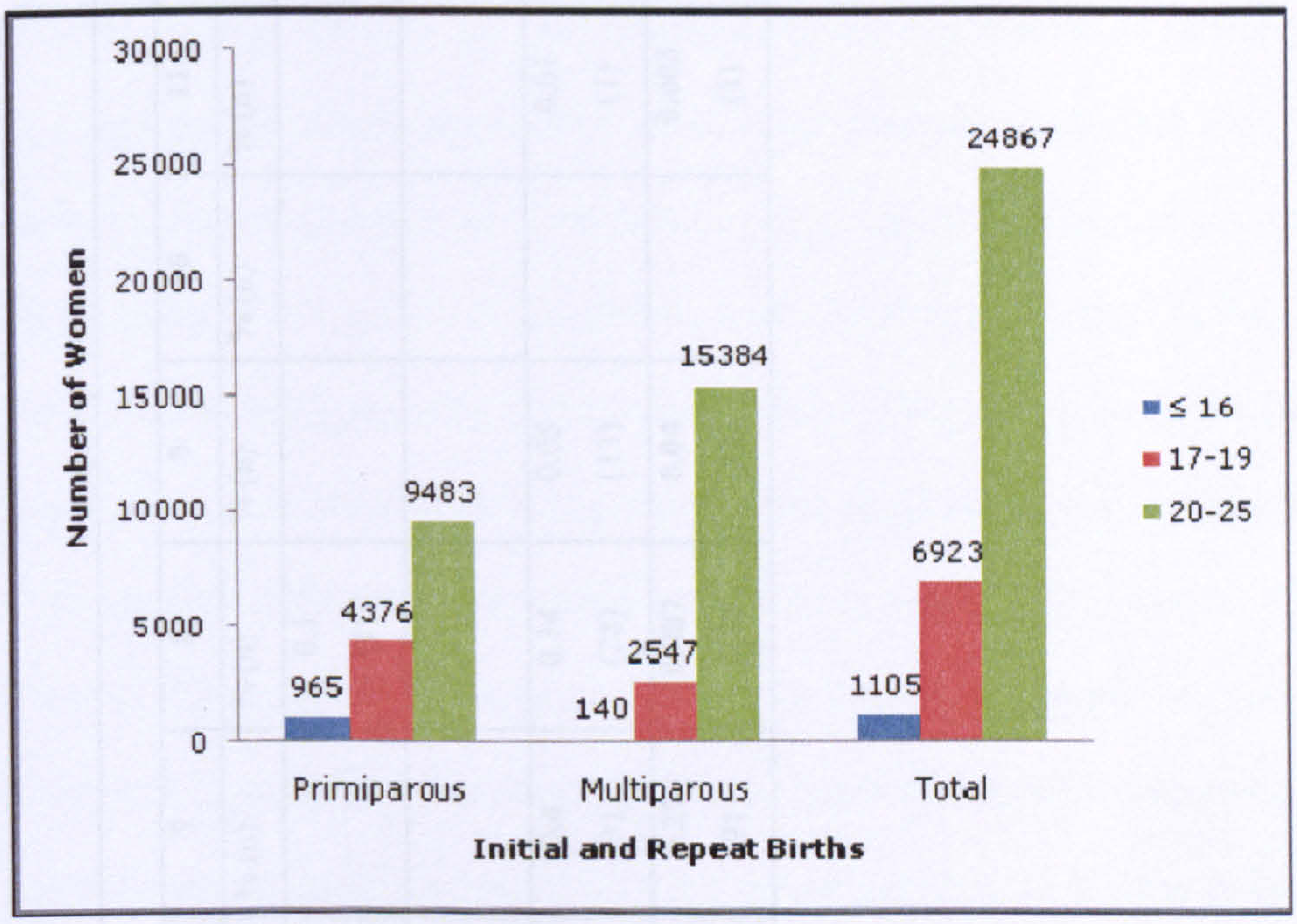


Table 3.22 Number of Pregnancies for Individual Women by Age Group

Age Group	Pregnancies											Total
	1	2	3	4	5	6	7	8	9	10	11	
	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)
≤ 16 years	87.3 (965)	11.8 (130)	0.7 (8)	0.1 (1)				0.1 (1)				100 (1105)
17-19 years	63.2 (4376)	29.06 (2012)	6.29 (436)	1.08 (75)	0.3 (22)	0.07 (2)						100 (6923)
20-25 years	38.1 (9483)	32.6 (8108)	17.3 (4305)	7.4 (1843)	2.9 (714)	1.1 (218)	0.4 (91)	0.14 (28)	0.05 (13)		0.01 (1)	100 (24847)
Total	45.1 (14824)	31.15 (10250)	14.43 (4749)	5.83 (1919)	2.23 (736)	0.86 (283)	0.27 (91)	0.087 (29)	0.04 (13)		0.003 (1)	100 (32895)

3.3.5.11 Multiple Entries for Individual Women in Dataset

Several studies [224, 225, 311] have highlighted that repeat births in teenagers in a short period of time can result in adverse outcomes for the mother and neonate. Summary details of some previous pregnancies were available in the data, but these data did not distinguish between multiple index births to the same woman being recorded in the dataset. Bethea [227] acknowledged within her study that multiple births to the same woman could have been included in the analysis but from the data available to her study was unable to identify the number of women that this affected. Within the current study a method has been used to identify women who have more than one index birth within the same dataset. This was achieved by using several variables to identify births to the same women in the dataset.

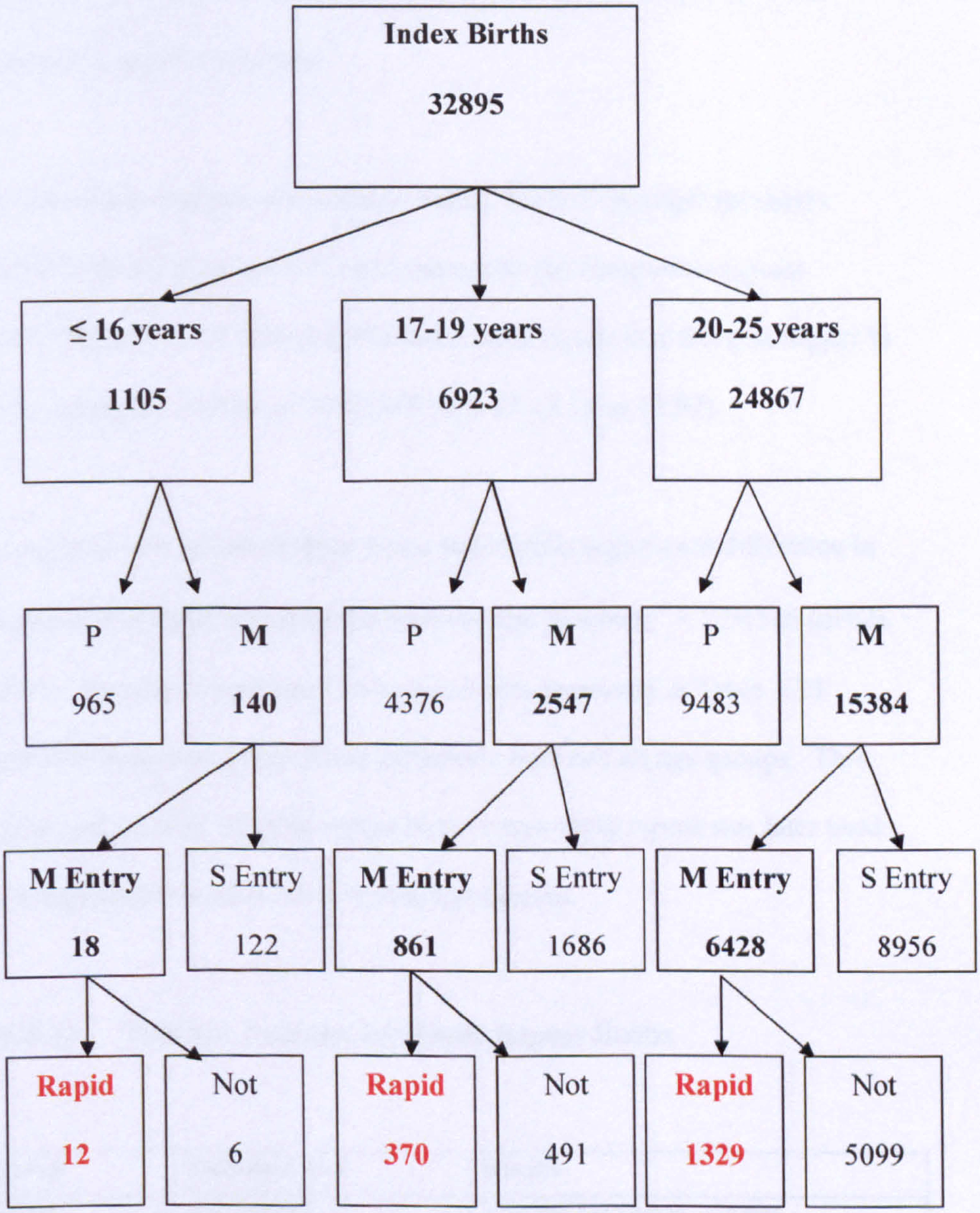
Linking women who gave birth at the same unit could be achieved by using the unique identifier allocated by the maternity system to a woman for all her childbearing at that unit. This can not be used when women have given birth in both study units, for this purpose additional data was required. The Local Research Ethics Committee when granting approval for the research stipulated that all identifying data be removed from the dataset prior to analysis to protect the anonymity of the women. This identifying data included; mother's name, full address, mother's date of birth, general practitioner details, hospital number, unique identifer and next of kin. To identify women having more than one entry in the dataset some of this information was required. A separate smaller dataset was created using patient identifier information, derived hospital number, hospital identifier, mother's name, marital status, mother's date of birth and dates of previous deliveries. These data were then ordered and used to identify women having more than one entry in the dataset. Numbers of entries were then counted for each individual woman in the dataset by using syntax. The strength of this process was that whilst the researcher was carrying out the stages, a visual check could be made of the data and the number of entries for each woman verified. A new variable was then derived that linked these women with all previous index births in the dataset. On completion, only the derived variable that counted the number of entries was merged with the main dataset and linked via the unique identifier to cases. By using this process the terms of ethical approval were achieved and at no point were the personal details of individual women linked to the data analysis. There were 7307 women with multiple entries in the dataset. This was the interim stage used to identify the length of time between multiple entries of index births to individual women in the dataset.

3.3.5.12 Rapid Repeat Births

A short time period between births has been associated with an increased risk of poor maternal and neonatal outcomes [224, 225, 311]. There are variations in the definitions used by researchers to classify a rapid repeat birth. For the purposes of this study a further birth occurring within 18 months of a previous birth as described by Smith *et al* [225] has been adhered to.

The length of time between repeat births to the same woman was then examined. Data were ordered first, by a derived unique identifier, second, date of birth of mother and third, date of delivery. The time between births was then calculated by deducting the date of 1st index birth from the date of 2nd index birth and this process was repeated between 2nd and 3rd until all births to that woman had been exhausted. Rapid repeat births were then recorded for each individual woman and these were births that occurred within 548 days (18 months) of a previous birth. Figure 3.8 demonstrates the pictorial process of first identifying, women having a repeat birth in the dataset and second, of those repeat births how many were rapid repeats.

Figure 3.8 Births by Dataset Showing Number of Repeat Births and Number of Rapid Repeat Births by Age Group



Key to Figure

Line 3	P = Primiparous	M = Multiparous
Line 4	M Entry = Multiple entries for same women in dataset	
	S Entry = Single entry for same women in dataset	
Line 5	Rapid Repeats= Birth occurring to a women within 18 months of a previous	

Of the 18071 multiparous women within the dataset 40.4% (n=7307/18071, 95% CI 39.68 to 41.14) of these had multiple entries for births. In total 23.4% (n=1711/7307, 95% CI 22.43 to 24.37) of these multiple entries fitted the definition of a rapid repeat birth.

When examining multiparous women overall, 8.6% of younger teenagers (n=12/140 95% CI 3.74 to 13.46) and women in the comparative group (n=1329/15384 95% CI 8.16 to 9.04) had a rapid repeat, but this was higher in the older teenagers 14.5% (n=370/2547 95% CI 13.13 to 15.87).

A Chi-squared test indicated there was a statistically significant difference in the proportion of rapid repeat births between age groups ($\chi^2 = 229.345$ (df=2), $p \leq 0.001$). Results of post hoc Chi-squared tests presented in Table 3.23 indicate that there was a significant difference between all age groups. This dichotomised variable of rapid repeat birth or non-rapid repeat was later used as an independent variable when testing hypotheses.

Table 3.23 Post hoc Analysis for Rapid Repeat Births

Age Group	Statistical Test	Results
All groups	Chi-squared	**$\chi^2 = 229.345$ (df=2), $p \leq 0.001$**
≤ 16* v 17-19	Post Hoc chi-squared	**$\chi^2 = 4.028$ (df=1), $p=0.045$**
≤ 16* v 20-25	Post Hoc chi-squared	**$\chi^2 = 23.045$ (df=1), $p \leq 0.001$**
17-19* v 20-25	Post Hoc chi-squared	**$\chi^2 = 211.192$ (df=1), $p \leq 0.001$**

* indicates group with highest proportion of rapid repeat births Bold -= significant result in Table

3.3.5.13 Previous Lower Segment Caesarean Section

In multiparous women the association between repeat LSCS and poor maternal and neonatal outcomes has been described by several researchers [312-315]. The outcome of previous births to multiparous women was recorded in the booking history and available for analysis. Identification of previous LSCS to women was achieved by using syntax to search the previous birth outcome data in multiparous women.

Overall 8.7% (n=1574/18071, 95% CI 8.29 to 9.11) of women had a previous LSCS. Both younger teenagers 1.4% (n=2/140, 95% CI 9.44 to 10.96) and older teenagers 4.3% (n=110/2547 95% CI 3.51 to 5.09) had a small proportion of previous LSCS. The comparative group were over double that in the older teenagers at 9.5% (n=1462/15384, 95% CI 9.04 to 9.96). There was a statistically significant difference between all age groups ($\chi^2 = 271.990$ (df=2), $p \leq 0.001$) and this has been summarised in Table 3.24.

Table 3.24 Post hoc Analysis for Previous Lower Segment Caesarean Section

Age Group	**Statistical Test**	**Results**
All groups	Chi-squared	**$\chi^2 = 271.990$ (df=2), $p \leq 0.001$**
≤ 16 v 17-19*	Post Hoc chi-squared	**$\chi^2 = 13.731$ (df=1), $p \leq 0.001$**
≤ 16 v 20-25*	Post Hoc chi-squared	**$\chi^2 = 64.585$ (df=1), $p \leq 0.001$**
17-19 v 20-25*	Post Hoc chi-squared	**$\chi^2 = 212.070$ (df=1), $p \leq 0.001$**

* indicates group with highest proportion of previous LSCS Bold -= significant result in Table

3.3.5.14 Macrosomic Neonate (Over 4 kgs)

In total 8.6% (n=2817/32628 95% CI 8.3 to 8.9) of women were classified as having a macrosomic neonate at term. Women in the comparative group had the highest proportion of large neonates at 9.2% (n= 2280/24679 95% CI 8.84 to 9.56) and younger teenagers had the lowest proportion at 6.1% (n=67/1105 95% CI 4.69 to 7.51). For older teenagers 6.8% (n=470/6923 95% CI 6.21 to 7.39) had a large neonate. These findings have been summarised in Table 3.25.

Table 3.25 Incidence of Macrosomic Neonate by Age Group

Age Groups	Marcosomic Neonate				
	≤4Kgs		>4 Kgs		Total
	%	n	%	n	n
≤16 years	6.1	67	93.9	1038	**1105**
17-19 years	6.8	470	93.2	6453	**6923**
20-25 years	9.2	2280	90.8	22587	**24867**
Total	**8.6**	**2817**	**91.4**	**30078**	**32895**

Overall, there was a statistically significant difference between age groups of having a large neonate ($\chi^2 = 48.297$ (df=2), $p \leq 0.001$). Post hoc Chi-squared analyses indicated this was statistically significant only between the teenage groups and the comparative group, (≤16 versus 20-25 years $\chi^2 = 12.412$ (df=1), $p \leq 0.001$, 17-19 versus 20-25 years $\chi^2 = 38.812$ (df=1), $p \leq 0.001$).

In Table 3.26 a summary has been provided of the dichotomised associated risk factors presented in this chapter, overall and by age groups. These will be used for comparative purposes later in the thesis.

Table 3.26 Associated Risk Factors for All Women by Age Group

Risk Factors for Hypotheses	Total		Age Group					
			≤16 years		17-19 years		20-25 years	
	Yes	No	Yes	No	Yes	No	Yes	No
	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)
Primiparous n=32895	45.1 (14824)	54.9 (18071)	87 3(965)	12 7 (140)	63 2 (4376)	36 8 (2547)	38 1 (9483)	61.9 (15384)
Smoking* n=17442	35.9 (6255)	64.1 (11187)	38 9 (248)	61.1 (390)	44 9 (1807)	55 1 (2215)	32 9 (4200)	67.1 (8582)
Late booking n=32357	15.4 (4967)	84.6 (27390)	30 0 (324)	70 0 (755)	18 9 (1289)	81 1 (5527)	13.7 (3354)	86 3 (21108)
Multiple births n=32822	0.96 (318)	99.04 (32504)	0 3 (3)	99 7 (1101)	0 6 (44)	99.4 (6869)	1 1 (271)	98 9 (24534)
Non-white n=32629	12.2 (3997)	87.8 (28623)	9 1 (100)	90 9 (993)	10 6 (728)	89 4 (6136)	12 8 (3169)	87 2 (21503)
Epidural* n=19106	40.8 (7786)	59.2 (11320)	55 (336)	45 0 (275)	46 1 (1869)	53 9 (2181)	38 6 (5581)	61 4 (8864)
Prolonged second stage n=28236	10.2 (2894)	89.9 (25342)	9.3 (91)	90.7 (885)	10.2 (621)	89.8 (5455)	10.3 (2182)	89.7 (19002)
Operative birth n= 32469	29.2(9475)	70.8 (22994)	28 2 (309)	71 8 (786)	28 1 (1924)	72 9 (4913)	29 2 (7242)	70 8(17295)
Baby over ≤4kgs at birth n=32895	8.6 (2817)	91.4 (30078)	6.1 (67)	93.9 (1038)	6 8 (470)	93.2 (6453)	9.2 (2280)	90.8 (22587)
Premature birth n=32723	8.9 (2932)	91.1 (29791)	10 9 (120)	89.1 (981)	9.9 (681)	90 1 (6206)	8.6 (2131)	91 4 (22604)
Rapid repeat Birth** n=18071	9.5 (1711)	90.5 (16360)	8.6 (12)	91.4 (128)	14.5 (370)	85.5 (2177)	8.6 (1329)	91.4 (14055)
Previous LSCS** n=18071	8.7 (1574)	91.3 (16497)	1.4 (2)	98 6 (138)	4 3 (110)	95.7 (2437)	9.5 (1462)	90.5 (13922)

*Complete smoking data only available from 1996 to 2001 within the dataset and epidural data only available from one unit

** inclusion of multiparous women only

3.4 Summary of Findings

Women within the dataset have an age range of 13 to 25 years and accounted for approximately 34% (n=32,985/94,775) of births occurring within the two city maternity units during the 10 year study period. The largest age grouping was the comparative group (20-25 years) accounting for 75.6% of index births and the smallest group was the younger teenagers (≤16 years) accounting for only 3.4% of the births. The populations at the two units were similar in age profile and type of birth outcome.

The majority of the women describe themselves as 'single' when replying to the question of marital status at booking. Over half of the women stated partner or husband as their next of kin but a higher proportion of teenagers than women in the comparative group state 'parent' as their next of kin at booking.

The ethnicity of the women in the dataset reflects the city's population and women report a strong association with partners from the same ethnic groups. The exception to this observation was women who stated 'mixed race' as their denomination reported a higher percentage of Caucasian partners. In comparison to data sourced from the East Midlands Observatory site, the dataset is representative of the population mirroring the 15% ethnic minority population found in the city [316].

There are a range of deprivation scores for the women's residence for index pregnancies and women from the teenage groups have higher deprivations scores than the comparative group. This reflects the national picture with higher levels of continuing pregnancies from areas with higher deprivation indices [29, 317].

When examining antenatal variables, teenagers had a higher proportion of APH, premature birth, booking later for care and smoking during pregnancy, than the comparative group. Smoking rates in the study population were also higher than those found nationally for the same time period [318, 319]. The incidence of multiple births was low in the dataset (less than 1%) and this was similar for all age groups.

For intrapartum outcomes higher proportions of younger teenagers had a normal and instrumental birth but a lower proportion of LSCS births. The comparative group were opposite to this with a slightly lower proportion of normal births and instrumental births but the highest proportion of LSCS births. The normal birth rate was similar for all age groups at approximately 70% and was not statistically different. For instrumental births the proportions ranged from 14.4% to 18.3% between age groups and for LSCS between 10.7% and 14.4% and there was a statistical significant difference between age groups. The incidence of breech as a malpresentation was low in the study with less than 1% (0.9%) of pregnancies affected.

Overall, nearly half (44.5%) of women in the study suffered a degree of perineal trauma and this was similar for all age groups. Two fifths of women used an epidural as pain relief during childbirth and this proportion was higher in the teenage groups. Length of second stage of labour was similar for all age groups. When examining gravida the highest number of pregnancies recorded to a woman was 11 and the least 1. Over half of the women were multiparous (54.9%) and 40.4% had multiple entries within the dataset. Of these, 23.4% had a rapid repeat birth. Neonatal outcomes were examined and Apgar score was found to be similar for all age groups but low birth weight was more prevalent in the teenage groups and teenagers having a large neonate were lower in comparison to the comparative group.

These findings provide an insight into the data that were contained within the dataset and has examined differences in outcomes between age groups. However, this analysis does not provide details regarding variations between outcomes for teenagers having a first or subsequent birth to inform service provision. Therefore, the following overarching hypotheses have been posed for further analysis.

3.5 Hypotheses

A. Primiparous teenage women have an increased risk of adverse maternal and neonatal outcomes when compared with primiparous women in their early twenties and this risk is increased further for a younger teenager.

B. Multiparous teenage women have an increased risk of adverse maternal and neonatal outcomes when compared with multiparous women in their early twenties and this risk is increased further for a younger teenager.

C. Multiparous teenage women have an increased risk of adverse maternal and neonatal outcomes when compared to primiparous teenage women.

D. Multiparous teenage women having a rapid repeat birth have an increased risk of adverse maternal and neonatal outcomes when compared to multiparous teenagers not having a rapid repeat birth.

These overarching hypotheses will provide the context for sets of four hypotheses posed for each of the seven outcomes examined within the following chapters. These seven outcomes span antepartum (examined in chapter 4), intrapartum (examined in chapter 5) and postpartum (examined in chapter 6) periods of childbearing. The seven outcomes examined are grouped according to the period of childbearing in which they occur:

- antepartum haemorrhage and premature birth (chapter 4),
- instrumental birth, lower segment caesarean birth and perineal trauma (chapter 5),
- low apgar score and low birth weight (chapter 6).

CHAPTER 4 ANTEPARTUM OUTCOMES

4.1 Introduction

This chapter will explore antenatal outcomes for teenage women and compare them to outcomes in women in their early twenties. The literature review highlighted that teenage pregnancies have been associated with an increased incidence of antepartum haemorrhage and premature birth. These two conditions will be described and defined. Data will be analysed and findings compared with previously published literature.

4.2 Antepartum Haemorrhage

The definition used within this thesis for antepartum haemorrhage (APH) is that described as:

> "vaginal bleeding from the genital tract after the 22nd week of pregnancy"
>
> [320, p.228].

APH can be caused by bleeding from the placental site due to partial or complete separation of a placenta from the uterine wall or from lesions within the genital tract described as 'extraplacental bleeding' by Lindsay [321]. APH complicates between 2% and 5% of pregnancies and can result in fetal and maternal morbidity and mortality [320]. There are two common placental complications resulting in an APH: placenta praevia and placental abruption; in addition extraplacental complications may also cause APH.

4.2.1 Placenta Praevia

Placenta praevia occurs when the placenta is partially or completely implanted in the lower uterine segment as opposed to the normal implantation of the placenta in the upper uterine segment. The incidence of placenta praevia is stated as 1 in 200 pregnancies [322, 323] but this varies in incidence between primigravidae (1 in 250 pregnancies) and multigravidae (1 in 90 pregnancies). There is an additional variation in the incidence when a woman's age is considered. Lockwood and Funai [324] found an increased risk of placenta praevia as a woman's age increased. The aetiology of placenta praevia is unknown but factors that have an impact on the health of the decidua at the time of implantation have been associated with an increased risk of placenta praevia [325].

The main associated risk factors with placenta praevia are advancing maternal age, [326], smoking [327], previous caesarean section resulting in scar tissue formation [328] and a previous history of placenta praevia [320]. Earlier researchers [326] found that multiple pregnancies were also associated with placenta praevia, although this has been disputed by more recent research undertaken by Francois *et al* [325] that found no increased risk when comparing singleton and multiple pregnancies in a large cohort study.

4.2.2 Placental Abruption

Placental abruption is described as:

'bleeding following premature separation of a normally situated placenta'

[320, p 232]

Konje and Taylor [191] found that 0.49%-1.8% of pregnancies are affected by placental abruption. The aetiology of this specific type of antepartum haemorrhage has been associated with several factors including pregnancy induced hypertension [329], a sudden reduction in uterine size following rupture of the membranes or the birth of the first infant in a multiple pregnancy and as a result of direct trauma to the abdomen [330]. Research by Rasmussen *et al* [331] found that a previous caesarean increased the risk of placental abruption by 40%, whilst Andres [327] found a positive correlation between maternal smoking and abruption. Women having a higher parity [329] together with those from socially deprived backgrounds appear to be at increased risk [332]. As this complication has a poor outcome for both the mother and her unborn child it is an important aspect to investigate, particularly as many pregnant teenagers have several of the risk factors mentioned above. Particularly pregnant teenagers have higher social deprivation scores than their non-pregnant peers [10, 94] and more continue to smoke during their pregnancies when compared to older women [45].

4.2.3 Extraplacental Bleeding

The occurrence of genital lesions and extra-uterine APH are very rare and have been termed by Lindsay [321] as being "incidental or associated bleeding". This type of antepartum haemorrhage is a result of bleeding from either cervical polyps or cervical erosions but not the placenta site [321]. Lindsay [321] found that this occurred more frequently in older women and therefore is not so relevant here as the dataset is drawn from younger women.

4.3 Prematurity

Prematurity is the term used to describe an infant born before the completion of the 37^{th} week of pregnancy and accounts for approximately 7.4% of all births in England and Wales [195]. The term 'premature' has been further sub-divided by neonatologists into several categories depending on gestational age of the infant and it has been argued that the definition provided above should be amended to completion of the 34^{th} week of pregnancy due to advances in medical science [196]. However, for the purposes of this midwifery focused thesis (≤37 weeks) the official definition used in previous epidemiological studies [162, 195] will be adhered to, as this is consistent with the definition used to inform care provision within current maternity services.

Infants born prematurely have a higher morbidity and mortality rate in the first year of their life than term infants born between 37 and 43 weeks gestation [195]. The purpose of the in-utero assessment of a fetus' gestation is important as it informs the provision of care required during labour and birth, as all necessary precautions must be undertaken to maximise the chances for survival for the infant. National guidance [333] stresses that care should be led by an obstetrician in close liaison with a paediatrician in cases of premature labour and birth.

Prematurity is often a complication of a twin or higher order pregnancy, twin pregnancies accounted for 144.8 per 10,000 maternities in the UK during the year 2000 [334]. However, the rates of multiple pregnancies for women under 20 years of age are greatly reduced falling to just 61.2 per 10,000 maternities in the UK [334]. The impact of multiple births on the incidence of premature births is an important risk factor to be adjusted for even if the incidence in the study population is low. Therefore, it will be included in the analysis completed in this chapter.

Time of booking and adequate antenatal care has been presented as an associated risk factor when examining pregnancy outcomes. Smith and Pell [162] found that teenagers booked later in pregnancy than other women thus excluding them from full screening and care opportunities. As this may have an impact on antenatal complications that are being investigated in this thesis the time of booking will be included in the analysis. A common definition for a woman booking late for care adopted by previous researchers is booking post twenty weeks gestation [14, 189, 294] and this has been adhered to in this study.

In previous studies the incidence of prematurity was reported to be higher amongst teenage pregnancies especially in subsequent births [162, 197, 200, 213] although not all these studies adjusted for other associated risk factors during analysis.

Overall factors, identified by previous researchers that are associated with an increase risk of both APH and premature labour include smoking, deprivation, parity, previous LSCS, multiple births and rapid repeat births. These risk factors will be included adjusted for and examined in the analysis.

4.4 Hypotheses

Antepartum Haemorrhage

4.1a. Primiparous teenage women have an increased risk of antepartum haemorrhage when compared to primiparous women in their early twenties and this risk is increased further for younger teenagers.

4.1b. Multiparous teenage women have an increased risk of antepartum haemorrhage when compared to multiparous women in their early twenties and this risk is increased further for younger teenagers.

4.1c. Multiparous teenage women have an increased risk of antepartum haemorrhage when compared to primiparous teenage women.

4.1d. Multiparous teenage women having rapid repeat births have an increased risk of antepartum haemorrhage when compared to multiparous teenagers not having rapid repeat births.

Premature Birth

4.2a. Primiparous teenage women have an increased risk of premature birth when compared to primiparous women in their early twenties and this risk is increased further for younger teenagers.

4.2b. Multiparous teenage women have an increased risk of premature birth when compared to multiparous women in their early twenties and this risk is increased further for younger teenagers.

4.2c. Multiparous teenage women have an increased risk of premature birth when compared to primiparous teenage women.

4.2d. Multiparous teenage women having rapid repeat births have an increased risk of having a premature birth when compared to multiparous teenagers not having rapid repeat births.

Footnote: teenagers=women 19 years or under
Younger teenagers=woman aged 16 years and under

4.5 Analysis

Once data preparation was complete an exploratory analysis was undertaken on the variables of antepartum haemorrhage and premature birth. The recoded dichotomous data defining occurrence of an event was initially examined in a series of univariate analyses and continuous data were examined using boxplots. Associations between age and outcomes were then examined using cross-tabulations and Chi-squared tests for association. Unadjusted logistic regression analysis was completed for each of the outcome measures and associated risk factors. Then multivariate manual backward stepwise conditional logistic regression models were used to test the hypotheses. The rationale for selecting this type of logistic regression analysis has been presented in chapter 2 (p. 110). For hypotheses 4.1a, 4.1c and 4.2a and 4.2c associated risk factors adjusted for in the models were; smoking, late booking, multiple birth, and socio-deprivation. For hypotheses 4.1b and 4.2b associated risk factors adjusted for were; smoking, late booking, multiple birth, social deprivation, rapid repeat birth and previous LSCS. For hypotheses 4.1d and 4.2d smoking, late booking, multiple birth, social deprivation and previous LSCS were adjusted for.

4.6 Results

Within the initial section for each outcome the findings of univariate analysis for the whole sample have been repeated from chapter 3 to set the scene for the analysis within this chapter.

4.6.1 Antepartum Haemorrhage

Details for 100% (n=32895) of births were available for analysis. Overall 5.3% (n=1739, 95% CI 5.06 to 5.54) of index pregnancies were complicated by antepartum haemorrhage (APH). Teenage women had higher rates of pregnancies complicated by APH, with 6.6% (n=73 95% CI 5.14 to 8.06) of younger teenagers and 6.3% (n=435 CI 5.73 to 6.87) of older teenagers in comparison to 5.0% (n=1231 CI 4.76 to 5.24) of the comparative group and there was a statistically significant ($\chi^2 = 23.198$ (df=2), $p \leq 0.001$) difference between age groups.

A Chi-squared test indicated there was a significant difference in the occurrence of APH between groups ($\chi^2 = 23.198$ (df=2), $p \leq 0.001$). A post-hoc Chi-squared test indicated this was only significant between the teenage groups and the comparative group (≤16 versus 20-25, $\chi^2 = 6.084$ (df=1), p=0.014; 17-19 versus 20-25, $\chi^2 = 19.379$ (df=1), $p \leq 0.001$).

Unadjusted logistic regression analyses identified that older teenagers were 1.3 times (OR=1.287, 95% CI 1.166 to 1.443, $p \leq 0.001$) more likely to have an

APH in comparison to the comparative group. For younger teenagers the risk of having an APH was slightly higher at 1.36 times (OR=1.358, 95% CI 1.064 to 1.734, p=0.014) more likely than the comparative group.

4.6.2 Prematurity

Details for 99.5% (n=32723) of women were available pertaining to gestation at time of birth. Overall 8.9% (n=2932, 95% CI 8.59 to 9.21) of index births resulted in a premature birth. Teenage women had higher rates of premature birth, with 10.9% (n=120 95% CI 9.06 to 12.74) of younger teenagers and 9.9% (n=681 CI 9.19 to 10.61) of older teenagers in comparison to 8.6% (n=2131 CI 8.25 to 8.95) of the comparative group and there was a statistically significant (χ^2 = 15.952 (df=2), p$\leq$ 0.001) difference between age groups.

A Chi-squared test indicated there was a significant difference in the occurrence of premature birth between groups (χ^2 = 15.952 (df=2), p$\leq$0.001). A post-hoc Chi-squared test indicated this was only significant between the teenage groups and the comparative group ($\leq$16 versus 20-25, χ^2 = 6.913 (df=1), p=0.009) and 17-19 versus 20-25, χ^2 = 10.773 (df=1), p=0.001).

Unadjusted logistic regression analyses showed that older teenagers were 1.2 times (OR=1.182, 95% CI 1.085 to 1.288, p$\leq$ 0.001) more likely to have a premature birth in comparison to the comparative group. For younger teenagers the risk of having a premature birth was higher at 1.3 times

(OR=1.298, 95% CI 1.068 to 1.576, p= 0.009) more likely compared to the comparative group.

Known risk factors included in the multivariate analysis were: whether this was a woman's first birth, did the woman smoke, did the woman book late for care, was it a singleton or multiple birth, did a multiparous woman had a previous LSCS, did a multiparous woman have a rapid repeat birth. Only one continuous risk factor has been included in the analysis and that was the Jarman enumeration score for the woman. The presence of these risk factors will be examined for women who had an APH or a premature birth and compared with the findings for those who did not.

4.6.3 Presence of Associated Risk Factors for Women having an Antepartum Haemorrhage during Pregnancy or Labour

Women having an APH during either the index pregnancy or labour were selected for analysis and the presence of identified associated risk factors in these women are summarised in Table 4.1, Figure 4.1 and Table 4.3. All univariate logistic regression analysis was undertaken on women having either an APH or not.

Primiparous births – the proportion of women having an APH that were primiparous was 42% (n=731/1739, 95% CI 39.68 to 44.32). This was lower than within the overall population (45.1%), and marginally higher only in younger teenagers (≤16 87.7% versus 87.3%, 17-19 62.1% versus 63.2%, 20-

25 32.3% versus 38.1%). Univariate logistic regression analysis on women who had either an APH or not, found that primiparous women were less likely (OR=0.878, CI 0.796 to 0.968; p=0.009) to have an APH than women having a subsequent birth.

Smoking status –the proportion of women having an APH that were smokers was 31.2% (n=411/1319, 95% CI 28.70 to 33.70). This was lower than the overall population (35.9%) and the proportion was lower for each age group (≤16 34.6% versus 38.9%, 17-19 39% versus 44.9%, 20-25 28.1% versus 32.9%). However, on completion of univariate logistic regression analysis on women who had either an APH or not, women who smoked during pregnancy were 1.27 times more likely (OR=1.277, CI 1.133 to 1.440; p≤0.001) to have an APH than women who did not smoke.

Late booking – the proportion of women having an APH that had booked late for care was 12.5% (n=213/1707, 95% CI 10.93 to 14.07). This was lower than the overall population (15.4%) and the proportion was lower for each of the age groups, with younger teenagers being nearly half that found in the overall population (≤16 16.4% versus 30.0%, 17-19 14.8% versus 18.9%, 20-25 11.4% sus 13.7%). Univariate logistic regression analysis on women who had either an APH or not found that women who booked later for care in pregnancy were less likely (OR=0.777, CI 0.671 to 0.899; p=0.001) to have an APH than women who booked for care before 20 weeks gestation.

Multiple births – the proportion of women having an APH that had a multiple birth was 0.7% (n=12/1739, 95% CI 0.37 to 1.21). This was lower than the overall population (0.96%) and remained the case for all age groups with no multiple births occurring in the younger teenagers (≤16 0% versus 0.3%, 17-19 0.2% versus 0.6%, 20-25 0.9% versus 1.1%). Univariate logistic regression analysis on women who had either an APH or not found that women who had a multiple birth had no significant difference in risk (OR=0.699, CI 0.392 to 1.247; p=0.225) of having an APH when compared to a woman having a singleton birth.

Rapid repeat births – the proportion of women having an APH that had a rapid repeat birth was 9.4% (n=95/1008, 95% CI 7.6 to 11.2). This was similar to the overall population (9.5%). There was a variation for age groups when compared with the overall population. The proportion was lower for younger teenagers where no rapid repeat births occurred and slightly lower for older teenagers (≤16 0% versus 8.6 %, 17-19 13.3% versus 14.5%) but marginally higher in the comparative group (8.8% versus 8.6%). Univariate logistic regression analysis on women who had either an APH or not, found that women who had a rapid repeat birth had no significant difference in risk (OR=0.995, CI 0.800 to 1.236; p=0.995) of having an APH when compared to a multiparous woman who had not had a rapid repeat birth.

Previous LSCS – the proportion of women having an APH that had a previous LSCS was 8.3% (n=84/1008, 95% CI 6.6 to 10.0). This was similar to the overall population (8.7%) and this was consistent for older teenagers and the comparative group (17-19 4.2% versus 4.3%, 20-25 9.2% versus 9.5%). There were no previous LSCS occurring in the younger teenagers (≤16 0% versus 1.4 %). Univariate logistic regression analysis on women who had either an APH or not found that women who had a previous LSCS had no significant difference in risk (OR=0.950, CI 0.755 to 1.195; p=0.662) of having an APH when compared to a multiparous women who had not had a previous LSCS.

Deprivation – for women having an APH, Jarman enumeration scores were calculated for 96.26% (n=1674/1739, 95% CI 95.16 to 97.01) of women. The range in Jarman score was between -37.00 and 56.50 with a mean ($\bar{x}$) deprivation score of 11.87 (SD=16.29), which was higher than the mean Jarman score for the overall population ($\bar{x}$=10.52, [SD=16.37]). A boxplot was used to examine differences between the age groups for deprivation score and has been illustrated in Figure 4.1. When comparing age groups women having an APH came from a more deprived background than the overall population (≤16, $\bar{x}$=14.51 [SD=15.40] versus $\bar{x}$=12.5, [SD=16.16]; 17-19, $\bar{x}$=14.73 [SD=15.67] versus $\bar{x}$=13 [SD=16.08]; 20-25, $\bar{x}$=10.70 [SD=16.43] versus $\bar{x}$=9.7 [SD=16.37]). Univariate logistic regression analysis on women who had either an APH or not, found that a woman from a deprived background had an increased risk (OR=1.005, CI 1.002 to 1.008; p=0.001) of having an APH when compared to a woman from a less deprived background. For each increase of one in the deprivation score a woman from a deprived background was 1.005 times more likely to have an APH.

Figure 4.1 Boxplot of Jarman Enumeration Score by Age Group In Women Having an Antepartum Haemorrhage

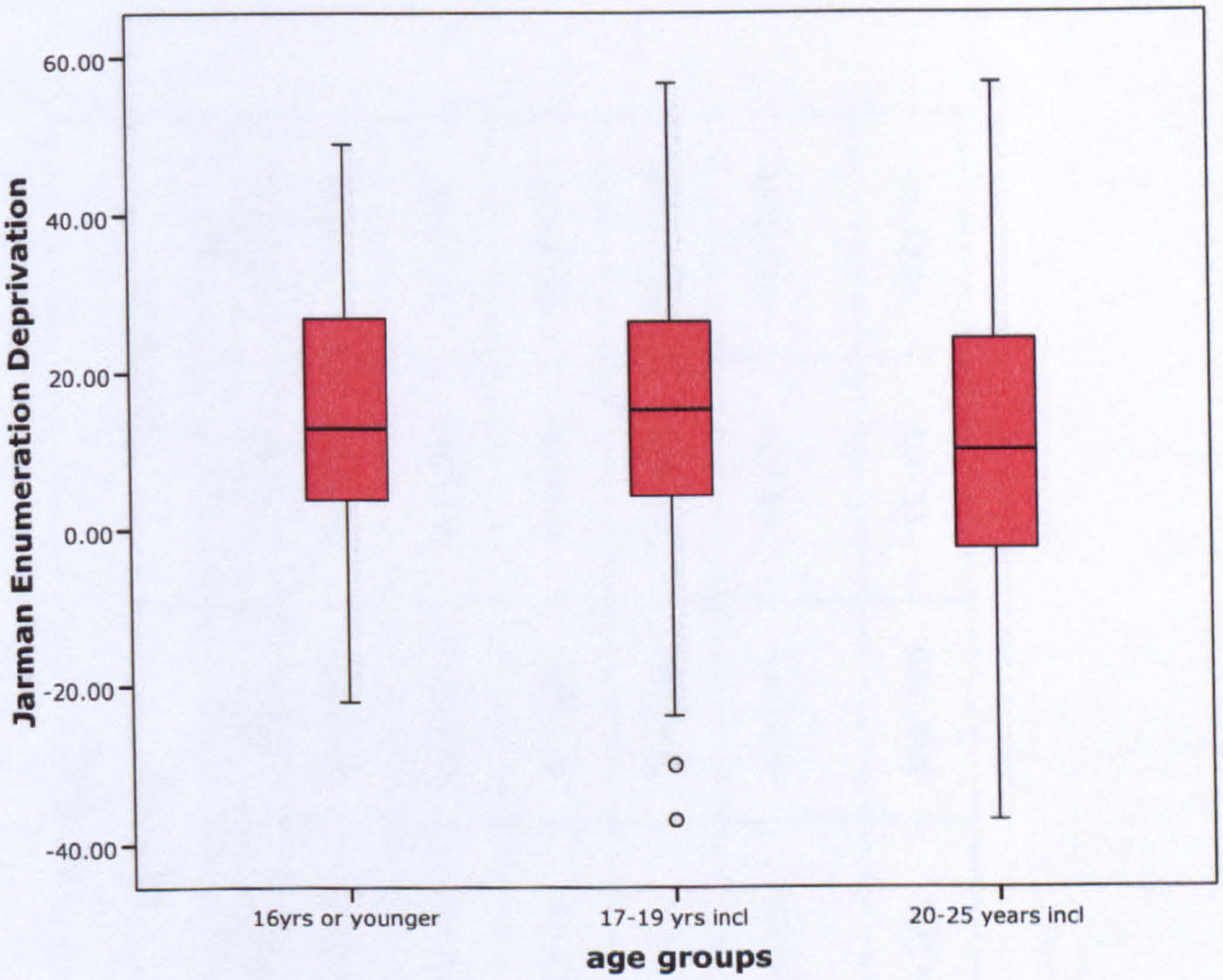


Table 4.1 Presence of Risk Factors Associated With Antepartum Haemorrhage ByAge Group

Factors Affecting Birth Outcome	Total		Age Group					
			≤16 years		17-19 years		20-25 years	
	Yes	No	Yes	No	Yes	No	Yes	No
	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)
Primiparous n=1739	42.0 (731)	58.0 (1008)	87.7(64)	12.3 (9)	62.1 (270)	37.9(165)	32.3 (397)	67.7 (834)
Smoking* n=1319	31.2 (411)	68.8 (908)	34.6 (18)	65.4 (34)	39.0 (134)	61.0 (210)	28.1 (259)	71.9 (664)
Late booking n=1707	12.5 (213)	87.5 (1494)	16.4 (12)	83.6 (61)	14.8 (63)	85.2 (364)	11.4 (138)	88.6 (1069)
Multiple births n=1739	0.7 (12)	99.3 (1727)	0.0(0)	100 (73)	0.2 (1)	99.8 (434)	0.9 (11)	99.1 (1220)
Rapid repeat birth§ n=1008	9.4 (95)	90.6 (913)	0 (0)	100 (9)	13.3 (22)	86.7 (143)	8.8 (73)	91.2 (761)
Previous LSCS§ n=1008	8.3 (84)	91.7 (924)	0 (0)	100 (9)	4.2 (7)	95.8 (158)	9.2 (77)	90.8 (757)

*Complete smoking data only available from 1996 to 2001 within the dataset

§analysis undertaken on multiparous women only

4.6.4 Presence of Associated Risk Factors for Women having a Premature Birth

Women having a premature birth were identified for analysis and the presence of associated risk factors in these births has been summarised in Table 4.2, Figure 4.2 and Table 4.3. All univariate logistic regression analysis was undertaken on women having either a premature or full term birth.

Primiparous births – the proportion of women having a premature birth that were primiparous was 46% (n=1348/2932, 95% CI 44.20 to 47.80). This was higher than the overall population (45.1%) and the proportion was lower in the teenage groups (≤16 84.2% v 87.3%, 17-19 58.4% v 63.2%) but higher in the comparative group (39.8% v 38.1%). Univariate logistic regression analysis on women who had either a premature birth or term birth, found that primiparous women had a similar risk (OR=1.042, CI 0.966 to 1.125; p=0.285) of premature birth as women having a subsequent birth.

Smoking status– the proportion of women smokers having a premature birth was 30.8% (n=703/2286, 95% CI 28.91 to 32.69). This was lower than the overall population (35.9%) and the proportion was lower for each age group (≤16 32.3% v 38.9%, 17-19 37.5% v 44.9%, 20-25 28.5% v 32.9%). However, on completion of univariate logistic regression analysis, on women who had either a premature birth or term birth, women who smoked during pregnancy were 1.26 times more likely (OR=1.264, CI 1.151 to 1.388; p≤0.001) to have a premature birth than women who did not smoke.

Late booking – the proportion of women who booked late for care having a premature birth was 24.9% (n=686/2755, 95% CI 23.29 to 26.51). This was higher than the overall population (15.4%) and the proportion was approximately 50% higher for each of the age groups, (≤16 47.2% v 30.0%, 17-19 28.5% v 18.9%, 20-25 22.5% v 13.7%). Univariate logistic regression analysis on women who had either a premature birth or term birth, found that women who booked later for care in pregnancy were twice as likely (OR=1.962, CI 1.790 to 2.152; p≤0.001) to have a premature birth than women who booked for care before 20 weeks gestation.

Multiple births – the proportion of women having a premature birth that had a multiple birth was 6.2% (n=181/2932, 95% CI 5.33 to 7.07). This was six times higher than the overall population (0.96%) and remained higher for all age groups (≤16 0.8% v 0.3%, 17-19 3.4% v 0.6%, 20-25 7.4% v 1.1%). Univariate logistic regression analysis on women who had either a premature birth or term birth, found that women who had a multiple birth were 14.7 times more likely (OR=14.781, CI 11.771 to 18.561; p≤0.001) to have a premature birth when compared to a woman having a singleton birth.

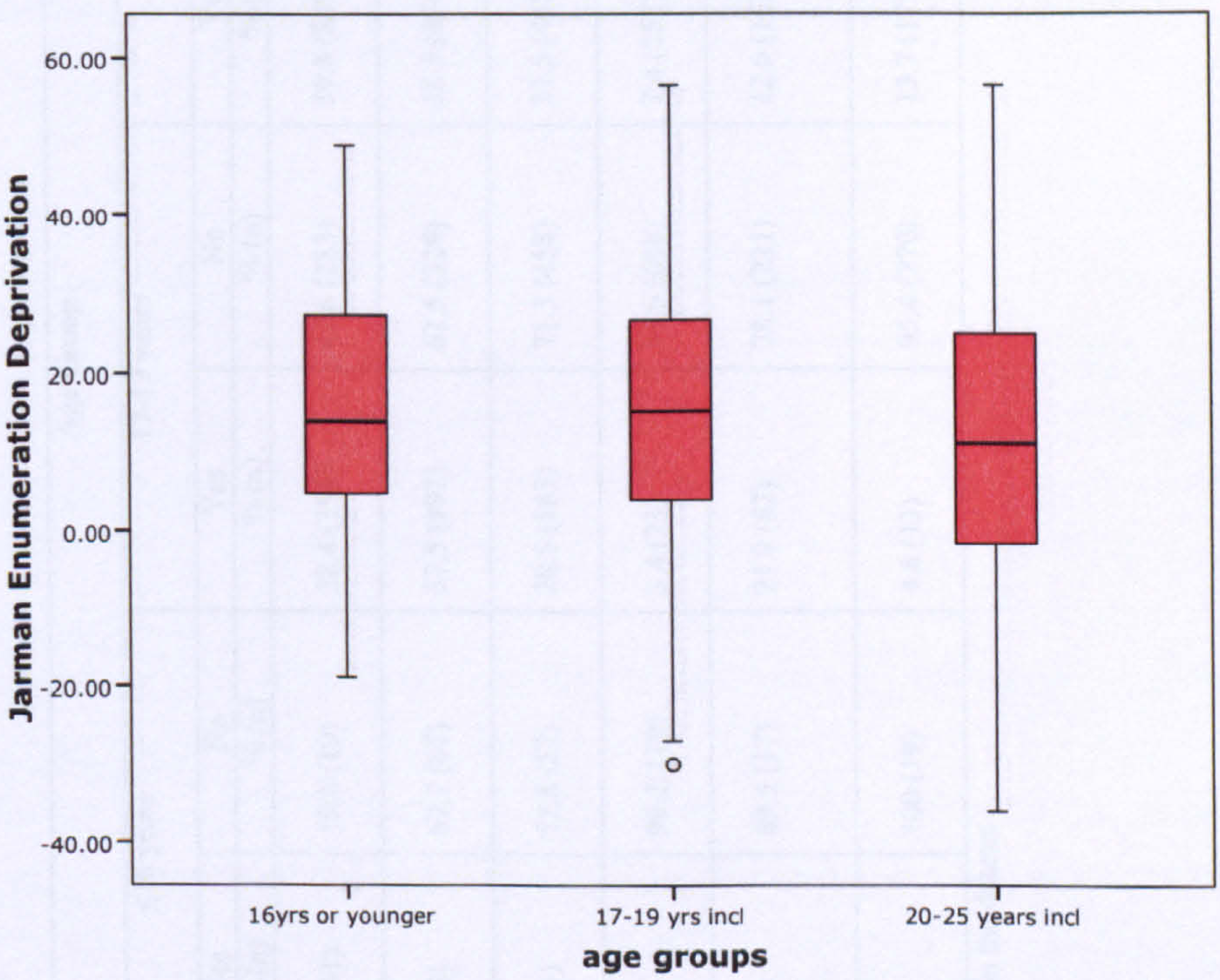
Rapid repeat births – the proportion of women having a premature birth that had a rapid repeat birth was 14.3% (n=226/1584, 95% CI 12.58 to 16.02). This was higher than the overall population (9.5%). There was a variation for age groups when compared with the overall population. The proportion was only slightly higher for younger teenagers (10.5% v 8.6%) but a third higher in the two older age groups (17-19 21.9% v 14.5%, 20-25 12.6% v 8.6%). Univariate logistic regression analysis on women who had either a premature birth or term birth, found that women who had a rapid repeat birth were 1.7 times more likely (OR=1.693, CI 1.456 to 1.968; $p \leq 0.001$) to have a premature birth when compared to a multiparous women who had not had a rapid repeat birth.

Previous LSCS – the proportion of women having a premature birth that had a previous LSCS was 11.9% (n=188/1584, 95% CI 10.31 to 13.49). This was higher than the overall population (8.7%) and was higher in the two older age groups (17-19 4.6% versus 4.3%, 20-25 13.7% versus 9.5%) but no previous LSCS occurred in the younger teenagers (≤16 0% v 1.4 %). Univariate logistic regression analysis on women who had either a premature birth or term birth, found that women who had a previous LSCS were 1.5 times more likely (OR=1.465, CI 1.246 to 1.722; $p \leq 0.001$) to have a premature birth when compared to a multiparous women who had not had a previous LSCS.

Deprivation - Within the dataset Jarman enumeration district was calculated for 91.33% (n=2678/2932, 95% CI 90.31 to 92.35) of women. The range in Jarman score was between -36.00 and 56.50 with a mean ($\bar{x}$) deprivation score of 12.22 (SD=16.39), which was higher than the mean Jarman score for the overall population ($\bar{x}$=10.2, [SD=16.37]). A boxplot was used to examine differences between the age groups for Jarman deprivation score and has been illustrated in Figure 4.2.

Comparing the mean Jarman scores for age groups in women having a premature birth, with those for the overall population, the two older groups of women came from a more deprived background ,(17-19, $\bar{x}$=14.30 [SD=16.1] versus $\bar{x}$=13.5 [SD=16.08]; 20-25, $\bar{x}$=11.27 [SD=16.5] versus $\bar{x}$=8.9 [SD=16.37]). Younger teenagers were from a more affluent background than those in the overall population ($\bar{x}$= 14.30, [SD=16.1] versus $\bar{x}$=12.5, [16.16]).

Figure 4.2 Boxplot of Jarman Enumeration Score by Age Group for Women Having a Premature Birth



Univariate logistic regression analysis on women who had either a premature birth or term birth, found that a woman from a deprived background had an increased risk (OR=1.007, CI 1.005 to 1.009; $p \leq 0.001$) of having a premature birth when compared to a woman from a less deprived background. For each increase of one in the deprivation score a woman from a deprived background was 1.007 times more likely to have a premature birth.

Table 4.2 Presence of Risk Factors Associated With Premature Birth ByAge Group

Factors Affecting Birth Outcome	Total		Age Group					
			≤16 years		17-19 years		20-25 years	
	Yes	No	Yes	No	Yes	No	Yes	No
	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)
Primiparous n=2932	46.0 (1348)	54.0 (1584)	84.2 (101)	15.8 (19)	58.4 (398)	41.6 (283)	39.8 (849)	60.2 (1282)
Smoking* n=2286	30.8 (703)	69.2 (1583)	32.3 (32)	67.7 (67)	37.5 (197)	62.5 (329)	28.5 (474)	71.5 (1187)
Late booking n=2755	24.9 (686)	75.1 (2069)	47.2 (51)	52.8 (57)	28.5 (183)	71.5 (458)	22.5 (452)	77.5 (1554)
Multiple births n=2932	6.2 (181)	93.8 (2751)	0.8(1)	99.2(119)	3.4 (23)	96.6 (658)	7.4 (157)	92.6 (1974)
Rapid repeat birth** n=1584	14.3 (226)	85.7 (1358)	10.5 (2)	89.5 (17)	21.9 (62)	78.1 (221)	12.6 (162)	87.4 (1120)
Previous LSCS** n=1584	11.9 (118)	88.1 (1396)	0 (0)	100 (19)	4.6 (13)	95.4 (270)	13.7 (175)	86.3 (1107)

*Complete smoking data only available from 1996 to 2001 within the dataset

** analysis undertaken on multiparous women only

4.6.5 Unadjusted Odds Ratios for Associated Risk Factors by Outcome of Interest

Unadjusted odds ratios were undertaken for all associated risk factors individually, APH compared to no APH and premature birth compared to full term birth. These are reported in the text and are presented in Table 4.3.

Table 4.3 Unadjusted Odds Ratios for Associated Risk Factors by Outcome of Interest

Associated Risk Factor	Outcome of Interest	
	APH Odds Ratio (95% CI)	Premature Birth Odds Ratio (95% CI)
Primiparous – yes/no	**0.878 (0.796 – 0.968) p=0.009**	1.042 (0.966 – 1.125) p=0.285
Smoking* - yes/no	**1.277 (1.133 – 1.440) p≤0.001**	**1.264 (1.151 – 1.388) p≤0.001**
Late booking – yes/no	**0.777 (0.671 – 0.899) p=0.001**	**1.962 (1.790 – 2.152) p≤0.001**
Multiple birth – yes/no	0.699 (0.392 – 1.247) p=0.225	**14.781 (11.771 – 18.561) p≤0.001**
Deprivation - continuous	**1.005 (1.002 – 1.008) p=0.001**	**1.007 (1.005 – 1.009) p≤0.001**
Rapid repeat birth yes/no§	0.995 (0.800 – 1.136) p=0.961	**1.693 (1.456 – 1.968) p≤0.001**
Previous LSCS - yes/no §	0.950 (0.755 – 1.195) p=0.662	**1.465 (1.246 -1.722) p≤0.001**

*complete smoking data was only available from 1996 to 2001

§ analysis undertaken on multiparous women only

Bold indicates significant finding

4.6.6 Multivariate Logistic Regression Explaining Birth Outcome Adjusting For Risk Factors

In this section backward manual conditional logistic regression has been undertaken. Each model is developed to address a hypothesis. The variable responsible for the large number of missing cases in each of the models undertaken was 'smoking status' during pregnancy. As stated previously completed data was only available from 1996 onwards, therefore resulting in a large number of missing cases. As a result each of the models has been run with smoking in and then run again with it excluded from the model and any differences in findings have been stated within the text and the relevant results tables.

Models examining Hypothesis 4.1a

Hypothesis 41a
'Primiparous teenage women have an increased risk of antepartum haemorrhage when compared to primiparous women in their early twenties and this risk is increased further for a younger teenager'

After selecting only primiparous women a backward manual stepwise conditional logistic regression model was run with having an antepartum haemorrhage or not as the outcome. Age group remained in the model regardless of significance and the explanatory variables included in the model were:

Smoking status- Yes/No

Late booking- Yes/No

Multiple birth- Yes/No

Jarman enumeration district- Continuous

Women having their first birth (n=14824) were selected for analysis with variables being entered into the model. At the initial stage 10440 (70.4%) cases were entered into the model and the final regression model contained 13628 (91.9%) cases. The first variable to be removed was smoking (OR=1.135, 95% CI 0.925 to 1.394; p=0.226), followed by multiple birth (OR=1.407, 95% CI 0.612 to 3.234; p=0.421). All other risk factors remained significant at the 0.05 level and therefore remained in the model. The findings of the analysis can be found in Table 4.4. A primiparous teenager had an increased risk of having an antepartum haemorrhage after adjusting for late booking and deprivation when compared to the comparative group. For a younger teenager this risk was slightly higher (OR= 1.676) than for an older teenager (OR= 1.481). For primiparous women from a deprived background there was an increased risk (OR=1.01) of having an antepartum haemorrhage but booking late for care was associated with a lower risk (OR=0.66) of having an antepartum haemorrhage.

Using the Nagelkerke R Squared test the model only explained 1.0% of the variance and the Hosmer and Leweshow Test (χ^2 = 8.215 (df=8), p=0.413) indicated the model was a good fit. The final model correctly classified 95.0% of cases and this was not increased on completion of the model.

A model excluding smoking was not repeated as being a smoker was the first variable to be removed from the model and the findings would be the same as before.

Table 4.4 Model for Hypothesis 4.1a Examining Antepartum Haemorrhage in Primiparous Women

Factor	Unadjusted OR for primiparous women (95%CI)	Adjusted OR for primiparous women (95% CI) n=13628
20-25 years ≤ 16 years 17-19 years	1.00 **1.626 (1.238 to 2.135) p≤0.001** **1.505 (1.284 to 1.764) p≤0.001**	1.00 **1.676 (1.262 to 2.227) p≤0.001** **1.481 (1.253 to 1.751) p≤0.001**
Smoking status* - yes/no	**1.247 (1.024 to 1.517) p=0.024**	
Late booking – yes/no	**0.771 (0.615 to 0.967) p=0.024†**	**0.664 (0.521 to 0.846) p≤0.001 †**
Multiple birth – yes/no	1.142 (0.531 to 2.457) p=0.734	
Jarman – continuous	**1.007 (1.002 to 1.011) p=0.004**	**1.005 (1.000 to 1.010) p=0.031**

*complete smoking data was only available from 1996 to 2001

† indicates a lower risk of APH in the results table

Bold indicates significant finding

Models examining Hypothesis 4.1b

Hypothesis 4.1b

'Multiparous teenage women have an increased risk of antepartum haemorrhage when compared to multiparous women in their early twenties and this risk is increased further for younger teenagers'.

After selecting only multiparous women a backward manual stepwise conditional logistic regression model was run with having an antepartum haemorrhage or not as the outcome. Age group remained in the model regardless of significance and the explanatory variables included in the model were:

Smoking status- Yes/No

Late booking- Yes/No

Multiple birth- Yes/No

Jarman enumeration district- Continuous

Rapid repeat birth- Yes/No

Previous LSCS- Yes/No

Multiparous women (n=18071) were selected for analysis with variables being entered into the model. At the initial stage 13080 (72.4%) cases were entered into the model and the final regression model contained 13709 (75.9%) cases. The first variable to be removed from the model was previous LSCS (OR=1.000, 95% CI 0.770 to 1.299; p=0.998), followed by rapid birth (OR=0.980, 95% CI 0.765 to 1.256; p=0.874), deprivation (OR=1.002, 95% CI 0.997 to 1.006; p=0.507) and multiple birth (OR=0.472, 95% CI 0.174 to

1.279; p=0.140). All other risk factors remained significant at the 0.05 level and remained in the model. The findings are summarised in Table 4.5. Multiparous teenagers were not at a statistically increased risk of having an antepartum haemorrhage after adjusting for smoking and late booking when compared to the comparative group. For multiparous women being a smoker increased the risk (OR=1.259) of having an antepartum haemorrhage but booking late for care was associated with a lower risk (OR=0.023) of having an antepartum haemorrhage.

Using the Nagelkerke R Squared test the model only explained 0.3% of the variance and the Hosmer and Leweshow Test (χ^2 = 0.927 (df=3), p=0.819) indicated the model was a good fit. The final model correctly classified 94.5% of cases and this was a slight increase of 0.1%.

Removing smoking from the model increased the number of cases included (n=17884) and three variables were removed from the model: rapid repeat birth (OR=0.968, 95% CI 0.773 to 1.212; p=0.778); previous LSCS (OR=0.951, 95% CI 0.752 to 1.202; p=0.675) and deprivation (OR=1.004, 95% CI 1.000 to 1.008; p=0.078). The removal of smoking did alter the results found in the earlier model. Late booking was still associated with a lower risk of APH but was joined by multiple birth but this was just significant (OR=0.370, p=0.05). However, both variance and fit statistics were altered very little by removing smoking. Multiparous older teenagers had an increased risk (OR=1.229, 95% CI 1.033 to 1.462;

p=0.020) of an APH after adjusting for late booking and multiple birth in comparison to the comparative group.

Table 4.5. Model for hypothesis 4.1b Examining Antepartum Haemorrhage in Multiparous Women

Factor	Unadjusted OR for multiparous women (95%CI)	Adjusted OR for multiparous women (95% CI) n=13709	Adjusted OR for multiparous women without Smoking n=17884
20-25 years ≤ 16 years 17-19 years	1.00 1.199 (0.608 to 2.263) p=0.601 1.208 (1.017 to 1.436) p=0.031	1.00 0.966 (0.423 to 2.206) p=0.934 1.140 (0.934 to 1.390) p=0.197	1.00 1.237 (0.627 to 2.441) p=0.540 1.229 (1.033 to 1.462) p=0.020
Smoking status*-yes/no	**1.270 (1.090 to 1.480) p=0.002**	**1.259 (1.079 to 1.469) p=0.003**	**Removed for analysis**
Late booking–.yes/no	**0.783 (0.645 to 0.950) p=0.013†**	**0.777 (0.626 to 0.966) p=0.023†**	**0.772 (0.636 to 0.937) p=0.009†**
Multiple birth–yes/no	0.447 (0.183 to 1.088) p=0.076		**0.370 (0.137 to 1.000) p=0.050†**
Jarman – Continuous	1.004 (1.001 to 1.018) p=0.074		
Rapid repeat birth§-yes/no	0.995 (0.800 to 1.236) p=0.961		
Previous LSCS§-yes/no	0.950 (0.755 to 1.195) p=0.662		

*complete smoking data was only available from 1996 to 2001

† indicates an association with a lower risk of APH in the results table

§ analysis undertaken on multiparous women only

Bold indicates significant finding

Models examining Hypothesis 4.1c

Hypothesis 41c

'Multiparous teenage women have an increased risk of having an antepartum haemorrhage when compared to primiparous teenage women'.

After selecting only teenage women a backward manual stepwise conditional logistic regression model was run with having either an antepartum haemorrhage or not as the outcome. Whether it was a first or subsequent birth remained in the model regardless of significance and the explanatory variables included in the model were:

Smoking status- Yes/No

Late booking- Yes/No

Multiple birth- Yes/No

Jarman enumeration district- Continuous

Teenage women (n=8028) were identified for analysis with variables being entered into the model. At the initial stage 6002 (74.8%) cases were entered into the model and the final regression model contained 7895 (98.3%) cases. The first variable to be removed was multiple birth (OR=0.468, 95% CI 0.064 to 3.431; p=0.455) followed by deprivation (OR=1.005, 95% CI 0.998 to 1.011; p=0.158) and smoking (OR=1.188, 95% CI 0.962 to 1.467; p=0.110) leaving only late booking adjusted for in the model. Findings of the analysis can be found in Table 4.6.

Multiparous teenagers had a similar risk of having an antepartum haemorrhage (OR= 1.044) as primiparous teenagers after adjusting for time of booking. For teenage women booking late in pregnancy was associated with a lower risk of having an antepartum haemorrhage regardless of whether it was a first or subsequent birth.

Using the Nagelkerke R Squared test the model explained 0.4% of the variance and the Hosmer and Leweshow Test ($\chi^2 = 0.354$ (df=2), p=0.838) indicated the model was a good fit. The final model correctly classified 93.7% of cases and this was not increased on completion of the model.

By removing smoking from the model there were fewer cases included (n=7617) and only multiple birth was removed from the model (OR=0.357, 95% CI 0.049 to 2.599; p=0.309). The removal of smoking did not alter the results found in the earlier model and both variance and fit statistics were unchanged by removing smoking.

Table 4.6. Model for Hypothesis 4.1c Examining Antepartum Haemorrhage in Teenage Women

Factor	Unadjusted OR for teenage women (95%CI)	Adjusted OR for teenage women (95% CI) n=7895	Adjusted OR for teenage women (95% CI) without Smoking n=7617
Multip – yes/no	1.038 (0.859 to 1.254) p=0.700	1.044 (0.863 to 1.263) p=0.660	1.019 (0.839 to 1.237) p=0.853
Smoker* – yes/no	1.204 (0.976 to 1.484) p=0.083		Removed for analysis
Late booking – yes/no	**0.672 (0.522 to 0.864) p=0.002†**	**0.672 (0.522 to 0.864) p=0.002†**	**0.667 (0.515 to 0.864) p=0.002†**
Multiple birth – yes / no	0.320 (0.046 to 2.325) p=0.260		
Jarman – continuous	**1.007 (1.001 to 1.013) p=0.017**		**1.007 (1.001 to 1.013) p=0.015**

*complete smoking data was only available from 1996 to 2001

† indicates an association with a lower risk of APH in the results table

Bold indicates significant finding

Models examining Hypothesis 4.1d

Hypothesis 4.1d

'Multiparous teenage women having rapid repeat births have an increased risk of having an antepartum haemorrhage when compared to multiparous teenage women not having a rapid repeat birth'.

After selecting only multiparous teenage women a backward manual stepwise conditional logistic regression model was run with having either an antepartum haemorrhage or not as the outcome. The variable depicting rapid repeat birth remained in the model regardless of significance and explanatory variables included in the model were:

Smoker- Yes/No

Late booking- Yes/No

Multiple birth- Yes/No

Jarman enumeration district- continuous

Previous LSCS- Yes/No

Multiparous teenage women (n=2687) were identified for analysis with variables being entered into the model. At the initial stage 2069 (77%) cases were entered into the model and this number increased to 2610 (97.1%) in the final regression model. The first variable to be removed from the model was multiple birth (OR=0.000, CI 0.000; p=0.999) followed by previous LSCS (OR=0.839, 95% CI 0.333 to 2.114; p=0.710); being a smoker (OR=1.131, 95% CI 0.786 to 1.630; p=0.507) and late booking (OR=0.784, 95% CI 0.517 to 1.187; p=0.250).

The findings of the analysis are presented in Table 4.7. After adjusting for deprivation multiparous teenagers having a rapid repeat birth had a similar risk of having an APH as multiparous teenagers not having a rapid repeat birth. Multiparous teenage women coming from a deprived background (OR= 1.012) had an increased risk of an APH in comparison to those from an affluent background.

Using the Nagelkerke R Squared test the model explained only 0.5% of the variance and the Hosmer and Leweshow Test (χ^2 = 13.436 (df=8), p=0.098) indicated the model was a good fit. The final model correctly classified 93.5% of cases and this was a decrease of 0.4%.

> By removing smoking from the model the number of cases included remained the same (n=2610) and there were no changes to the findings of the model.

Table 4.7. Model for Hypothesis 4.1d Examining Antepartum Haemorrhage in Multiparous Teenage Women

Factor	Unadjusted OR for multiparous teenagers (95%CI)	Adjusted OR for multiparous teenagers (95% CI) n=2610	Adjusted OR for multiparous teenagers (95% CI) without smoker n=2610
Rapid repeat birth – yes/no	0.866 (0.546 to 1.372) p=0.539	0.836 (0.525 to 1.330) p=0.450	0.836 (0.525 to 1.330) p=0.450
Smoker* – yes/no	1.230 (0.863 to 1.752) p=0.253		Removed for analysis
Late booker – yes/no	0.742 (0.493 to 1.119) p=0.155		
Multiple birth – yes /no	0.000 (0.000) p=0.998		
Jarman – continuous	**1.012 (1.001 to 1.022) p=0.029**	**1.012 (1.002 to 1.023) p=0.024**	**1.012 (1.002 to 1.023) p=0.024**
Previous LSCS – yes/no	0.961 (0.440 to 2.099) p=0.921		

*complete smoking data was only available from 1996 to 2001

Bold indicates significant finding

Models examining Hypothesis 4.2a

Hypothesis 4.2a

'Primparous teenage women have an increased risk of premature labour when compared to primiparous women in their early twenties and this risk is increased further for younger teenagers'.

After selecting only primiparous women a backward manual stepwise conditional logistic regression model was run with having a premature labour or not as the outcome. Age group remained in the model regardless of significance and the explanatory variables included in the model were:

Smoking status- Yes/No

Late booking- Yes/No

Multiple birth- Yes/No

Jarman enumeration district- Continuous

Women having their first birth (n=14824) were selected for analysis with variables being entered into the model. At the initial stage 10422 (70.3%) cases were entered into the model and the final regression model contained 13588 (91.7%) cases. The only variable to be removed was smoking (OR=1.137, 95% 95% CI 0.962 to 1.343; p=0.113). All other risk factors remained significant at the 0.05 level and therefore remained in the model. The findings of the analysis can be found in Table 4.8. Being a primiparous teenager was not significantly associated with having a premature birth after adjusting for late booking, multiple birth and deprivation when compared to the comparative group. For primiparous women when adjusting for other risk factors booking late (OR=1.799), having a multiple birth (OR=16.110) and coming from a deprived background (OR=1.005) increased a women's risk of a premature birth.

Using the Nagelkerke R Squared test the model explained 3.8% of the variance and the Hosmer and Leweshow Test (χ^2 = 6.390 (df=8), p=0.604) indicated the model was a good fit. The final model correctly classified 92.1% of cases and this was an increase of 0.4% on completion of the model.

A model excluding smoking was not repeated as being a smoker was the first variable to be removed from the model and the findings would be the same as before.

Table 4.8 Model for hypothesis 4.2a Examining Premature Birth in Primiparous Women

Factor	Unadjusted OR for primiparous women (95%CI)	Adjusted OR for primiparous women (95% CI) n=13588
20-25 years ≤ 16 years 17-19 years	1.00 1.187 (0.955 to 1.476) p=0.123 1.018 (0.899 to 1.154) p=0.776	1.00 1.139 (0.896 to 1.449) p=0.287 1.031 (0.895 to 1.186) p=0.674
Smoking status* - yes/no	1.052 (0.902 to 1.227) p=0.519	
Late booking –yes/no	**2.034 (1.772 to 2.335) p≤0.001**	**1.799 (1.545 to 2.094) p≤0.001**
Multiple birth– yes/no	**17.963 (12.380 to 26.064) p≤0.001**	**16.110 (10.684 to 24.293) p≤0.001**
Jarman – continuous	1.005 (0.999 to 1.010) p=0.097	**1.005 (1.000 to 1.009) p=0.014**

*complete smoking data was only available from 1996 to 2001

Bold indicates significant finding

Models examining Hypothesis 4.2b

Hypothesis 4.2b

'Multiparous teenage women have an increased risk of premature birth when compared to multiparous women in their early twenties and this risk is increased further for younger teenagers'.

After selecting only multiparous women a backward manual stepwise conditional logistic regression model was run with 'having a premature birth' or not as the outcome. Age group remained in the model regardless of significance and the explanatory variables included in the model were:

Smoking status- Yes/No

Late booking- Yes/No

Multiple birth- Yes/No

Jarman enumeration district- Continuous

Rapid repeat birth- Yes/No

Previous LSCS- Yes/No

Women having a subsequent birth (n=18071) were selected for analysis with variables being entered into the model. At the initial stage 13044 (72.2%) cases were entered into the model and the final regression model had no further cases. All variables remained significant at the 0.05 level and therefore remained in the model. The findings of the analysis can be found in Table 4.9. Multiparous teenagers were at an increased risk of having a premature birth after adjusting for smoking, late booking, multiple birth, deprivation, rapid repeat birth and previous LSCS when compared to the comparative group. The risk was increased (OR=1.934) for younger teenagers. For multiparous women being a smoker (OR=1.392), booking late for care (OR=1.921), having a multiple birth (OR=14.344), coming from a deprived background (OR=1.007), having a rapid repeat birth (OR=1.402) or previous LSCS (OR=1.467) increased the women's risk of having a premature birth.

Using the Nagelkerke R Squared test the model explained 6.1% of the variance and the Hosmer and Leweshow Test (χ^2 = 14.268 (df=8), p=0.075) indicated the model was a good fit. The final model correctly classified 91.1% of cases.

By removing smoking from the model this increased the number of cases included (n=17187) but did not change the overall findings and both variance and fit statistics were altered very little by removing smoking.

Table 4.9 Model for hypothesis 4.2b Examining Premature Birth in Multiparous Women

Factor	Unadjusted OR for multiparous women (95%CI)	Adjusted OR for multiparous women (95% CI) n=13044	Adjusted OR for multiparous women without Smoking n=17187
20-25 years	1.00	1.00	1.00
≤ 16 years	**1.718 (1.055 to 2.796) p=0.029**	**1.934 (1.153 to 3.243) p=0.012**	**1.698 (1.023 to 2.820) p=0.041**
17-19 years	**1.372 (1.198 to 1.572) p≤0.001**	**1.227(1.043 to 1.442) p=0.013**	**1.367(1.185 to 1.577) p≤0.001**
Smoking status* - yes/no	**1.423 (1.262 to 1.605) p≤0.001**	**1.392 (1.225 to 1.582) p≤0.001**	Removed from analysis
Late booking – yes/no	**1.910 (1.687 to 2.162) p≤0.001**	**1.921 (1.662 to 2.220) p≤0.001**	**1.711 (1.498 to 1.954) p≤0.001**
Multiple birth – yes/no	**13.175 (9.862 to 17.602) p≤0.001**	**14.344 (10.141 to 20.290) p≤0.001**	**13.203 (9.701 to 17.969) p≤0.001**
Jarman – Continuous	**1.007 (1.002 to 1.012) p=0.006**	**1.007 (1.003 to 1.011) p≤0.001**	**1.007 (1.004 to 1.011) p≤0.001**
Rapid repeat birth - yes/no	**1.693 (1.456 to 1.968) p≤0.001**	**1.402 (1.174 to 1.673) p≤0.001**	**1.499 (1.277 to 1.758) p≤0.001**
Previous LSCS - yes/no	**1.465 (1.246 to 1.722) p≤0.001**	**1.467 (1.212 to 1.776) p≤0.001**	**1.430 (1.203 to 1.699) p≤0.001**

*complete smoking data was only available from 1996 to 2001

Bold indicates significant finding

Models examining Hypothesis 4.2c

Hypothesis 4.2c

'Multiparous teenage women have an increased risk of having a premature birth when compared to primiparous teenage women'.

After selecting only teenage women a backward manual stepwise conditional logistic regression model was run with having either a premature birth or not as the outcome. The first or subsequent birth remained in the model regardless of significance and the explanatory variables included in the model were:

Smoking status- Yes/No

Late booking- Yes/No

Multiple birth- Yes/No

Jarman enumeration district- Continuous

Teenage women (n=8028) were identified for analysis with variables being entered into the model. At the initial stage 5986 (74.6%) cases were entered into the model and remained the same in the final regression model. All variables remained significant at the 0.05 level and therefore remained in the model. Findings of the analysis can be found in Table 4.10.

After adjusting for smoking, time of booking and deprivation being a multiparous teenager increased the risk of having a premature birth (OR= 1.269) in comparison to being a primiparous teenager. For teenagers being a smoker (OR=1.231), booking late in pregnancy (OR=2.065), having a multiple birth (OR=10.301) and coming from a deprived background (OR=1.009) increased the risk of having a premature birth.

Using the Nagelkerke R Squared test the model explained 4.1% of the variance and the Hosmer and Leweshow Test ($\chi^2 = 6.489$ (df=8), p=0.593) indicated the model was a good fit. The final model correctly classified 90.4% of cases and this was an increase of 0.1%.

By removing smoking from the model this increased the number of cases included (n=7593) but did not alter the overall results found in the earlier model with both variance and fit statistics being similar.

Table 4.10 Model for Hypothesis 4.2c Examining Premature Birth in Teenage Women

Factor	Unadjusted OR for teenage women (95%CI)	Adjusted OR for teenage women (95% CI) n=5986	Adjusted OR for teenage women (95% CI) without Smoking n=7593
Multip – yes/no	**1.225 (1.053 to 1.424) p=0.009**	**1.269 (1.061 to 1.517) p=0.009**	**1.341 (1.144 to 1.573) p≤0.001**
Smoker* – yes/no	1.117 (0.941 to 1.326) p=0.207	**1.231 (1.028 to 1.474) p=0.024**	Removed for analysis
Late booking – yes/no	**1.902 (1.612 to 2.243) p≤0.001**	**2.065 (1.711 to 2.494) p≤0.001**	**1.828 (1.539 to 2.170) p≤0.001**
Multiple birth – yes / no	**9.620 (5.404 to 17.124) p≤0.001**	**10.301 (5.206 to 20.380) p≤0.001**	**9.988 (5.420 to 18.406) p≤0.001**
Jarman – continuous	**1.007 (1.002 to 1.012) p=0.003**	**1.009 (1.003 to 1.014) p=0.001**	**1.007 (1.002 to 1.012) p=0.005**

*complete smoking data was only available from 1996 to 2001

Bold indicates significant finding

Models examining Hypothesis 4.2d

Hypothesis 4.2d

'Multiparous teenage women having rapid repeat births have an increased risk of having a premature birth when compared to multiparous teenage women not having a rapid repeat birth'.

After selecting only multiparous teenage women a backward manual stepwise conditional logistic regression model was run with having either a premature birth or not as the outcome. The variable depicting rapid repeat birth remained in the model regardless of significance and the explanatory variables included in the model were:

Smoker- Yes/No

Late booking- Yes/No

Multiple birth- Yes/No

Jarman enumeration district- continuous

Previous LSCS- Yes/No

Multiparous teenage women (n=2687) were identified for analysis with variables being entered into the model. At the initial stage 2063 (76.8%) cases were entered into the model and this number increased to 2137 (79.5%) in the final regression model. The first variable to be removed from the model was previous LSCS (OR=0.832, 95% CI 0.416 to 1.662; p=0.603) followed by deprivation (OR=1.003, 95% CI 0.994 to 1.013; p=0.467). The findings of the analysis can be found in Table 4.11.

After adjusting for time of booking and multiple birth multiparous teenagers having a rapid repeat birth had an increased risk of having a premature birth in comparison to multiparous teenagers not having a rapid repeat birth (OR=1.617). Multiparous teenagers booking later for care (OR= 1.794) or having a multiple birth (OR=16.499) were at an increased risk of having a premature birth.

Using the Nagelkerke R Squared test the model explained 5.5% of the variance and the Hosmer and Leweshow Test (χ^2 = 8.528 (df=4), p=0.374) indicated the model was a good fit. The final model correctly classified 89.1% of cases and this was an increase of 0.4%.

By removing smoking from the model the number of cases included increased to (n=2659) but did not alter the results found in the earlier model with both variance and fit statistics being similar.

Table 4.11 Model for Hypothesis 4.2d Examining Premature in Multiparous Teenage Women Having a Rapid Repeat birth or Not

Factor	Unadjusted OR for multiparous teenagers (95%CI)	Adjusted OR for multiparous teenagers (95% CI) n=2137	Adjusted OR for multiparous teenagers (95% CI) without smoking n=2659
Rapid Repeat Birth – yes/no	**1.747 (1.294 to 2.359) $p \leq 0.001$**	**1.617 (1.150 to 2.272) $p=0.006$**	**1.615 (1.185 to 2.200) $p=0.002$**
Smoker* – yes/no	**1.443 (1.103 to 1.890) $p=0.008$**	**1.516 (1.149 to 1.999) $p=0.003$**	Removed for analysis
Late booker – yes/no	**1.576 (1.202 to 2.066) $p=0.001$**	**1.794 (1.321 to 2.437) $p \leq 0.001$**	**1.500 (1.137 to 1.980) $p=0.004$**
Multiple birth – yes /no	**14.395 (5.987 to 34.609) $p \leq 0.001$**	**16.499 (5.926 to 45.937) $p \leq 0.001$**	**14.045 (5.786 to 34.097) $p \leq 0.001$**
Jarman – continuous	1.005 (0.997 to 1.013) $p=0.225$		
Previous LSCS – yes/no	1.035 (0.573 to 1.869) $p=0.909$		

*complete smoking data was only available from 1996 to 2001

Bold indicates significant finding

4.6.7 Summary of Findings

4.6.7.1 Univariate Analysis

Overall 5.3% (n=1739) of women in the study had an APH and 8.9% (n=2932) of women had a premature birth. When comparing age, teenagers had a higher proportion of both APH and premature birth than older women. When comparing the teenage groups a higher proportion of younger teenagers had an APH and premature birth than older teenagers. Statistically, there was a significant difference in APH and premature birth only between teenagers and older women but not between the teenage groups. On completion of unadjusted regression analyses both younger and older teenagers were more likely to have an APH ($\leq$16 OR=1.626, 17-19 OR=1.505) but had a similar risk of premature birth ($\leq$16 OR=1.187 p=0.123, 17-19 OR=1.018 p=0.776) to older women.

4.6.7.2 Multivariate Analysis

On completion of the models adjusting for associated risk factors, primiparous teenagers were more likely to have an APH in comparison to older women. This risk increased if it was a younger teenager (17-19 OR=1.481, p$\leq$0.001 $\leq$16 OR=1.676, p$\leq$0.001). In the multiparous model teenagers had a similar statistical risk of APH as older women and in the teenage model multiparous teenagers had a similar statistical risk as primiparous teenagers of having an APH. The final model for multiparous teenagers found that teenagers having a rapid repeat birth had a similar statistical risk of APH as a teenager who delayed a second birth post eighteen months.

In the primiparous model with premature birth as the outcome teenagers had a similar statistical risk of having a premature birth as older women. For multiparous women, teenagers were more likely to have a premature birth than older women and for younger teenagers this risk was increased. When entering teenagers only, multiparous teenagers were more likely to have a premature birth than teenagers having a first birth. If the multiparous teenager had a further birth within eighteen months she was more likely to have a premature birth than a teenager waiting longer between births. The hypotheses posed in this chapter have been addressed and the acceptance or rejection of these hypotheses has been presented in Table 4.12.

Table 4.12 Summary of Hypothesis for Antepartum Haemorrhage and Premature Birth

<table>
<tr><td colspan="3">Hypothesis Tested
Primiparous teenage women have an increased risk of adverse maternal and neonatal outcomes when compared with primiparous women in their early twenties and this risk is increased further for a younger teenager.</td></tr>
<tr><td>Population: Primiparous Women</td><td colspan="2">Outcomes Examined</td></tr>
<tr><td>Comparison Groups (compared with 20-25 year old women)</td><td>APH</td><td>PB</td></tr>
<tr><td>All teenagers</td><td>Accepted</td><td>Rejected</td></tr>
<tr><td>Under 16 year olds</td><td>Accepted</td><td>Rejected</td></tr>
<tr><td colspan="3">Hypothesis Tested
Multiparous teenage women have an increased risk of adverse maternal and neonatal outcomes when compared with multiparous women in their early twenties and this risk is increased further for a younger teenager.</td></tr>
<tr><td>Population: Multiparous Women</td><td colspan="2">Outcomes Examined</td></tr>
<tr><td>Comparison Groups (compared with 20-25 year old women)</td><td>APH</td><td>PB</td></tr>
<tr><td>All teenagers</td><td>Rejected **</td><td>Accepted</td></tr>
<tr><td>Under 16 year olds</td><td>Rejected</td><td>Accepted</td></tr>
<tr><td colspan="3">Hypothesis Tested
Multiparous teenage women have an increased risk of adverse maternal and neonatal outcomes when compared to primiparous teenage women</td></tr>
<tr><td rowspan="2">Population: All Teenagers</td><td colspan="2">Outcomes Examined</td></tr>
<tr><td>APH</td><td>PB</td></tr>
<tr><td>Multiparous teenagers more likely than primiparous teenagers</td><td>Rejected</td><td>Accepted</td></tr>
<tr><td colspan="3">Hypothesis Tested
Multiparous teenage women having a rapid repeat birth have an increased risk of adverse maternal and neonatal outcomes when compared to multiparous teenagers not having a rapid repeat birth.</td></tr>
<tr><td rowspan="2">Population: Multiparous Teenagers</td><td colspan="2">Outcomes Examined</td></tr>
<tr><td>APH</td><td>PB</td></tr>
<tr><td>Rapid repeat births more likely than Non Rapid</td><td>Rejected</td><td>Accepted</td></tr>
</table>

****Accepted when smoking removed from model for 17-19 year olds only**

4.6.7.3 Associated Risk Factors Entered into the Models

When smoking was adjusted for in the APH models it only remained significant in the multiparous model and increased a woman's risk of having an APH (OR=1.259), in all other models smoking did not remain statistically significant and was removed from the analysis. This was the reverse for the models on premature birth where it was removed in the primiparous model and remained significant in the remaining three models. Smoking increased the likelihood of a woman having a premature birth if she was multiparous regardless of age or timing between births.

Except within the rapid repeat model, for teenagers booking later than 20 weeks gestation was associated with a lower risk of APH when adjusting for other risk factors. In the rapid repeat model a teenage woman booking later for care had a similar statistical risk of APH as a woman booking early. However, all women who booked late for care regardless of age or whether their first or subsequent birth, were more likely to have a premature birth than a woman who booked earlier.

Women having a multiple birth had a similar statistical risk of APH as women having a singleton pregnancy but were more likely to have a premature birth when adjusting for other factors. This remained the case whether it was a woman's first or subsequent birth or whether a teenager had a rapid repeat birth.

Women from deprived backgrounds having their first birth and teenagers having a rapid repeat birth were more likely to have an APH when adjusting for other risk factors. Both primiparous and multiparous women were more likely to have a premature birth if they came from a deprived background. Teenage women having a rapid repeat birth had a similar statistical risk of having a premature birth as those delaying a subsequent birth. Having a previous LSCS increased the risk of a woman having a premature birth but did not increase the risk of having an APH.

4.7 Discussion

4.7.1 Antepartum Haemorrhage

Antepartum haemorrhage remains a major cause of both maternal and neonatal morbidity and mortality in modern day obstetrics [186, 187, 193, 335, 336]. It is thought to affect between 2-5% of all pregnancies [193, 320], this range is lower than that found in the overall population within this study (5.3%). Rates for teenagers were higher, with younger teenagers having the highest proportion of affected pregnancies (6.6%). This confirms the findings of Ananth *et al* [337] that more younger women have an APH, although the authors did not discuss this in the context of their findings. An earlier paper by Ananth *et al* [192] investigating different causes of APH, found that in singleton pregnancies younger women had more abruptions which resulted in utero-placental bleeding disorders but only when parity was higher, confirming the findings of Brenner [326]. The current study found that only primiparous teenagers were at an increased risk of APH not those having subsequent births. Two explanations may explain the differences between the findings of this and previous studies. First, several risk factors have been identified as being associated with APH [192, 193, 337, 338] a criticism of earlier studies has been the lack of inclusion of these when undertaking analysis [338]. Within the current study several risk factors were entered into the models and this may account for the differences in findings to previous studies. Second, previous researchers have undertaken analysis on either primiparous women only or have not distinguished between first and subsequent births in study populations. As a result findings that were presented were either for primiparous or all teenage women not providing a full spectrum of the variations that may occur. The current study provides an insight into the differences in APH for teenagers between first and subsequent births.

4.7.2 Premature Birth

Premature birth remains one of the key concerns for neonatal morbidity and mortality complicating 7% [320] of all births. Several researchers have observed that teenagers are at an increased risk of premature birth when compared to older women [162, 197, 200, 213, 339-341] and this is partly confirmed by the findings of this study, but not all teenagers are at an increased risk of premature birth.

When examining parity, studies varied in whether they investigated first births only [136, 183, 340] or first and subsequent births [162, 200, 225, 339, 342, 343]. Primiparous teenagers have a similar statistical risk of premature birth as older women confirming the findings of some researchers [162, 183, 344] but contradicted others [14, 16, 160, 294, 298]. This area requires further investigation and the differences in study findings may be accounted for by variations in the populations selected, age groupings or associated risk factors that were adjusted for in analysis.

As found by Smith and Pell [162] and Basso [339], multiparous teenagers were more likely to have a premature birth, and this remained the case after adjusting for associated risk factors. No studies were identified from the literature that conducted a direct comparison between multiparous and primiparous teenagers and teenagers having a rapid repeat birth. Parity is an important factor for premature birth in teenagers. There is an increased risk if the teenager is multiparous rather than primiparous and this risk increases if a repeat birth is rapid. Basso [339] Zhu [226] and Smith and Pell [162, 225] all noted an association between rapid repeat births and premature birth but not all these studies were undertaken purely on teenagers. Therefore the findings of this study are more pertinent to inform policy.

4.7.3 Associated Risk Factors and their Effect on Antepartum Haemorrhage and Premature Birth in the Models

4.7.3.1 Smoking and Antepartum Haemorrhage

Teenage women who smoke during pregnancy have been found to have an increased risk of APH [327]. Within this study when smoking was the sole explanatory variable a woman was more likely to have an APH. When additional associated risk factors were entered during multivariate analysis, smoking was only associated with an increased risk of APH in the multiparous model. One possible explanation for this may be the type of smoking behaviour of the women.

Qualitative studies working with female teenagers have found that the reasons why a woman smokes changes as a young woman moves through her teenage years [153, 154]. Teenagers start smoking as they see it as an opportunity to be socially accepted by peers and as they pass through their teenage years and into their twenties, the social aspect becomes less important and other drivers take over. This phenomenon may indicate that younger teenagers smoke less frequently and the subsequent effect of smoking on the pregnancy is reduced. However, Lennon *et al* [152] found that young women who already have a child use smoking as a coping strategy and as a result smoke on a more regular basis than those having their first child. Women who have had a positive outcome from a previous pregnancy while they smoked may also accept this as an indication that smoking is not harmful to the pregnancy and this in turn provides a rationale for continuing to smoke. In addition it is thought to be the prolonged exposure to smoking that has been presented as a risk factor for placental related complications which would again support the evidence that multiparous teenagers are at an increased risk of APH. While these facts may explain the differences found between the primiparous and multiparous teenagers, it does not provide a full explanation of why smoking does not increase the risk of APH in the teenager models. This requires further research with more detailed data on smoking habits and number of cigarettes smoked by women.

4.7.3.2 Smoking and Premature Birth

The findings of this thesis have established that not all teenagers that smoke are at an increased risk of premature birth, it is only multiparous teenagers that have an increased risk of premature birth. Earlier studies by Delpisheh *et al* [160] and Windham [345] stated that all teenagers were at an increased risk of premature birth. Both of these previous studies were epidemiological studies that included teenagers and did not adjust for whether this was a first or subsequent birth.

Delpisheh *et als* study excluded women who had more than one birth during the study period but as the data collection was only for a few months each year this did not exclude repeat pregnancies. Windham *et als* study included only late teenagers post 18 years therefore does not provide a complete picture for all teenagers and did not distinguish between first and subsequent births when presenting their findings. A cohort study by Smith and Pell [162] did compare teenagers having a first and subsequent birth with older women. Their findings were similar to those presented in this thesis, but Smith and Pell did not include teenage models in their analysis.

While taking into consideration the discussion presented in section 4.7.3.2, regarding smoking behaviour this again may have an impact on the incidence of premature birth. Earlier studies have indicated that there is a dose response effect [346-348] as the more cigarettes the woman smokes the more likely they are to have a premature birth. As the number of cigarettes smoked was not available for analysis in this study this aspect could not be addressed.

The current study is significant as it provides additional information on the effects of smoking in first and subsequent teenage births when compared to older women and also provides evidence on the effects of smoking on antenatal outcomes between teenagers.

4.7.3.3 Late Booking and Anepartum Haemorrhage

Previous researchers have suggested that poor antenatal outcomes experienced by teenagers are caused by late access and subsequent lack of antenatal care [27, 28, 190, 219, 294]. For this study it was only late access to care that was included within the multivariate analysis as data on continued attendance was not available for analysis.

For those women who had an APH in the current analysis a higher proportion of teenagers than older women booked late for care. However, this did not increase the likelihood of the teenager having an APH (OR=0.777, p=0.966) when other risk factors were included in the multivariate analysis. Except for teenagers having a rapid repeat, booking late for care was associated with a significantly lower risk of APH when entered as either a sole or joint explanatory variable for teenagers. Possible explanations for this must be considered.

Part of the process of providing antenatal care is to educate the pregnant women about normal pregnancy and to recognise possible complications to the pregnancy. If women do not attend for care until later in the pregnancy this aspect may not be addressed and as a result women may have had a small APH and not reported it. This suggestion is particularly important for teenagers who may not realise they are pregnant and therefore not recognise a 'spotting' as a danger and fail to report it. Therefore, the reporting and recording of actual APH would be reduced in this instance and not recorded in the data used for analysis.

As majority of APHs are as a result of complications with the placenta this may be difficult to diagnose and predict antenatally. Placenta praevia is only diagnosed on ultrasound scan or at the point bleeding occurs, as a result non-attendance for antenatal care would not prevent this type of APH. Placental abruption tends to be a spontaneous event with little or no warning; again this would not be diagnosed until the woman presented with APH. These clinical factors should be taken into consideration when interpreting these findings.

4.7.3.4 Late Booking and Premature Birth

Several studies [172-174, 294] have highlighted that teenagers generally book later for care than older peers and that teenagers are at an increased risk of premature birth than older women. The analysis in this thesis concurs with these findings as a higher proportion of women who had a premature birth booked later for care, than those women who had term neonates. In all cases booking late for care was associated with an increased risk of having a premature birth when entered as either a sole or joint explanatory variable in the models. Teenagers' were twice ($OR=2.065$. $p\leq0.001$) as likely to have a premature birth but the likelihood was reduced if the teenager had a rapid repeat birth ($OR=1.794$, $p\leq0.001$) being similar to that of primiparous women ($OR=1.799$, $p\leq0.001$).

It is clear from both the findings of this thesis and the published literature that when examining teenagers alone, they are at an increased risk of premature birth. A possible cause of this association is the higher prevalence of sexually transmitted infections (STIs) in younger women [78, 132]. Several studies [69, 132, 134] have found higher incidences of STIs in pregnancy resulting in a premature birth. This aspect could not be examined in the thesis as data was incomplete but does warrant further investigation.

4.7.3.5 Deprivation and Antepartum Haemorrhage

It is well documented that women from a deprived background have an increased risk of complications during childbearing [10, 12, 94, 110, 141, 207]. The findings of this study support in part that deprivation may increase a woman's risk of antenatal complications even when other risk factors are considered.

The effects of deprivation on the risk of APH for women in this study were varied. For those women having their first birth or teenagers having a rapid repeat birth deprivation increased the risk of APH. However, for multiparous women and teenagers per se deprivation did not increase the risk of APH. There is little literature that focuses on deprivation and APH as noted by Ananth *et al* [337] and no previous research papers were identified in the literature review that purely focussed on teenagers. This study has highlighted that only in certain cases deprivation may increase the risk of APH. Health professionals providing care for primiparous women and teenagers having a rapid repeat birth from a deprived background should be particularly vigilant for APH as these women are at an increased risk.

4.7.3.6 Deprivation and Premature Birth

In this study deprivation was associated with an increased risk of premature birth except when a teenager had a rapid repeat birth. These findings concur with those of Smith and Elander [110] who studied teenagers aged 15 years and younger. In contrast Olausson *et al* [349] concluded that biological reasons were a risk factor for preterm birth in teenagers rather than deprivation. Olausson *et als* study was a broader study examining smoking and anthropometric measures in conjunction with deprivation, which may explain the differences with other studies. It is documented that teenagers having repeat births are more likely to come from a deprived background [222] so it is difficult to explain why deprivation increases the risk of premature birth in multiparous women but not teenagers having a rapid repeat birth.

Teenagers having a rapid repeat birth may be in a more stable relationship [12, 57]. As a result the teenager although from a deprived background has support rather than material wealth and may be less stressed by her social position thus having a positive effect on the pregnancy. To test this explanation a prospective study collecting more indepth data on the individual social circumstances of the woman would be required.

4.7.3.7 Previous Lower Segment Caesarean and Antepartum Heamorrhage

Several studies have stated that a woman having a previous LSCS has an increased risk of placenta praevia which may cause an APH [192, 194, 350] but these findings were not confirmed in the present study. Multiparous teenagers who had a previous LSCS had a similar statistical risk of an APH as older women who had a previous LSCS.

From an obstetric perspective the combination of having a previous LSCS and a further birth in quick succession would place the teenager in a high risk category for the complication of APH. The findings of this study warrant further investigation on a larger cohort of teenagers as these finding may be an anomaly due to the smaller number of teenagers who had a previous LSCS and subsequently a rapid repeat birth.

4.7.3.8 Previous Lower Segment Caesarean Section and Premature Birth

Women in this study having a previous LSCS were at an increased risk of premature birth except if the birth was a rapid repeat birth to a teenager. Bahl *et al* [312] study found no increased risk of premature birth and so conflicts with the current findings. Other literature [314, 351] has examined maternal and neonatal morbidity but not specifically the gestation at which a future birth took place. Both the current study and Bahl *et al* had small sample sizes in the teenage groups and this should be taken into considered when making any recommendations from the findings. A previous scar on the uterus increases the risk for the women of having a uterine rupture [314, 351] but this is thought to be linked with timing between births rather than just having a previous LSCS [352]. In addition uterine rupture usually occurs during active labour and is not necessarily associated with premature labour so causative factors are questionable. From a practice perspective it is important to take into consideration these findings and observe women who had a previous LSCS closely for signs of premature labour but it is suggested that further research is required to clarify these findings further.

4.7.3.9 Multiple Birth and Antepartum Haemorrhage

All the studies that were identified in the literature review for this thesis excluded multiple births from the analysis on APH and concentrated on singleton births. Therefore, the discussion here will focus on the clinical issues of multiple births. Although the placental site is increased with a multiple birth, multiple births are rarer in younger women. However, if they do occur the evidence from the findings presented here is that teenagers are at no greater risk of APH when having a multiple pregnancy than women generally.

4.7.3.10 Multiple Birth and Premature Birth

Within the published literature the risk of premature birth is a well established complication of multiple pregnancies [336, 353] but the incidence found in univariate analysis appears high for young women in comparison to that quoted in the literature [334].

Having a multiple birth as a teenager was associated with an increased risk of premature birth after adjusting for associated risk factors. These findings are similar to the general population and indicate that multiple pregnancies in teenagers should be managed with the same level of vigilance as older women.

The findings of this chapter have been compared to the published literature and differences highlighted and possible explanations have been presented. Conclusions and recommendations will be presented in Chapter 7.

CHAPTER 5 INTRAPARTUM OUTCOMES

5.1 Introduction

The intrapartum outcomes to be considered are whether teenagers have an increased risk of instrumental birth, LSCS birth or perineal trauma. These three outcomes will be described and associated risk factors identified and discussed. This will be followed by a brief methodology and analysis section. The findings of the analysis will then be presented followed by a brief summary and discussion of the findings.

5.2 Instrumental birth

Instrumental birth has become an accepted part of obstetric practice by obstetricians [354]. Over the last twenty years there has been a gradual increase in the number of instrumental births undertaken in England. In 1991 when data collection commenced for this study, the reported instrumental birth rate ranged between 9.6% [355] and 9.9% [93] of all births in England. At the end of the data collection period the national instrumental birth rate had risen to 11% of births in England [315]. The rates quoted above are not age specific.

The definition used in this thesis was that provided by Mojoko and Gardner. They define instrumental birth in their review as:

> *Instrumental vaginal delivery is when obstetric forceps or the vacuum extractor is used to assist delivery of the baby.*
>
> [356, p.3]

The definition highlights two distinct approaches that of using either forceps or ventouse to achieve the delivery. The preference of using either forceps or ventouse during an instrumental birth has changed during the timescale of the study. In England, forceps births declined from 7.5% in 1991 to 3.7% in 2000 and during the time period the rates for ventouse births increased from 9.6% to 11.1% [355]. The movement by obstetricians to favour ventouse over forceps has been attributed to the increase in litigation cases concerning childbirth and risks associated with forceps births [357]. There remains considerable debate within obstetrics over which type of instrumental birth is safer for the women and neonate as forceps and ventouse have differing indications and one method is not best suited to all obstetric complications [354, 358].

The incidence of instrumental birth in teenagers has been reported within the literature. Several studies have compared teenage intrapartum outcomes with those of older women [16, 181, 189, 205, 298, 359, 360]. Geist *et al* [298], Al-Ramahi *et al* [359] and Paranjothy [361] found teenagers were at an increased risk of instrumental birth, while Gupta *et al* [189], Lao *et al* [205], Allen *et al* [360] and Jolly *et al* [181] found that teenagers were at a reduced risk of instrumental birth.

Within the literature several risk factors have been identified as being associated with an increased risk of instrumental birth in women. These are increased parity [36], epidural analgesia [200, 362], prolonged second stage of labour [189, 309, 310, 363-365], having a macrosomic neonate [342, 365], having a previous LSCS [365, 366] and a woman having rapid repeat births

[162, 367]. These risk factors apply to all women regardless of age and should be considered when undertaking analysis on instrumental births in teenagers.

5.3 Lower Segment Caesarean Section

The use of LSCS as an alternative to normal spontaneous vaginal birth has increased over the last two decades within the UK and internationally [204, 368] with numerous debates over its appropriate use [314, 369]. The rates of LSCS vary greatly not only between countries but also between units within countries [315]. In 1992 at the start of data collection for this study England's national LSCS rate was 12.9% [228] and had risen to 23% by 2004 [370]. More recent figures provided by the Health Commission [355] show rates had decreased in 2006 to 16.3% in England. The increase in the LSCS rate within England is not unique and internationally there has been a marked rise in the number of LSCS performed but not always with a clear clinical indication [371]. In the UK this has resulted in the publication of the National Institute for Clinical Excellence (NICE) guidelines [368] recommending a reduction in Lower Segment Caesarean Section (LSCS) rates in England.

In previous studies the incidence of LSCS in teenage women was found to be lower than in older women [162, 181, 182, 189, 205, 298, 342, 344, 359, 372] although the reasons behind this reduced rate is unclear. LSCS does have associated factors that have been reported by previous researchers to increase the risk of LSCS. Many are the same as instrumental birth, epidural analgesia [307, 362, 373], prolonged second stage of labour [189, 309, 310, 363-365], macrosomic neonate [374], previous LSCS [351, 375] and rapid repeat births [162, 367]. There is also a familial debate that women from the same family have similar complications that necessitate LSCS [376] but this is outside the realms of this thesis to investigate.

5.3.1 Associated Risk Factors for Instrumental and Lower Segment Caesarean Births.

Parity as a risk factor for instrumental and LSCS birth has been examined by several researchers [14, 182, 189, 205, 359, 377]. The researchers compared teenage outcomes with outcomes for older women but did not consider the difference between initial and subsequent births. Three studies [14, 182, 377] found that teenagers had a higher incidence of instrumental births and a lower incidence of LSCS births when compared to older women. In contrast the findings of Gupta *et al* [189] and Lao and Ho [205] both found reduced rates of instrumental and LSCS births in teenagers having their first birth. The research by Al-Ramahi and Saleh [359] included both primiparous and multiparous teenagers but the findings were not reported separately.

Epidural analgesia has been reported by several authors [305, 378, 379] as an associated risk factor for instrumental and LSCS births. The studies undertaken in the area are not confined to first or subsequent births and include all women. No studies were identified that examined epidural use and its impact in teenage birth outcomes.

Prolonged second stage of labour has been associated with instrumental birth. The definition of prolonged second stage is still debated by experts [380] although the National Institute for Clinical Evidence (NICE) have produced guidelines to assist in this classification [204]. NICE differentiate between the time deemed acceptable for the second stage for different parities in woman. In primiparous women it is acceptable to have an active second stage of two hours but this is halved if the woman is multiparous. These time parameters are often applied when deciding on further interventions during the birthing process but remain contentious within midwifery and obstetrics domains [381]. Hellman and Prystowsky's [382] initial work in the 1950s identified the link between prolonged second stage and adverse maternal and neonatal outcomes. This was followed by large studies [363, 364] and systematic reviews [309] all concluding that a prolonged second stage was associated with an increase in both instrumental and LSCS births. There has been little work undertaken on teenage women and the length of stages of labour.

It has long been recognised that a baby's size may influence the progress of labour and have an impact on the incidence of normal birth. Previous papers [14, 162] and policy documents [28, 29] have highlighted that teenagers have a higher incidence of small for gestational age babies than older women but a paper by Lao and Ho [205] found a substantial number of macrosomic infants among teenage births. Having a macrosmic neonate increases the women's risk of having an instrumental birth or LSCS [365, 366].

The incidence of LSCS among teenage women is reported to be low in comparison to older women [162, 189, 205] and multiparous teenagers are associated with a reduction in emergency LSCS relative to other age groups [162]. Other researchers [220, 222, 383] have stated that timing between pregnancies can also impact on teenage pregnancy outcomes. However, these papers do not compare the rapid repeat pregnancy outcomes with those of teenagers waiting longer between births. Although there is evidence of increased intrauterine rupture in women having a further pregnancy shortly after a previous LSCS [343] the impact of previous LSCS on instrumental and subsequent LSCS is an unknown factor especially for teenage women.

5.4 Perineal Trauma

Perineal trauma is an integral risk during the process of childbearing and women are affected to varying degrees during the birth process. The degree of perineal trauma and its classification is well documented within the literature and appropriate repair and after care are evidence based [384, 385]. During the study period national figures are available for the episiotomy rates but do not include rates of perineal tears. In the early 1990s at start of data collection for this study national rates were over 20% but these had declined to 14% by 2000-2001 [370]. This decline corresponded with a change in practice away from routine episiotomy and also an increased incidence of LSCS. This data was not specific for initial or subsequent births.

The incidence and degree of perineal trauma in primiparous women has a consequence for future birth outcomes and this is especially important if the woman is a teenager at the start of her childbearing [386, 387]. Dahlen [386] found that multiparous women had a reduced risk of severe perineal trauma except in the case of instrumental births or having a macrosomic neonate when the risk of perineal trauma was increased. General associated risk factors for perineal trauma are similar to those identified for instrumental and LSCS births. These are gravida [386], epidural [378], prolonged second stage [309, 363, 388, 389],and macrosomic neonates [386, 389]. The subject of perineal trauma is complex but the literature is lacking when focussing on teenagers' experiences.

5.4.1 Summary

It is clear from the review of the literature that the birth outcomes identified for teenagers have rarely been examined specifically for teenagers or have been examined without adjusting for other associated risk factors. Further research is required regarding instrumental birth, LSCS birth and perineal trauma in teenagers.

5.5 Hypotheses

The following hypotheses will be tested using the methodology described in Chapter 2.

Instrumental birth

5.1a. Primiparous teenage women have an increased risk of having an instrumental birth when compared to primiparous women in their early twenties and this risk is increased further for younger teenagers.
5.1b. Multiparous teenage women have an increased risk of having an instrumental birth when compared to multiparous women in their early twenties and this risk is increased further for younger teenagers.
5.1c. Multiparous teenage women have an increased risk of having an instrumental birth when compared to primiparous teenage women.
5.1d. Multiparous teenage women having rapid repeat births have an increased risk of having an instrumental birth when compared to multiparous teenagers not having rapid repeat births.

Lower Segment Caesarean Section

5.2a. Primiparous teenage women have an increased risk of having a LSCS when compared to primiparous women in their early twenties and this risk is increased further for younger teenagers.
5.2b. Multiparous teenage women have an increased risk of having a LSCS when compared to multiparous women in their early twenties and this risk is increased further for younger teenagers.
5.2c. Multiparous teenage women have an increased risk of having a LSCS when compared to primiparous teenage women.
5.2d. Multiparous teenage women having rapid repeat births have an increased risk of having a LSCS when compared to multiparous teenagers not having rapid repeat births.

Perineal Trauma

5.3a. Primiparous teenage women have an increased risk of perineal trauma during normal birth when compared to primiparous women in their early twenties and this risk is increased further for younger teenagers.

5.3b. Multiparous teenage women have an increased risk of perineal trauma during normal birth when compared to multiparous women in their early twenties and this risk is increased further for younger teenagers.

5.3c. Multiparous teenage women have an increased risk of perineal trauma during normal birth when compared to primiparous teenage women.

5.3d. Multiparous teenage women having rapid repeat births have an increased risk of perineal trauma during normal birth when compared to multiparous teenagers not having rapid repeat births.

Footnote: teenagers=women 19 years or under
Younger teenagers=woman aged 16 years and under

5.6 Analysis

Once data preparation was complete an initial descriptive analysis was undertaken on the variables instrumental birth, LSCS and perineal trauma. These outcomes were initially examined in a series of univariate analyses. Associations between age groups and selected categorical outcomes were then examined using cross-tabulations and Chi-squared tests for association. Unadjusted logistic regression analysis was then completed for each of the outcome measures and associated risk factors. This was then followed by multivariate manual backward stepwise conditional logistic regression as described in Chapter 2 (p.110) for each of the hypotheses. For hypotheses 5.1a, 5.1c, 5.2a, 5.2c, 5.3a and 5.3c associated risk factors adjusted for in the models were; epidural, prolonged second stage, and macrosomic neonate. For hypothesis 5.1b , 5.1d, 5.2b, 5.2d, 5.3b and 5.3d associated risk factors adjusted for were the same as the previous hypotheses with the addition of rapid repeat birth and previous LSCS.

5.7 Results

5.7.1 Instrumental Birth

The women selected for analysis had either an instrumental birth or a normal birth allowing comparisons between the outcome of interest, instrumental birth, and optimal outcome of normal birth.

In the selected women 17.8% (n=4988/27982 95% CI 17.35 to 1825) were recorded as having an instrumental birth and 82.2% (n=22994/27982 95% CI 81.71 to 82.69) a normal birth. Teenage women had a higher proportion of instrumental births, with 19.5% (n=786/977, 95% CI 17.02 to 21.98) of younger teenagers and 18.7% (n=1127/6040, 95% CI 17.72 to 19.68) of older teenagers in comparison to 17.5% (n=3670/20965, 95% CI 16.99 to 18.01) of the comparative group. A Chi-squared test indicated that for those birthing vaginally, there was a significant difference in the occurrence of instrumental birth between age groups (χ^2= 6.314 (df=2), p=0.043). A post hoc Chi-squared test indicated there was only a statistically significant difference between the older teenagers and the comparative group (χ^2= 4.272 (df=1), p=0.039).

Unadjusted logistic regression analysis found that older teenagers were more likely to have an instrumental birth in comparison to the comparative group

(OR=1.081, 95% CI 1.004 to 1.164, p=0.039). For younger teenagers there was no significant increase in risk (OR=1.145, 95% CI 0.974 to 1.347, p=0.101) in comparison to women in their early twenties.

5.7.2 Lower Segment Caesarean Section

Women were selected for analysis having either a LSCS birth or a normal birth to enable direct comparisons between the optimal outcome of normal birth and that of LSCS.

In the selected women 16.3% (n=4487/27481 95% CI 15.86 to 16.74) were recorded as having a LSCS birth. Teenage women had a lower proportion of LSCS births, with 13.1% (n=118/904, 95% CI 10.9 to 15.3) of younger teenagers and 14% (n=797/5710, 95% CI 13.1 to 14.9) of older teenagers in comparison to 17.1% (n=3572/20867, 95% CI 16.59 to 17.61) of the comparative group. A Chi-squared test indicated there was a significant difference in the occurrence of LSCS birth between age groups (χ^2= 40.272 (df=2), p≤0.001). A post hoc Chi-squared test indicated there was only a statistically significant difference between the teenage groups and the comparative group (≤16 versus 20-25, χ^2= 10.171 (df=1), p=0.001; 17-19 versus 20-25, χ^2= 32.589 (df=1), p≤0.001).

Unadjusted logistic regression analysis found that teenage women had a statistically lower risk of a LSCS than women from the comparative group

(<16 years OR=0.727, 95% CI 0.597 to 0.885, p=0.001 and 17-19 year age group OR=0.785, 95% CI 0.723 to 0.853, p≤ 0.001).

5.7.3 Perineal Trauma

Women were selected for analysis who had a normal birth so the outcome of perineal trauma was not complicated by instrumental interventions.

In this sample 43.1% of women (n=9415/21859 95% CI 42.44 to 43.76) were recorded as having perineal trauma during their index birth. Teenage women had a slightly lower proportion of perineal trauma in normal birth, with 41.7% (n=313/750, 95% CI 38.17 to 45.23) of younger teenagers and 41% (n=1916/4665, 95% CI 39.69 to 42.51) of older teenagers in comparison to 43.7% (n=7186/16444, 95% CI 42.94 to 44.46) of the comparative group.

A Chi-squared test indicated a significant difference in the occurrence of perineal trauma between age groups (χ^2= (d=f2) 10.803, p=0.005). A post hoc Chi-squared test indicated there was only a statistically significant difference between older teenagers and the comparative group (17-19 versus 20-25, χ^2= 10.233 (df=1), p=0.001).

Unadjusted logistic regression analysis found that older teenagers had a reduced risk of incurring perineal trauma than women in the comparative group (OR=0.898, 95% CI 0.841 to 0.959, p=0.001). Younger teenagers had a similar risk (OR=0.923, 95% CI 0.796 to 1.070, p=0.288) to women in the comparative group.

The previous analyses described the proportion of instrumental birth, LSCS birth and perineal trauma within the dataset by age group. Known dichotomous risk factors included in the multivariate analysis included whether this is the woman's first birth, whether the woman has used epidural analgesia during birth, had a large infant, had a prolonged second stage of labour, or whether a multiparous woman had a previous LSCS, or a rapid repeat birth. The presence of these risk factors found in all women has been presented in Chapter 3 and this analysis has been repeated for women who had an instrumental birth, a LSCS birth or suffered perineal trauma and compared with those findings for all women.

5.7.4 Presence of Associated Risk Factors for Women Having an Instrumental Birth

Women having an instrumental index birth were identified for analysis and the presence of associated risk factors in these births has been summarised in Table 5.1 and Table 5.4. All univariate logistic regression analysis was undertaken on women having either an instrumental or normal birth.

Primiparous births - the proportion of women having an instrumental birth that were primiparous was 67.5% (n=3369/4988, 95% CI 61.72 to 66.68). This was 50% higher than that found in the overall population (45.1%) and the proportion was increased for each age group (≤16 89% v 87.3%, 17-19 75.5% v 63.2, 20-25 64% v 38.1%). Univariate logistic regression analysis on women who had either an instrumental or normal birth found that primiparous women were three times more likely (OR=3.167, CI 2.968 to 3.380; $p \leq 0.001$) to have an instrumental birth than women having a subsequent vaginal birth.

Epidural Analgesia - the proportion of women using an epidural for pain relief that had an instrumental birth was 78.1% (n=2236/2862, 95% CI 76.58 to 79.62). This was nearly double that found in the overall population (40.8%) and increases were present for each age group (≤16 89% v 55%, 17-19 79% v 46.1, 20-25 77.6% v 38.6%). Univariate logisitic regression analysis on women who had either an instrumental or normal birth found that women having an epidural were 7 times more likely (OR=7.157, CI 6.504 to 7.875; $p \leq 0.001$) to have an instrumental birth than women not having an epidural.

Prolonged Second Stage - the proportion of women having a prolonged second stage of labour that had an instrumental birth was 36.4% (n=1789/4920, 95% CI 35.06 to 37.74). This was over three times higher than in the overall population (10.2%) and this proportion was consistent for each age group (≤16 27.8% v 9.3%, 17-19 34% v 10.2, 20-25 37.5% v 10.3%). Univariate logistic regression analysis on women who had either an instrumental or normal birth found that women having a prolonged second stage were 14 times more likely (OR=14.231, CI 13.018 to 15.557; $p \leq 0.001$) to have an instrumental birth than women who do not have a prolonged second stage of labour.

Macrosomic neonate – the proportion of women having a macrosomic neonate that had an instrumental birth was 10.4% (n=518/4988, 95% CI 9.55 to 11.25). This was higher than that found in the overall population (8.6%) and this remained higher for each age group (≤16 7.3% v 6.1%, 17-19 9.1% v 6.8, 20-25 10.9% v 9.2%). Univariate logistic regression analysis on women who had either an instrumental or normal birth found that women who gave birth to a macrosomic baby, were 1.35 times more likely (OR=1.348, CI 1.216 to 1.494; p≤0.001) to have an instrumental birth than a woman who gave birth to a smaller baby vaginally.

Rapid repeat births - the proportion of women having an instrumental birth that had a rapid repeat birth was only 2.6% (n=42/1619, 95% CI 1.82 to 3.38). This was only a third of that found in the overall population (9.5%). There were no younger teenagers who had a rapid repeat birth and an instrumental birth. For the two remaining age groups the proportions were similar but much lower than found in the overall dataset (17-19 2.5% v 14.5%, 20-25 2.6% v 8.6%). Univariate logistic regression analysis on women who had either an instrumental or normal birth found that women having a rapid repeat birth had a reduced risk (OR= 0.223, CI 0.167 to 0.312; p≤0.001) of having an instrumental birth than other multiparous women delivering vaginally.

Previous LSCS – the proportion of women having an instrumental birth that had a previous LSCS was 7.9% (n=128/1619, 95% CI 6.59 to 9.21). This was slightly lower than that found in the overall population (8.7%) and was consistent for the two older age groups (17-19 3.6% v 4.3%, 20-25 8.9% v

9.5%). There were no previous LSCS occurring in younger teenagers (≤16 0% v 1.4%). However, on completion of the univariate logistic regression analysis on women who had a previous LSCS were twice as likely (OR=2.227, CI 1.822 to 2.723; p≤0.001) to have an instrumental birth than women who had not had a previous LSCS.

Table 5.1 Women Having an Instrumental Birth by Age Group: Presence of Associated Risk Factors

Associated Risk Factors	Total		Age Group					
			≤16 years		17-19 years		20-25 years	
	Yes	No	Yes	No	Yes	No	Yes	No
	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)
Primip n=4988	**67.5 (3369)**	**32.5 (1619)**	89 (170)	11 (21)	75.5 (851)	24.5 (276)	64 (2348)	36 (1322)
Epidural* n=2862	**78.1 (2236)**	**21.9 (629)**	84 (89)	16 (17)	79 (493)	21 (131)	77.6 (1654)	22.4 (478)
Prolonged Second Stage n=4920	**36.4 (1789)**	**63.6 (3131)**	27.8 (52)	72.2 (135)	34 (375)	66 (728)	37.5 (1362)	62.5 (2268)
Macrosomic neonate n=4988	**10.4 (518)**	**89.6 (4470)**	7.3 (14)	92.7 (177)	9.1 (103)	90.9 (1024)	10.9 (401)	89.1 (3269)
Rapid Repeat Birth n=1619	**2.6 (42)**	**97.4 (1577)**	0 (0)	100 (21)	2.5 (7)	97.5 (269)	2.6 (35)	97.4 (1287)
Previous LSCS §n=1619	**7.9 (128)**	**92.1 (1491)**	0 (0)	100 (21)	3.6 (10)	96.4 (266)	8.9 (118)	91.1 (1204)

*Epidural data only available for one study site within the dataset

§ inclusion of multiparous women only

5.7.5 Presence of Associated Risk Factors for Women Having a Lower Segment Caesarean Birth

Women having an LSCS index birth were identified for analysis and the presence of associated risk factors in these births have been summarised in Table 5.2 and Table 5.4. All univariate logistic regression analyses were undertaken on women having either a LSCS or normal birth.

Primiparous births - the proportion of women having an LSCS birth that were primiparous was 48% (n=2153/4487, 95% CI 46.54 to 49.46). This was slightly higher than that found in the total sample population (45.1%) and the proportion was increased for each age group (≤16 89.8% v 87.3%, 17-19 65.6% v 63.2, 20-25 42.7% v 38.1%). Univariate logistic regression analysis on women who had either a LSCS or normal birth found that women having their first birth were approximately one and half times more likely (OR=1.404, CI 1.317 to 1.497; $p \leq 0.001$) to have a LSCS birth than women having a subsequent vaginal birth.

Epidural analgesia - the proportion of women using an epidural as pain relief who had a LSCS birth was 36.9% (n=939/2545, 95% CI 35.03 to 38.77). This was less than that found in the total sample population (40.8%) and this decrease remained the case for each age group (≤16 52.6% v 55%, 17-19 40% v 46.1, 20-25 35.8% v 38.6%). Univariate logistic regression analysis on women who had either a LSCS or normal birth found that women using epidural analgesia were more likely (OR=1.171, CI 1.073 to 1.279; $p \leq 0.001$) to have a LSCS birth than women not having an epidural and vaginal birth.

Prolonged second stage - the proportion of women having a prolonged second stage who had a LSCS birth was 68.8% (n=212/308, 95% CI 63.63 to 73.97). This was over six times higher than that found in the total sample population (10.2%) and this proportion was substantially higher for each age group (≤16 62.5% v 9.3%, 17-19 56.5% v 10.2, 20-25 72.3% v 10.3%). Univariate logistic regression analysis on women who had either a LSCS or normal birth found women with a prolonged second stage were 55 times more likely (OR=55.001, CI 42.818 to 70.652; p≤0.001) to have a LSCS birth than women who did not have a prolonged second stage of labour and vaginal birth.

Macrosomic neonate - the proportion of women having a macrosomic neonate that had a LSCS birth was 10.5% (n=471/4447, 95% CI 9.6 to 11.40). This was higher than that found in the total sample population (8.6%) and this remained higher for each age group (≤16 8.5% v 6.1%, 17-19 9.0% v 6.8, 20-25 10.9% v 9.2%). Univariate logistic regression analysis on women who had either a LSCS or normal birth found women who gave birth to a macrosomic baby were 1.3 times more likely (OR=1.299, CI 1.170 to 1.442; p≤0.001) to have a LSCS birth than a woman who had a vaginal birth with a normal weight neonate.

Rapid repeat birth - the proportion of women having a LSCS birth that had a rapid repeat birth was 8.1% (n=190/2334, 95% CI 6.99 to 9.21). This was less than the proportion found in the total sample population (9.5%). There were no younger teenagers who had a rapid repeat birth and a LSCS birth. Older teenagers who had a rapid repeat birth was similar to that found in the overall population (17-19 14.6% v 14.5%) but women in the comparative group had a lower proportion than the overall population (20-25, 7.3% v 8.6%). Univariate logistic regression analysis on women who had either a LSCS or normal birth found that women having a rapid repeat birth had a reduced risk (OR= 0.759, CI 0.648 to 0.890; $p \leq 0.001$) of having a LSCS birth than other multiparous women.

Previous LSCS – the proportion of women having a LSCS birth that had a previous LSCS was 39.6% (n=924/2334, 95% CI 37.62 to 41.58). This was five times higher than in the total sample proportion (8.7%). There were higher proportions in the two older age groups than in the overall population (17-19 22.3% v 4.3%, 20-25 42.1% v 9.5%) but no younger teenagers had a repeat LSCS (0% v 1.4%). Univariate logistic regression analysis on women who had either a LSCS or normal birth found that women who had a previous LSCS were 17 times more likely (OR=17.003, CI 15.066 to 19.189; $p \leq 0.001$) to have a LSCS birth than women who had not had a previous LSCS and vaginal birth.

Table 5.2 Women Having a Lower Segment Caesarean Section by Age Group: Presence of Associated Risk Factors

Associated Risk Factors	Total		Age Group					
			≤16 years		17-19 years		20-25 years	
	Yes	No	Yes	No	Yes	No	Yes	No
	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)
Primip n=4487	48 (2153)	52 (2334)	89.8 (106)	10.2 (12)	65.6 (523)	34.4 (274)	42.7 (1524)	57.3 (2048)
Epidural* n=2545	36.9 (939)	63.1 (1606)	52.6 (30)	47.4 (27)	40 (171)	60 (257)	35.8 (738)	64.2 (1322)
Prolonged Second Stage n=308	68.8 (212)	31.2 (96)	62.5 (5)	37.5 (3)	56.5 (35)	43.5 (27)	72.3 (172)	27.7 (66)
Macrosomic neonate n=4487	10.5 (471)	89.5 (4016)	8.5 (10)	91.5(108)	9.0 (72)	91.0 (725)	10.9 (389)	89.1 (3183)
Rapid Repeat Birth§ n=2334	8.1 (190)	91.9 (2144)	0 (0)	100 (12)	14.6 (40)	85.4 (234)	7.3 (150)	92.7 (1898)
Previous LSCS § n=2334	39.6 (924)	60.4 (1410)	0 (0)	100 (12)	22.3 (61)	77.7 (213)	42.1 (863)	57.9 (1185)

*Epidural data only available for one study site within the dataset

§ inclusion of multiparous women only

5.7.6 Presence of Associated Risk Factors for Women Having Perineal Trauma during Normal Birth

Women suffering perineal trauma during normal birth were identified for analysis and the presence of associated risk factors in these births have been summarised in Table 5.3 and Table 5.4. All univariate logistic regression analysis was undertaken on women having either perineal trauma or not during a normal birth.

Primiparous women – the proportion of primiparous women suffering perineal trauma during normal birth was 47% (n=4421/9415, 95% CI 45.99 to 48.01). This was slightly higher than that found in the overall population (45.1%) and the proportion was increased for each age group (≤16 90.1% v 87.3%, 17-19 65.7% v 63.2, 20-25 40.1% v 38.1%). Univariate logistic regression analysis on women who had perineal trauma or not, found that women having their first birth were approximately 1.7 times more likely (OR=1.696, CI 1.606 to 1.792; p≤0.001) to have perineal trauma than women having a subsequent birth.

Epidural analgesia – the proportion of women suffering perineal trauma during a normal birth while using epidural analgesia was 37.9% (n=2182/5755, 95% CI 36.65 to 39.15). This was less than that found in the overall population (40.8%) and this reduction remained consistent for each age group (≤16 51.3% v 55%, 17-19 43.3% v 46.1, 20-25 35.8% v 38.6%). Univariate logistic regression analysis on women who suffered perineal trauma or not found that women having an epidural were one and a half times more likely (OR=1.425, CI 1.325 to 1.532; p≤0.001) to suffer perineal trauma than women not having an epidural.

Prolonged second stage – the proportion of women having a prolonged second stage who suffered perineal trauma during a normal birth was low at 5.4% (n=502/9306, 95% CI 4.94 to 5.86). This was half that found in the overall population (10.2%) and this remained similar for each age group (≤16 5.2% v 9.3%, 17-19 5.8% v 10.2, 20-25 5.3% v 10.3%). Univariate logistic regression analysis on women who suffered perineal trauma or not found that women with a prolonged second stage were twice as likely (OR=2.033, CI 1.766 to 2.341; p≤0.001) to suffer perineal trauma than women who did not have a prolonged second stage of labour.

Macrosomic neonate – the proportion of women having a macrosomic neonate that suffered perineal trauma was 9.2% (n=859/9373, 95% CI 8.61 to 9.79). This was higher than that found in the overall population (8.6%) and this difference remained consistent for each age group (≤16 6.5% v 6.1%, 17-19 7.1% v 6.8, 20-25 9.8% v 9.2%). Univariate logistic regression analysis on women who suffered perineal trauma or not found women who gave birth to a macrosomic baby were 1.6 times more likely (OR=1.603, CI 1.453 to 1.768; p≤0.001) to suffer perineal trauma during a normal birth than a woman who gave birth to a baby of normal weight.

Rapid repeat birth – the proportion of women suffering perineal trauma during normal birth 8.6% (n=428/4994, 95% CI 7.82 to 9.38). This was less than the proportion found in the overall dataset (9.5%). When examining the age groups the proportion was higher for younger teenagers (9.7% v 8.6%) but lower for the remaining two age groups (17-19 12.9% v 14.5%, 20-25 7.9% v 8.6). Univariate logistic regression analysis on women who suffered perineal trauma or not found that women having a rapid repeat birth had a reduced risk (OR= 0.723, CI 0.641 to 0.816; $p \leq 0.001$) of suffering perineal trauma than other multiparous women.

Previous LSCS – the proportion of women suffering perineal trauma during normal birth following a previous LSCS was 4.1% (n=859/9373, 95% CI 3.55 to 4.65). This was half that found in the overall multiparous women in the dataset (8.7%). When examining the age groups the proportion was higher in younger teenagers (3.2% v 1.4%) but lower in the remaining two age groups (17-19 2.1% v 6.8%, 20-25 4.5% v 9.5) for women who had a previous LSCS. Univariate logistic regression analysis on women who suffered perineal trauma or not found that women who had a previous LSCS were 1.2 times more likely (OR=1.202, CI 1.001 to 1.443; $p \leq 0.001$) to suffer perineal trauma than women who had not had a previous LSCS.

Table 5.3 **Women Having Perineal Trauma during Normal Birth: Presence of Associated Risk Factors**

Associated Risk Factors	Total		Age Group					
			≤16 years		17-19 years		20-25 years	
	Yes	No	Yes	No	Yes	No	Yes	No
	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)
Primip n=9415	**47 (4421)**	**53 (4994)**	90.1 (282)	9.9 (31)	65.7 (1258)	34.3 (658)	40.1 (2881)	59.9 (4305)
Epidural* n=5755	**37.9 (2182)**	**62.1 (3573)**	51.3 (96)	48.7 (91)	43.3 (528)	56.7 (692)	35.8 (1558)	64.2 (2790)
Prolonged Second Stage n=9306	**5.4 (502)**	**94.6 (8804)**	5.2 (16)	94.8 (289)	5.8 (110)	94.2 (1775)	5.3 (376)	94.7 (6740)
Macrosomic neonate n=9373	**9.2 (859)**	**90.4 (8514)**	6.5 (20)	93.5 (290)	7.1 (136)	92.9 (1767)	9.8 (703)	90.2 (6457)
Rapid Repeat Birth§ n=4994	**8.6 (428)**	**91.4 (4566)**	9.7 (3)	90.3 (28)	12.9 (85)	87.1 (573)	7.9 (340)	92.1 (3965)
Previous LSCS § n=4994	**4.1 (207)**	**95.9 (4787)**	3.2 (1)	96.8 (30)	2.1 (14)	97.9 (644)	4.5 (192)	95.5 (4113)

*Epidural data only available for one study site within the dataset

§ inclusion of multiparous women only

5.7.7 Unadjusted Odds Ratios for Associated Risk Factors by Outcomes of Interest

Unadjusted odds ratios were undertaken for all associated risk factors individually for normal birth compared to all other outcomes, instrumental birth compared to normal birth, LSCS birth compared to normal birth and perineal trauma compared to no perineal trauma in women having a normal birth. These are reported in the text and are presented in Table 5.4.

Table 5.4 Unadjusted Odds Ratios for Associated Risk Factors by Type of Delivery and Perineal Trauma

Associated Risk Factor	Index Birth Outcome			
	Normal Birth♦ Odds Ratio (95% CI)	**Instrumental Births♦♦ Odds Ratio (95% CI)**	**LSCS Birth ♦♦ Odds Ratio (95% CI)**	**Perineal Trauma Odds Ratio (95% CI)**
Primiparous	**0.482 (0.460 – 0.506) p≤0.001†**	**3.167 (2.968 – 3.380) p≤0.001**	**1.404 (1.317 -1.497) p≤0.001**	**1.696 (1.606 – 1.792) p≤0.001**
Epidural Analgesia*	**0.350 (0.328 – 0.373) p≤0.001†**	**7.157 (6.504 – 7.875) p≤0.001**	**1.171 (1.073 – 1.279) p≤0.001**	**1.425 (1.325 – 1.532) p≤0.001**
Prolonged Second Stage	**0.071 (0.065 – 0.077) p≤0.001†**	**14.231 (13.018 – 15.557) p≤0.001**	**55.001 (42.818 – 70.652) p≤0.001**	**2.033 (1.766 – 2.341) p≤0.001**
Macrosomic neonate	**0.761 (0.702 – 0.826) p≤0.001†**	**1.348 (1.216 – 1.494) p≤0.001**	**1.299 (1.170 – 1.442) p≤0.001**	**1.603 (1.453- 1.768) p≤0.001**
Rapid Repeat Birth§	**1.795 (1.563 – 2.061) p≤0.001**	**0.223 (0.167 – 0.312) p≤0.001†**	**0.759 (0.648 – 0.890) p≤0.001†**	**0.723 (0.641 – 0.816) p≤0.001†**
Previous LSCS§	**0.113 (0.101 – 0.127) p≤0.001†**	**2.227 (1.822 -2.723) p≤0.001**	**17.003 (15.066 – 19.189) p≤0.001**	**1.202 (1.001 – 1.443) p=0.049**

* Epidural data available for only one site ♦ against all other births ♦♦ against normal births only

§analysis undertaken on multiparous women only † indicates a lower risk of the outcome in the results table **Bold indicates significant result in table**

5.7.8 Multivariate Logistic Regression Explaining Birth Outcome Adjusting For Risk Factors

Backward manual conditional stepwise logistic regression was undertaken for each of the models developed to address the hypotheses posed in this chapter for the reasons stated in the methodology chapter.

The variable responsible for the large number of missing cases in each of the models undertaken was epidural analgesia during labour, as data were only available from one study site. As a result each of the models has been run and then repeated excluding epidural from the model and any differences in findings reported within the text and relevant tables of results.

Models examining Hypothesis 5.1a

Hypothesis 5.1a

'Primparous teenage women have an increased risk of having an instrumental birth when compared to primiparous women in their early twenties and this risk is increased further for younger teenagers'.

After identifying primiparous women a backward manual stepwise conditional logistic regression model was run with having either an instrumental or normal birth as the outcome. Age group remained in the model regardless of significance and the explanatory variables included in the model were:

Epidural Analgesia- Yes/No

Prolonged Second Stage- Yes/No

Macrosomic Neonate- Yes/No

Women having their first birth (n=14824) were selected for analysis with variables being entered into the model. 7286 (49.2%) cases were entered into the initial model and all risk factors remained significant at the 0.05 level and remained in the model.

The findings of the analysis can be found in Table 5.5. Being a primiparous teenager reduced a woman's risk of having an instrumental birth when compared to the comparative group after adjusting for all associated risk factors. For younger teenagers this risk was slightly lower (OR= 0.585) than for older teenagers (OR= 0.675). For primiparous women: using epidural analgesia (OR=3.17), having a prolonged second stage of labour (OR=5.47), and having a macrosomic neonate (OR=1.5) there was an increased risk of an instrumental birth rather than a normal birth.

Using the Nagelkerke R Squared test the model explained 24.9% of the variance and the Hosmer and Leweshow Test ($\chi^2 = 9.844$ (df=7) p=0.198) indicated the model was a good fit. The final model correctly classified 78.1% of cases and this was an increase of 5.1%.

> By removing Epidural from the initial model it increased the number of cases included (n=12328) but did not greatly alter the findings of the analysis.

Table 5.5 Model for Hypothesis 5.1a examining Instrumental Birth in Primiparious Women

Factor	Unadjusted OR for primiparous women (95%CI)	Adjusted OR for primiparous women (95% CI) n=7286	Adjusted OR for primiparous women (95% CI) without Epidural n=12328
20-25 years	1.00	1.00	1.00
≤ 16 years	0.585 (0.491 to 0.696) $p \leq 0.001$†	0.640 (0.499 to 0.819) $p \leq 0.001$†	0.672 (0.557 to 0.810) $p=0.001$†
17-19 years	0.675 (0.617 to 0.739) $p \leq 0.001$†	0.708 (0.622 to 0.807) $p \leq 0.001$†	0.749 (0.679 to 0.825) $p \leq 0.001$†
Epidural* - yes/no	4.468 (3.962 to 5.039) $p \leq 0.001$	3.170 (2.789 to 3.603) $p \leq 0.001$	Removed for analysis
Prolonged second stage –yes/no	8.262 (7.414 to 9.207) $p \leq 0.001$	5.474 (4.763 to 6.291) $p \leq 0.001$	7.954 (7.134 to 8.868) $p \leq 0.001$
Macrosomic neonate– yes/no	1.679 (1.452 to 1.940) $p \leq 0.001$	1.532 (1.247 to 1.883) $p \leq 0.001$	1.374 (1.169 to 1.615) $p \leq 0.001$

* Epidural data available for only one site

† indicates a lower risk of instrumental birth in the results table

Bold indicates significant result in table

Models examining Hypothesis 5.1b

Hypothesis 5.1b

'Multiparous teenage women have an increased risk of having an instrumental birth when compared to mulitparous women in their early twenties and this risk is increased further for younger teenagers'.

After identifying multiparous women a backward manual stepwise conditional logistic regression model was run with having either an instrumental or normal birth as the outcome. Age group remained in the model regardless of significance and the explanatory variables included in the model were:

Epidural Analgesia- Yes/No

Prolonged Second Stage- Yes/No

Macrosomic Baby- Yes/No

Rapid Repeat Birth- Yes/No

Previous LSCS- Yes/No

Women having subsequent births (n=18071) were selected for analysis with variables being entered into the model. At the initial stage 8744 (48.4%) cases were entered into the model and this number was the same after completing the regression model. The only variable not reaching the 0.05 level of significance was having a macrosomic neonate (OR=1.196, CI 0.934 to 1.531; p=0.541) which was removed from the model.

The findings of the analysis can be found in Table 5.6. Being a multiparous older teenager reduced a woman's risk (OR=0.711) when compared to a woman from the comparative group of having an instrumental birth after adjusting for the remaining associated risk factors. Younger teenagers had a reduced risk (OR=0.629) of having an instrumental birth compared to the comparative group. For multiparous women; using epidural analgesia (OR=5.6); having a prolonged second stage of labour (OR=12); and a previous LSCS (OR=2.4) there was an increased risk of an instrumental birth rather than a normal birth. For multiparous women, having a rapid repeat birth reduced the risk (OR=0.282) of having an instrumental birth rather than a normal birth.

Using the Nagelkerke R Squared test the model explained 32.9% of the variance and the Hosmer and Leweshow Test ($\chi^2 = 7.916$ (df=4) p=0.095) indicated the model was a good fit. The final model correctly classified 91.8% of cases and this was an increase of 1.6%.

> Removing epidural from the initial model increased the number of cases included (n=15260) and as previous the only variable to be removed was macrosomic neonate (OR=1.099, CI 0.911 to 1.325: p=0.325). The removal of epidural did alter the results found in the earlier model. For multiparous teenagers regardless of age, there was an increased rather than a decreased risk (≤16 years OR=2.169, 17-19 years OR=1.201) of an instrumental birth rather than normal birth in comparison to the comparative group. However, both variance and fit statistics were altered very little by removing epidural.

Table 5.6 Model for Hypothesis 5.1b examining Instrumental Birth in Multiparous Women

Factor	Unadjusted OR for multiparous women (95%CI)	Adjusted OR for multiparous women (95% CI) n=8744	Adjusted OR for multiparous women (95% CI) without Epidural n=15260
20-25 years	1.00	1.00	1.00
≤ 16 years	**1.769 (1.104 to 2.835) p=0.018**	0.629 (0.190 to 2.077) p=0.447	**2.169 (1.291 to 3.645) p=0.003**
17-19 years	**1.254 (1.092 to 1.439) p=0.001**	**0.711 (0.555 to 0.912) p=0.007†**	**1.201 (1.023 to 1.412) p=0.026**
Epidural* – yes/no	**9.666 (8.199 to 11.394) p≤0.001**	**5.636 (4.709 to 6.744) p≤0.001**	Removed for analysis
Prolonged second stage – yes/no	**25.993 (22.173 to 30.470) p≤0.001**	**12.022 (9.679 to 14.931) p≤0.001**	**25.167 (21.428 to 29.559) p≤0.001**
Macrosomic neonate– yes / no	**1.374 (1.165 to 1.614) p≤0.001**		
Rapid Birth – yes/no	**0.228 (0.167 to 0.312) p≤0.001†**	**0.282 (0.174 to 0.459) p≤0.001†**	**0.257 (0.184 to 0.360) p≤0.001†**
Previous LSCS – yes/no	**2.227 (1.822 to 2.723) p≤0.001**	**2.410 (1.762 to 3.296) p≤0.001**	**2.750 (2.200 to 3.436) p≤0.001**

* Epidural data available for only one site

† indicates a lower risk of Instrumental birth in the results table.

Bold indicates significant result in table

Models examining Hypothesis 5.1c

Hypothesis 5.1c

'Multiparous teenage women have an increased risk of having an instrumental birth when compared to primiparous teenage women'.

After identifying teenage women a backward manual stepwise conditional logistic regression model was run having either an instrumental or normal birth as the outcome. Whether first or subsequent birth remained in the model regardless of significance and the explanatory variables included in the model were:

Epidural Analgesia- Yes/No

Prolonged Second Stage- Yes/No

Macrosomic Neonate- Yes/No

Teenage women (n=8028) were identified for analysis with variables being entered into the model. At the initial stage 4047 (50.4%) cases were entered into the model and this number was the same after completing the regression model. The only variable not reaching the 0.05 level of significance was macrosomic neonate (OR=1.343, CI 0.972 to 1.855; p=0.074) which was removed from the model.

The findings of the analysis can be found in Table 5.7. Being a primiparous teenager was associated with an increased risk of having an instrumental birth (OR= 0.429) after adjusting for associated risk factors when compared to a multiparous teenager. For teenage women using epidural analgesia (OR=3.63) and having a prolonged second stage of labour (OR=7.6) increased the risk of an instrumental birth rather than a normal birth.

Using the Nagelkerke R Squared test the model explained 27.5% of the variance and the Hosmer and Leweshow Test ($\chi^2 = 2.837$ (df=3), p=0.417) indicated the model was a good fit. The final model correctly classified 84.6% of cases and this was an increase of 2.2%.

By removing epidural from the model this increased the number of cases included (n=6899). As in the earlier model the only variable to be removed was macrosomic neonate (OR=1.268, CI 0.987 to 1.628; p=0.063). By removing epidural this reduced the risk of primiparous teenagers having an instrumental birth (OR=0.533) rather than a normal birth. Teenagers were also at an increased risk of prolonged second stage (OR=10.783) but the variance and fit were similar for both models.

Table 5.7 Model for Hypothesis 5.1c examining Instrumental Birth in Teenage Women

Factor	Unadjusted OR for teenage women (95%CI)	Adjusted OR for teenage women (95% CI) n=4047	Adjusted OR for teenage women (95% CI) without Epidural n=6899
Multip – yes/no	0.509 (0.443 to 0.586) $p \leq 0.001$†	0.429 (0.339 to 0.541) $p \leq 0.001$†	0.533 (0.458 to 0.621) $p \leq 0.001$†
Epidural* – yes/no	**5.632 (4.644 to 6.831) $p \leq 0.001$**	**3.636 (2.956 to 4.471) $p \leq 0.001$**	Removed for analysis
Prolonged second stage – yes/no	**11.069 (9.304 to 13.168) $p \leq 0.001$**	**7.599 (6.051 to 9.544) $p \leq 0.001$**	**10.783 (9.051 to 12.847) $p \leq 0.001$**
Macrosomic neonate – yes / no	**1.545 (1.241 to 1.924) $p \leq 0.001$;**		

* Epidural data available for only one site

† indicates a lower risk of Instrumental birth in the results table

Bold indicates significant result in table

Models examining Hypothesis 5.1d

Hypothesis 5.1d

'Multiparous teenage women having rapid repeat births have an increased risk of having an instrumental birth when compared to multiparous teenage women not having a rapid repeat birth'.

After identifying multiparous teenage women a backward manual stepwise conditional logistic regression model was run having an instrumental or normal birth as the outcome. The variable depicting rapid repeat birth remained in the model regardless of significance and the explanatory variables included in the model were:

Epidural Analgesia- Yes/No

Prolonged Second Stage- Yes/No

Macrosomic Neonate- Yes/No

Previous LSCS- Yes/No

Multiparous teenage women (n=2687) were identified for analysis with variables being entered into the model. At the initial stage 1243 (46.3%) cases were entered into the model and this number was the same after completing the regression model. The first variable to be removed from the model was previous LSCS (OR=1.412, CI 0.389 to 5.126; p=0.600) followed by macrosomic neonate (OR=1.807, CI 0.946 to 3.452; p=0.073).

The findings of the analysis can be found in Table 5.8. Being a multiparous teenager having a rapid repeat birth reduced the risk of having an instrumental birth rather than a normal birth in comparison to multiparous teenagers not having a rapid repeat birth. For multiparous teenage women using: epidural analgesia (OR=3.49) and having a prolonged second stage of labour (OR=15.3) there was an increased risk of an instrumental rather than a normal birth.

Using the Nagelkerke R Squared test the model explained 34% of the variance and the Hosmer and Leweshow Test (χ^2 = 1.863 (df=3), p=0.601) indicated the model was a good fit. The final model correctly classified 92% of cases an increase of 1.3%.

By removing epidural from the model this increased the number of cases included (n=2687) and only one variable was removed previous LSCS (OR=1.812, CI 0.796 to 4.120; p=0.156). The only change to the findings of the repeated model was a lessened risk of instrumental rather than normal birth in teenagers having a rapid repeat birth and if the multiparous teenager had a macrosomic neonate there was an increased risk of having an instrumental birth (OR=1.634) rather than a normal birth. Both the variance and fit were similar for both models.

Table 5.8 Model for Hypothesis 5.1d examining Instrumental Birth in Multiparous Teenage Women Having a Rapid Repeat Birth or Not

Factor	Unadjusted OR for multiparous teenagers (95%CI)	Adjusted OR for multiparous teenagers (95% CI) n=1243	Adjusted OR for multiparous teenagers (95% CI) without Epidural n=2687
Rapid Repeat Birth – yes/no	**0.128 (0.060 to 0.273) p≤0.001†**	**0.320 (0.110 to 0.931) p=0.037†**	**0.179 (0.083 to 0.387) p≤0.001†**
Epidural* – yes/no	**5.632 (4.644 to 6.831) p≤0.001**	**3.492 (2.084 to 5.853) p≤0.001**	Removed for analysis
Prolonged second stage – yes/no	**11.069 (9.304 to 13.168) p≤0.001**	**15.344 (9.131 to 25.785) p≤0.001**	**15.218 (10.638 to 21.769) p≤0.001**
Macrosomic neonate – yes /no	**2.239 (1.549 to 3.235) p≤0.001**		**1.634 (1.053 to 2.534) p=0.028**
Previous LSCS – yes/no	1.726 (0.855 to 3.483) p= 0.128		

* Epidural data available for only one site

† indicates a lower risk of instrumental birth in the results table

Bold indicates significant result in table

Models examining Hypothesis 5.2a

Hypothesis 5.2a

'Primparous teenage women have an increased risk of having a LSCS birth when compared to primiparous women in their early twenties and this risk is increased further for younger teenagers'.

After identifying primiparous women a backward manual stepwise conditional logistic regression model was run having a LSCS or normal birth as the outcome. Age group remained in the model regardless of significance and the explanatory variables included in the model were:

Epidural Analgesia- Yes/No

Prolonged Second Stage- Yes/No

Macrosomic Neonate- Yes/No

Women having their first birth (n=14824) were identified for analysis with variables being entered into the model. At the initial stage 5438 (36.7%) cases were entered into the model and this number was the same after completing the regression model. All risk factors remained significant at the 0.05 level and remained in the model.

The findings of the analysis can be found in Table 5.9. A primiparous teenager had a similar risk of having a LSCS birth after adjusting for all associated risk factors as the comparative group. For primiparous women using: epidural analgesia (OR=7.17), having a prolonged second stage of labour (OR=17.75) or having a macrosomic neonate (OR=4.88) there was an increased risk of a LSCS birth rather than a normal birth.

Using the Nagelkerke R Squared test the model explained 35.8% of the variance and the Hosmer and Leweshow Test (χ^2 = 1.186 (df=5), p=0.946) indicated the model was a good fit. The final model correctly classified 97.8% of cases.

As the cases in the model were reduced due to epidural the model was rerun without epidural. By removing epidural from the model this increased the number of cases (n=9203) and some of the risk identified was increased. For primiparous women having: a prolonged second stage (OR=33.544) the risk of having a LSCS rather than a normal birth was increased and having a macrosomic neonate (OR=3.884) lowered the increased risk of having a LSCS birth rather than a normal birth. Both the variance and fit were similar for both models.

> Removing epidural from the initial model increased the number of cases included (n=9203) but did not change the overall results.

Table 5.9 Model for Hypothesis 5.2a examining Lower Segment Caesarean Section Birth in Primiparous Women

Factor	Unadjusted OR for primiparous women (95%CI)	Adjusted OR for primiparous women (95% CI) n=5438	Adjusted OR for primiparous women (95% CI) without Epidural n=9203
20-25 years	1.00	1.00	1.00
≤ 16 years	**0.562 (0.454 to 0.694) $p \leq 0.001$†**	0.643 (0.258 to 1.601) p=0.343	0.444 (0.187 to 1.049) p=0.064
17-19 years	**0.639 (0.573 to 0.713) $p \leq 0.001$†**	0.638 (0.387 to 1.052) p=0.078	0.761 (0.530 to 1.094) p=0.141
Epidural* - yes/no	**1.169 (1.034 to 1.323) p=0.013**	**7.174 (3.398 to 15.147) $p \leq 0.001$**	Removed for analysis
Prolonged second stage –yes/no	**38.432 (27.777 to 53.173) $p \leq 0.001$**	**17.750 (11.391 to 27.659) $p \leq 0.001$**	**33.544 (24.135 to 46.621) $p \leq 0.001$**
Macrosomic neonate– yes/no	**2.145 (1.832 to 2.511) $p \leq 0.001$**	**4.885 (3.045 to 7.835) $p \leq 0.001$**	**3.884 (2.673 to 5.643) $p \leq 0.001$**

* Epidural data available for only one site

† indicates a lower risk of instrumental birth in the results table

Bold indicates significant result in table

Models examining Hypothesis 5.2b

Hypothesis 5.2b

'Multiparous teenage women have an increased risk of having a LSCS birth when compared to multiparous women in their early twenties and this risk is increased further for younger teenagers'.

The later part of the above hypothesis cannot be addressed as there were no multiparous younger teenage women who had a LSCS. Therefore, only the first part of the hypothesis can be examined. Iin the following model a comparison of all teenagers has been made with the comparative group.

After identifying multiparous women a backward manual stepwise conditional logistic regression model was run with either a LSCS or normal birth as the outcome. Age group remained in the model regardless of significance and the explanatory variables included in the model were:

Epidural Analgesia- Yes/No

Prolonged Second Stage- Yes/No

Macrosomic Neonate- Yes/No

Rapid Repeat Birth- Yes/No

Previous LSCS- Yes/No

Women having subsequent births (n=18071) were identified for analysis with variables being entered into the model. At the initial stage 7965 (44.1%) cases were entered into the model and this number was the same after completing the regression model. Variables that did not reach the 0.05 level of significance were rapid repeat birth

(OR=0.814, CI 0.246 to 2.693; p=0.736) followed by previous LSCS (OR=0.357, CI 0.047 to 2.734; p=0.321) which were removed from the model.

The findings of the analysis can be found in Table 5.10. A mulitparous teenager was not at an increased risk of having a LSCS birth rather than a normal birth after adjusting for associated risk factors when compared to the comparative group. Women using: epidural analgesia (OR=2.674); having a prolonged second stage of labour (OR=35.648), or a macrosomic neonate (OR=1.831) were at an increased risk of a LSCS birth rather than a normal birth.

Using the Nagelkerke R Squared test the model explained 30.1% of the variance and the Hosmer and Leweshow Test ($\chi^2 = 3.742$ (df=3), p=0.291) indicated the model was a good fit. The final model correctly classified 99.1% of cases.

> Variance was similar for both models however the second model was not a good fit ($\chi^2 = 0.000$ (df=1), p=0.000) therefore the results have not been reported.

Table 5.10 Model for Hypothesis 5.2b examining Lower Segment Caesarean Section Birth in Multiparous Women

Factor	Unadjusted OR for multiparous women (95%CI)	Adjusted OR for multiparous women (95% CI)
20-25 years **≤ 19 years**	1.00 **0.796 (0.697 to 0.908) p=0.001**	1.00 0.956 (0.490 to 1.864) p=0.895
Epidural – yes/no	0.989 (0.864 to 1.135) p=0.873	**2.674 (1.429 to 5.003) p=0.002**
Prolonged second stage – yes/no	**75.278 (50.272 to 112.722) p≤0.001**	**35.648 (20.103 to 63.212) p≤0.001**
Macrosomic baby – yes /no	1.008 (0.867 to 1.172) p=0.919	**1.831 (1.010 to 3.318) p=0.046**
Rapid Birth – yes/no	**0.759 (0.648 to 0.890) p=0.001†**	
Previous LSCS – yes/no	**17.003 (15.066 to 19.189) p≤0.001**	

* Epidural data available for only one site

† indicates a lower risk of LSCS birth in the results table

Bold indicates significant result in table

Models examining Hypothesis 5.2c

Hypothesis 5.2c

'Multiparous teenage women have an increased risk of having a LSCS birth when compared to primiparous teenage women'.

After identifying teenage women a backward manual stepwise conditional logistic regression model was run having either an instrumental or normal birth as the outcome. Whether first or subsequent birth remained in the model regardless of significance and the explanatory variables included in the model were:

Epidural Analgesia- Yes/No

Prolonged Second Stage- Yes/No

Macrosomic Neonate- Yes/No

Teenage women (n=8028) were selected for analysis with variables being entered into the model. At the initial stage 4135 (51.5%) cases were entered into the model and this number was the same after completing the regression model. All variables remained significant at the 0.05 level and remained in the model.

The findings of the analysis can be found in Table 5.11. A multiparous teenager had a similar statistical risk of having a LSCS birth after adjusting for associated risk factors when compared to a primiparous teenager. Teenagers using: epidural analgesia (OR=3.969); having a prolonged second stage of labour (OR=4.148) or having a macrosomic neonate (OR=2.477) were at an increased risk of having a LSCS birth rather than a normal birth.

Using the Nagelkerke R Squared test the model explained 11.1% of the variance and the Hosmer and Leweshow Test ($\chi^2 = 2.764$ (df=4), p=0.598) indicated the model was a good fit. The final model correctly classified 98.8% of cases.

By removing epidural from the initial model this increased the number of cases (n=5379) included but multiparous women still had a similar statistical risk of having a LSCS birth in comparison to primiparous teenage women. As before all variables remained in the model and the main findings were the same. For teenage women a prolonged second stage of labour (OR=11.159) and women having a large baby (OR=2.682) were at an increased risk of having a LSCS birth rather than a normal birth. The model explained a similar amount of variance and it was a good fit.

Table 5.11 Model for Hypothesis 5.2c examining Lower Segment Caesarean Section Birth in Teenage Women

Factor	Unadjusted OR for teenage women (95%CI)	Adjusted OR for teenage women (95% CI) n=3375	Adjusted OR for teenage women (95% CI) without Epidural n=5379
Multip – yes/no	**1.256(1.082 to 1.459) p=0.003**	1.167 (0.585 to 2.329) p=0.660	0.817 (0.471 to 1.417) p=0.472
Epidural* – yes/no	1.014 (0.836 to 1.230) p=0.890	**3.969 (1.589 to 9.916) p=0.003**	Removed for analysis
Prolonged second stage – yes/no	**29.828 (18.260 to 48.723) $p \leq 0.001$**	**4.148 (2.140 to 8.040) $p \leq 0.001$**	**11.159 (6.841 to 18.202) $p \leq 0.001$**
Macrosomic neonate – yes/no	**1.561 (1.213 to 2.009) p=0.001**	**2.477 (1.141 to 5.380) p=0.022**	**2.682 (1.469 to 4.897) p=0.001**

* Epidural data available for only one site

Bold indicates significant result in table

Models examining Hypothesis 5.2d

Hypothesis 5.2d

'Multiparous teenage women having rapid repeat births have an increased risk of having a LSCS birth when compared to multiparous teenage women not having a rapid repeat birth'.

After identifying multiparous teenage women a backward manual stepwise conditional logistic regression model was run having either a LSCS or normal birth as the outcome. The variable depicting rapid repeat birth remained in the model regardless of significance and the explanatory variables included in the model were:

Epidural Analgesia- Yes/No

Prolonged Second Stage- Yes/No

Macrosomic Neonate- Yes/No

Previous LSCS- Yes/No

Multiparous teenage women (n=2687) were identified for analysis with variables being entered into the model. At the initial stage 1272 (47.3%) cases were entered into the model and this number increased to 2686 (100%) cases after completing the regression model. All associated risk factors did not reach the 0.05 significance level and were removed from the model. The variables were removed in the following order: previous LSCS (OR=0.000, CI 0.000; p=0.998); length of second stage (OR=1.320, CI 0.253 to 6.880 p=0.742); macrosomic neonate (OR=1.123, CI 0.613 to 2.057; p=0.707); and finally epidural analgesia (OR=0.903, CI 0.623 to 1.308; p=0.588).

Multiparous teenagers having a rapid repeat birth had a similar statistical risk (OR=0.978) of having a LSCS birth rather than a normal birth when compared to women not having a rapid repeat birth. As the model was such a poor fit no diagnostics have been reported and the model has not been included.

Models examining Hypothesis 5.3a

Hypothesis 5.3a

'Primparous teenage women have an increased risk of perineal trauma during normal birth when compared to primiparous women in their early twenties and this risk is increased further for younger teenagers'.

After identifying primiparous women having a normal birth a backward manual stepwise conditional logistic regression model was run having perineal trauma or not as the outcome. Age group remained in the model regardless of significance and the explanatory variables included in the model were:

Epidural Analgesia- Yes/No

Prolonged Second Stage- Yes/No

Macrosomic Neonate- Yes/No

Women having a normal first birth (n=9117) were selected for analysis with variables being entered into the model. At the initial stage 5280 (57.9%) cases were entered into the model and this number was increased to 8589 (94.2%) after completing the regression model. The only variable to be removed from the model was epidural analgesia (OR=1.059, CI 0.947 to 1.185; p=0.313).

The findings of the analysis can be found in Table 5.12. Being a primiparous teenager reduced the risk of suffering perineal trauma after adjusting for associated risk factors when compared to the comparative group. For younger teenagers the statistical risk was lower (OR=0.630) than for older teenagers (OR=0.624). Primiparous women having: a prolonged second stage of labour (OR=2.344) or a macrosomic neonate (OR=1.761) were at an increased risk of suffering perineal trauma during normal birth.

Using the Nagelkerke R Squared test the model explained 2.5% of the variance and the Hosmer and Leweshow Test ($\chi^2 = 0.190$ (df=3), p=0.991) indicated the model was a good fit. The final model correctly classified 55.6% of cases an increase of 4.7% overall.

> A model excluding epidural was not repeated as epidural was the only variable to be removed from the model and the findings would be the same as before.

Table 5.12 Model for Hypothesis 5.3a Examining Perineal Trauma during Normal Birth in Primiparous Women

Factor	Unadjusted OR for primiparous women (95%CI)	Adjusted OR for primiparous women (95% CI) n=8589
20-25 years	1.00	1.00
≤ 16 years	**0.631 (0.535to 0.744) p≤0.001†**	**0.630 (0.534 to 0.745) p≤0.001†**
17-19 years	**0.668 (0.609 to 0.733) p≤0.001†**	**0.677 (0.608 to 0.732) p≤0.001†**
Epidural* - yes/no	**1.135 (1.019 to 1.265) p=0.021**	
Prolonged second stage – yes/no	**1.611 (1.355 to 1.916) p≤0.001**	**1.514 (1.271 to 1.803) p≤0.001**
Macrosomic baby – yes/no	**1.905 (1.578 to 2.299) p≤0.001**	**1.861 (1.540to 2.249) p≤0.001**

* Epidural data available for only one site

† indicates a lower risk of perineal trauma in the table

Bold indicates significant result in table

Models examining Hypothesis 5.3b

Hypothesis 5.3b

'Multiparous teenage women have an increased risk of perineal trauma during normal birth when compared to mulitparous women in their early twenties and this risk is increased further for younger teenagers'.

After identifying multiparous women having a normal birth a backward manual stepwise conditional logistic regression model was run having either perineal trauma or not as the outcome. Age group remained in the model regardless of significance and the explanatory variables included in the model were:

Epidural Analgesia- Yes/No

Prolonged Second Stage- Yes/No

Macrosomic Neonate- Yes/No

Rapid Repeat Birth- Yes/No

Previous LSCS- Yes/No

Women having subsequent normal births (n=13877) were selected for analysis with variables being entered into the model. At the initial stage 7833 (56.4%) cases were entered into the model and this number was the same after completing the regression model. All variables remained significant at the 0.05 level and remained in the model.

The findings of the analysis can be found in Table 5.13. Younger multiparous teenagers were not at a statistically significant risk (OR=0.709) of suffering perineal trauma during normal birth when compared to the comparative group after adjusting for associated risk factors. Older multiparous teenagers were at a reduced risk (OR=0.863) of suffering perineal trauma during normal birth when compared to the comparative group after adjusting for associated risk factors. Multiparous women using: epidural analgesia (OR=1.284); having a prolonged second stage (OR=2.301), having a macrosomic neonate (OR=1.625) or having a previous LSCS (OR=1.314) were at an increased risk of suffering perineal trauma during a normal birth. Those women having a rapid repeat birth were at a reduced risk (OR=0.738) of suffering perineal trauma during a normal birth.

Using the Nagelkerke R Squared test the model explained 2.3% of the variance and the Hosmer and Leweshow Test ($\chi^2 = 2.199$ (df=4), p=0.699) indicated the model was a good fit. The final model correctly classified 63.8% of cases an overall increase of 0.7%.

> By removing epidural from the initially model the number of cases included for analysis was increased (n=12997). The remaining findings were the similar to the original model.

Table 5.13 Model for Hypothesis 5.3b Examining Perineal Trauma during Normal Birth in Multiparous Women

Factor	Unadjusted OR for multiparous women (95%CI)	Adjusted OR for multiparous women (95% CI) n=7833	Adjusted OR for multiparous women (95% CI) without Epidural n=12997
20-25 years	1.00	1.00	1.00
≤ 16 years	0.700 (0.458 to 1.069) p= 0.099	0.709(0.368 to 1.369) p=0.306	**0.675 (0.437 to 1.043) p=0.077**
17-19 years	**0.874 (0.789 to 0.968) p=0.010†**	**0.863(0.752 to 0.991) p=0.037†**	**0.894 (0.806 to 0.993) p=0.036 p≤0.001†**
Epidural* – yes/no	**1.367 (1.233 to 1.516) p≤0.001**	**1.284 (1.153 to 1.430) p≤0.001**	Removed for analysis
Prolonged second stage – yes/no	**2.098 (1.636 to 2.689) p≤0.001**	**2.301 (1.691 to 3.129) p≤0.001**	**2.016 (1.571 to 2.589) p≤0.001**
Macrosomic neonate – yes/no	**1.659 (1.475 to 1.865) p≤0.001**	**1.625 (1.402 to 1.840) p≤0.001**	**1.630 (1.448 to 1.834) p≤0.001**
Rapid Birth – yes/no	**0.723 (0.641 to 0.816) p≤0.001†**	**0.738 (0.629 to 0.867) p≤0.001†**	**0.731 (0.647 to 0.826) p≤0.001†**
Previous LSCS – yes/no	**1.202 (1.001 to 1.443) p=0.049**	**1.314 (1.035 to 1.669) p=0.025**	**1.212 (1.008 to 1.458) p=0.041**

* Epidural data available for only one site

† indicates a reduced risk of perineal trauma in the table

Bold indicates significant result in table

Models examining Hypothesis 5.3c

Hypothesis 5.3c

'Multiparous teenage women have an increased risk of perineal trauma during normal birth when compared to primiparous teenage women having a normal birth'.

After identifying teenage women having a normal birth a backward manual stepwise conditional logistic regression model was run having either perineal trauma or not as the outcome. Whether first or subsequent birth remained in the model regardless of significance and the explanatory variables included in the model were:

Epidural Analgesia- Yes/No

Prolonged Second Stage- Yes/No

Macrosomic Neonate- Yes/No

Teenage women (n=5699) were selected for analysis with variables being entered into the model. At the initial stage 3311 (58.1%) cases were entered into the model and this increased to 5340 (93.7%) after completing the regression model. Epidural analgesia was the only variable to be removed from the model (OR=1.112, CI 0.962 to 1.285; p=0.153).

The findings of the analysis can be found in Table 5.14. Being a multiparous teenager reduced a woman's risk (OR=0.668) of suffering perineal trauma during normal birth after adjusting for associated risk factors when compared to primiparous teenagers. Teenage women having: prolonged second stage of labour

(OR=1.725) or a macrosomic neonate (OR=1.812) were at an increased risk of perineal trauma during normal birth.

Using the Nagelkerke R Squared test the model explained 2.3% of the variance and the Hosmer and Leweshow Test (χ^2 = 0.010 (df=1), p=0.920) indicated the model was a good fit. The final model correctly classified 60% of cases and increase of 1% overall.

As epidural was the only variable to be removed from the model this was not repeated for this hypothesis.

Table 5.14 Model for Hypotheis 5.3c Examining Perineal Trauma during Normal Birth in Teenage Women

Factor	Unadjusted OR for teenage women (95%CI)	Adjusted OR for teenage women (95% CI) n=3311
Multip – yes/no	0.668 (0.596 to 0.749) $p \leq 0.001$†	0.668 (0.595 to 0.754) $p \leq 0.001$†
Epidural* – yes/no	1.247 (1.085 to 1.433) $p=0.002$	
Prolonged second stage – yes/no	1.862 (1.424 to 2.435) $p \leq 0.001$	1.725 (1.316 to 2.262) $p \leq 0.001$
Macrosomic neonate – yes / no	1.796 (1.433 to 2.252) $p \leq 0.001$	1.812 (1.441 to 2.280) $p \leq 0.001$

* Epidural data available for only one site

† indicates a lower risk of the perineal trauma in the results table.

Bold indicates significant result in table

Models examining Hypothesis 5.3d

Hypothesis 5.3d

'Multiparous teenage women having rapid repeat births have an increased risk of perineal trauma during normal birth when compared to multiparous teenage women not having a rapid repeat birth'.

After identifying multiparous teenage women having a normal birth a backward manual stepwise conditional logistic regression model was run having either perineal trauma or not as the outcome. The variable depicting rapid repeat birth remained in the model regardless of significance and the explanatory variables included in the model were:

Epidural Analgesia- Yes/No

Prolonged Second Stage- Yes/No

Macrosomic Neonate- Yes/No

Previous LSCS- Yes/No

Multiparous teenage women having a normal birth (n=2072) were selected for analysis with variables being entered into the model. At the initial stage 1121 (54.1%) cases were entered into the model and this number increased to 1934 (93.3%) cases after completing the regression model. The variables removed from the model having not reached the 0.05 significance level were: previous LSCS (OR=1.463, CI 0.658 to 3.251; p=0.350), macrsomic baby (OR=1.417, CI 0.894 to 2.247; p=0.138), and epidural analgesia (OR=1.244, CI 0.951 to 1.629; p=0.111).

After removing these variables from the model using the Nagelkerke R Squared test the model explained only 1.1% of the variance and the Hosmer and Leweshow Test ($\chi^2 = 0.000$ (df=0), p=0.000) indicated the model was not a good fit. As the model was such a poor fit the model has not been reported.

5.7.9 Summary of Findings

5.7.9.1 Univariate analysis of outcomes of interest

The following summary is based on the analysis undertaken comparing instrumental and LSCS birth with normal birth and perineal trauma in normal births only. The findings will differ from those presented for the whole study population.

When ocusing birth outcome 17.8% (n=4988/27982) of women in the study had an instrumental birth, 16.3% (n=4487/27481) had a LSCS birth and 43.1% (n=9415/21859) of women suffered perineal trauma during a normal birth. When comparing age, teenagers had a higher proportion of instrumental births but a lower proportion of LSCS births compared to the comparative group. When examining teenagers, younger teenagers had a higher proportion of instrumental births (19.5%) but a lower proportion of LSCS births (13.1%) than older teenagers. Younger and older teenagers had similar proportions of perineal trauma but women in the comparative group were slightly higher at 43.7%.

When undertaking analysis on outcome and age only older teenagers were at an increased risk of instrumental birth (OR=1.081, p=0.039) but at a reduced risk of LSCS birth (OR=0.785, $p \leq 0.001$) and perineal trauma (OR=0.898, p=0.001) than the comparative group. Younger teenagers had a similar statistical risk of instrumental birth (OR=1.145, p=0.101) and perineal trauma (OR=0.923, p=0.288) but a reduced risk of LSCS birth (OR=0.727, p=0.001) than the comparative group.

5.7.9.2 Multivariate Analysis

On completion of the models after adjusting for associated risk factors primiparous teenagers were less likely to have an instrumental birth (≤ 16 OR=0.640, $p \leq 0.001$, 17-19 OR=0.708, $p \leq 0.001$) or suffer perineal trauma (≤ 16 OR=0.630, $p \leq 0.001$, 17-19 OR=0.667, $p \leq 0.001$) in comparison to the comparative group. If the teenager was younger the likelihood of these complications was even lower than their older peers. For primiparous teenage women there was a similar statistical risk of having a LSCS birth as the comparative group.

In the multiparous model, only older teenagers were less likely to have an instrumental birth (OR=0.711, p=0.007) or suffer perineal trauma (OR=0.863, p=0.037) compared to the comparative group. Younger multiparous teenagers had the same statistical risk for instrumental birth and perineal trauma as the comparative group.

When entering teenagers only, multiparous teenagers were less likely to have an instrumental birth (OR=0.429, p=0.009) or suffer perineal trauma (OR=0.668, p≤0.001) than teenagers having a first birth. If the multiparous teenager had a further birth within eighteen months they were less likely to have an instrumental birth (OR=0.429, p≤0.001) or suffer perineal trauma (OR=0.704, p=0.011) than a teenager waiting longer between births.

In all models teenagers were not statistically at an increased risk of a LSCS birth when other associated risk factors were taken into consideration. The hypotheses posed in this chapter have been addressed and the acceptance or rejection of hypotheses has been presented in Table 5.15. Two models were inconclusive as the models were not a good fit and therefore these hypotheses could not be addressed.

5.7.9.3 Associated Risk Factors Entered into the Models

When epidural was adjusted for in the instrumental models it increased a woman's risk of having an instrumental birth regardless of her age, whether it was her first or subsequent birth, or the length of time between births. This was similar for LSCS birth with the exception of a rapid repeat birth to a teenager, where it did not remain significant in the model. Epidurals were not as influential on perineal trauma. Having an epidural only increased the risk of perineal trauma in multiparous women but not multiparous teenagers.

Having a prolonged second stage increased the risk for instrumental birth and LSCS birth for all women. The risks were statistically higher for LSCS birth than instrumental birth in all models except the teenage model where it was reversed. If a multiparous woman had a prolonged second stage the risk was higher for instrumental or LSCS birth and this remained the case for teenagers.

Women having a macrosomic neonate were at an increased risk of LSCS and perineal trauma regardless of age or whether it was a first or subsequent birth. There was only an increased risk of instrumental birth in primiparous women when having a macrosomic neonate. If a woman had a rapid repeat birth having a macrosomic neonate did not increase the risk of instrumental birth, LSCS birth or perineal trauma.

For multiparous women, having a previous LSCS increased the risk of instrumental birth, LSCS birth and perineal trauma but not if the birth was a rapid repeat to a teenager. A multiparous woman having a rapid repeat birth was less likely to have either an instrumental birth or suffer perineal trauma. Having a rapid repeat birth did not remain statistically significant in the LSCS models for multiparous women.

Table 5.15 Summary of Hypotheses for Instrumental Birth, Lower Segment Caesarean Section Birth and Perineal Trauma

Hypothesis Tested *Primiparous teenage women have an increased risk of adverse maternal and neonatal outcomes when compared with primiparous women in their early twenties and this risk is increased further for a younger teenager.*			
Population: Primiparous Women	**Outcomes Examined**		
Comparison Groups (compared with 20-25 year old women)	**Instrumental Birth**	**LSCS Birth**	**Perineal Trauma**
All teenagers	Rejected	Rejected	Rejected
Under 16 year olds	Rejected	Rejected	Rejected
Hypothesis Tested *Multiparous teenage women have an increased risk of adverse maternal and neonatal outcomes when compared with multiparous women in their early twenties and this risk is increased further for a younger teenager.*			
Population: Multiparous Women	**Outcomes Examined**		
Comparison Groups (compared with 20-25 year old women)	**Instrumental Birth**	**LSCS Birth**	**Perineal Trauma**
All teenagers	Rejected	Rejected	Rejected
Under 16 year olds	Rejected	Not Addressed	Rejected
Hypothesis Tested *Multiparous teenage women have an increased risk of adverse maternal and neonatal outcomes when compared to primiparous teenage women*			
Population: All Teenagers	**Outcomes Examined**		
	Instrumental Birth	**LSCS Birth**	**Perineal Trauma**
Multiparous teenagers more likely than primiparous teenagers	Rejected	Rejected	Rejected
Hypothesis Tested *Multiparous teenage women having a rapid repeat birth have an increased risk of adverse maternal and neonatal outcomes when compared to multiparous teenagers not having a rapid repeat birth.*			
Population: Multiparous Teenagers	**Outcomes Examined**		
	Instrumental Birth	**LSCS Birth**	**Perineal Trauma**
Rapid repeat births more likely than Non Rapid	Rejected	Not Addressed	Not Addressed

5.8 Discussion

5.8.1 Instrumental Birth

During the same period the proportion of women having an instrumental birth was higher in this study than that quoted nationally [93, 355]. The proportions were higher in all age groups and may indicate it is a local phenomenon rather than woman centred. Allen *et als* [360] research compared local provider units from the same region and found that birth outcomes varied according to the category of unit. This may explain the high prevalence in this study as all births were from two similar category regional referral units.

Teenagers overall were not at an increased risk for instrumental birth in comparison to older women and in many cases teenagers were less likely to have an instrumental birth than older women. These findings concur with those of previous researchers [181, 189, 205, 227]. However, this study goes further in adding an insight into the difference between initial and subsequent births to teenagers.

The majority of the studies mentioned above on instrumental birth focused on primiparous teenagers and did not differentiate between outcomes in multiparous teenagers. Allen *et al* [360] acknowledged that in their study they were unable to identify repeat pregnancies in teenagers so could not adjust for this in analysis. Multiparous teenagers were identified in this study, and having a second birth did reduce the risk for instrumental birth (OR=0.429, p=0.009). This was also the case for teenagers having a rapid repeat births

(OR=0.320, p=0.037) which addresses the shortfall of previous research. Timing between pregnancies was not associated with an increased risk of instrumental birth. Previous experience of childbirth may be as influential for teenagers as for older women in that first experiences of birth may be key in promoting better outcomes in teenagers. As seen in this study teenagers had slightly higher rates of normal birth than older women and this may have assisted in the reduced risk of instrumental birth observed in this study when compared to national data.

5.8.2 Lower Segment Caesarean Section Birth

The number of women having a LSCS birth nationally nearly doubled during the timescale of this study [370]. It is against this background that the findings of this study must be considered. The proportion of women having a LSCS birth in the current study was two thirds (16.3%) of that found nationally (23%). The age of the study population may in part explain this observation. In previous studies it has been older women with a higher parity that have more LSCS births rather than younger women [315]. Further a lower incidence of LSCS births in teenage women has been observed by previous researchers [16, 162, 181, 182, 189, 205, 342, 344, 359, 372]. This is not disputed by the findings of this study in which teenagers have a similar statistical risk of LSCS birth as older women and when comparing teenagers only, the number of births and timing between births did not affect the risk of LSCS for teenagers.

It is difficult to explain why the study population and, in particular teenagers, have a lower incidence of LSCS births. It is clear that age is not a risk factor from the results of the models even when adjusting for associated risk factors. This study does confirm the findings of previous studies [16, 189, 360] but little explanation was offered for these findings in these studies.

A positive stance would suggest that younger women and in particular teenagers are more likely to labour efficiently and therefore do not encounter the problems that lead to the intervention of performing a LSCS. This would concur with the comments made by Drife [372] that teenagers do not have a biological problem with childbirth.

An alternative explanation could be that the health professional providing intrapartum care for teenagers was more reluctant to undertake a LSCS because of the consequences for future births. However, against a background of increasing LSCS births nationally the reasons for younger women having such a lower rate should be investigated in more depth as this may provide evidence to inform practice for all women.

5.8.3 Perineal Trauma

Over forty percent (43.5%) of all women in the study suffered a degree of perineal trauma. This high percentage may in part be due to the definition used in the data extraction. It was stated in the literature review that there were no published rates of perineal trauma for the data collection period other than for episiotomy. Therefore, whether the rate in the current study was comparable with that found nationally cannot be verified. When comparing age groups teenagers had a lower proportion of perineal trauma than older women but there were no studies identified with which to compare these findings.

On completion of the models after adjusting for associated risk factors, all except younger multiparous teenagers had a reduced risk of perineal trauma when compared to older women. As these were women having a normal birth the outcomes cannot be compared with Robinson *et als* [390] study that focused on operative birth rather than normal birth. In Dahlen *et als* [386] study primiparous women were found to be at an increased risk of perineal trauma but this was not the case in this study. A possible explanation for this is that Dahlen *et als* study was examining severe trauma only, which was not classified in the current study. Although it could be assumed that if all perineal trauma was included as in this study that this should provide a more accurate view of whether teenagers are at risk of perineal trauma or not.

Being multiparous appeared to have the same positive effects for teenagers as in older women, in that women are at a reduced risk of perineal trauma if the woman has birthed before [386, 387]. The reasons why teenagers have a reduced risk of perineal trauma is debateable. It could be argued that teenagers may be fitter and more active than older women and as a result this has a positive impact on the perineal body and the birthing process. Again the argument could be suggested that midwives (who would be attending normal births) refrain from performing episiotomies in teenagers but this would not prevent all perineal trauma so does not provide a robust theory. In order to answer this question a prospective study would be required to assess the actions of the midwives and the progress of the teenagers during the second stage.

5.8.4 Associated Risk Factors and Their Effect on Instrumental, Lower Segment Caesarean Section Birth and Perineal Trauma in the Models

5.8.4.1 Epidural and Instrumental birth

The association between epidural use and an increased risk of instrumental birth has been well documented [307, 362] but a systematic review by Leighton and Halpern [305] disputed these findings. Data from this thesis supports the findings of Howell [307] and Downe [381] but has established that for the study population, epidural use is more problematic for multiparous women than other groups (OR=5.6, $p \leq 0.001$). Teenagers with an epidural were also at an increased risk of instrumental birth but the risk was lower statistically (OR=3.55 grouped) than multiparous women generally.

The proportion of women in the study having an epidural is very high and explanation for this should be considered. There are wide variations between the use of epidural during normal birth and that recorded for instrumental birth. Nationally, epidural use in normal birth was 13% at the end of the study period but for instrumental birth this was increased to nearly half (48%) [370]. In the current study three quarters of women (78.1%) having an instrumental birth used an epidural for pain relief. Teenagers had the highest uptake with 84% of younger teenagers and 79% of older teenagers having an epidural. Percentages were slightly lower in older women but did not reduce greatly (77.6%).

Mechanisms for coping with the pain of childbirth are a key component of antenatal care and preparation [148]. It has been established that teenagers are less likely to attend for antenatal care than older women [391] and this may provide some explanation for the high use of epidurals during labour. Women who are ill-prepared for labour are more likely to be frightened of the process and react less favourably to the pain in labour that may explain the high use of epidurals as pain relief rather than other non-invasive methods.

At the time of data collection the majority of maternity units in the UK had an epidural service established but this was not available on a 24 hour basis in all units. The national figures quoted above are based on data collected for all maternity units [370] and include units with limited epidural services. Although only one unit in the study had data on epidural use, this unit had a full epidural service providing full access for women and those providing care on a 24 hour basis. This may provide an explanation for the higher proportions of women using epidurals in the study as the epidural rate for all women included in the study was 40%, much higher than the rates nationally (13%) at the time of data collection [215].

5.8.4.2 Epidural and Lower Segment Caesarean Section

The proportion of women who had a LSCS birth who also had an epidural was 36.9%. This is similar to the rates quoted nationally for emergency LSCS (35%) but lower than that for elective LSCS birth (68% including spinal and epidural) [370]. Teenagers' use of epidurals as pain relief was higher than the comparative group, with the younger teenagers having the highest proportion (52.6%). Although epidural use is associated with increased operative birth the actual proportions of women in this study that had a LSCS birth were lower than that found nationally (23%) [370]. A limitation of this study is that it was not possible to identify whether women had an elective or emergency LSCS. This should therefore be taken into consideration when interpreting this discussion.

As stated on page 48, teenagers had a similar statistical risk of LSCS birth as older women when associated risk factors were considered but the use of epidural increases the risk of a woman having a LSCS birth in all hypotheses except in rapid repeat births to teenagers. In contrast to instrumental birth it is primiparous women who were more at risk of LSCS when using an epidural. Primiparous women were 7 times (OR=7.17, $p \leq 0.001$) more likely to have a LSCS birth in comparison to multiparous women who are 2.6 times (OR=2.674), $p=0.002$) more likely. Teenage women overall, if having an epidural, are at an increased risk of LSCS birth (OR=3.9, $p=0.003$) but this is removed if the teenager has a rapid repeat birth.

The findings of this study are difficult to compare with that of previous researchers as the studies identified were not undertaken specifically on epidural and its effects on LSCS births in teenagers. Fraser *et als* [373] study was conducted on primiparous women and found that the timing of epidural was more influential on the outcome of birth but their outcome was 'difficult delivery' which included both instrumental and LSCS births. Leighton and Halpern's [305] systematic review found that having an epidural did not affect the incidence of LSCS birth but the findings of this study challenge those findings as epidural use is problematic whether it is a woman's first or subsequent birth and this is also true for teenagers.

5.8.4.3 Epidural and Perineal Trauma

The proportion of women having an epidural and also perineal trauma was nearly three times higher (37.9%) than that found nationally in normal births for the same period of time (13%) [370]. Proportions again were higher in the younger teenagers as seen in the previous two outcomes (51.3%). When epidural was entered into the perineal trauma models alongside other associated risk factors epidural increased the risk of perineal trauma only in multiparous women ($OR=1.28$, $p \leq 0.001$) but was not significant for primiparous or teenage women.

5.8.4.4 Prolonged Second Stage and Instrumental Birth

The association of prolonged second stage and an increased risk of instrumental birth has been observed in previous studies [310, 389]. A systematic review by Altman and Lyndon-Rochelle [309] acknowledged that whilst there was evidence of this association the studies included in their review had weaknesses. Several of the studies failed to distinguish between first and subsequent births and the definitions of prolonged second stage were not consistent. In the current study the effect of prolonged second stage on instrumental birth has been examined in both first and subsequent births and differences between age groups has been examined addressing some of the criticisms cited by Altman and Lydon-Rochelle.

Having a prolonged second stage increased the risk for all women regardless of whether they were having a first or subsequent birth. The likelihood of instrumental birth doubled (OR=12.022) if the woman had a subsequent birth in comparison to a first birth (OR=5.747). Similar findings were presented in the models containing only teenagers, with teenagers having a rapid repeat birth most likely to have an instrumental birth (OR=15.344).

From clinical experience this is a surprising finding as women who have birthed previously usually perform better in subsequent births. Associated risk factors such as epidural that had been identified by previous researchers as causing prolonged second stage had been adjusted for in this study [379]. It is difficult to offer an explanation for these findings except that the definition used in this study for prolonged second stage may have impacted on the results.

5.8.4.5 Prolonged Second Stage and Lower Segment Caesarean Section Birth

Within the literature the effect of prolonged second stage on LSCS alone has been replaced by the term 'operative birth' [310, 363, 364]. In all these studies there was an increased risk of operative birth following prolonged second stage but only Cheng [310] specified that their study included only primiparous women.

These findings were confirmed in the present study with all women except teenagers having rapid repeat births, had an increased likelihood of LSCS birth after prolonged second stage. Again there were differences between primiparous and multiparous women, multiparous women (OR=35.658) being twice as likely as primiparous women (OR=17.750) to have a LSCS with prolonged second stage. Whether this is linked to the fact that teenagers generally have lower rates of LSCS cannot be answered in this analysis.

5.8.4.6 Prolonged Second Stage and Perineal Trauma

Within the published literature having a prolonged second stage was associated with an increased risk of perineal trauma [363, 379] and this could be severe [309, 389]. In the current study the degree of trauma could not be compared but all women in the study were more likely to have perineal trauma after prolonged second stage.

In contrast to the other outcomes examined (instrumental and LSCS birth) there was little difference in the trauma between primiparous (OR=1.514) and multiparous (2.301) women when having a prolonged second stage but multiparous women fared less well. When considering teenagers alone those having a rapid repeat birth were more likely to have perineal trauma after prolonged second stage.

5.8.4.7 Macrosomic Neonate and Instrumental and Lower Segment Caesarean Section Birth

The majority of the literature published regarding birth weight in teenagers has focused on the incidence of LBW and no papers were identified that investigated the effect of large neonates in teenagers. Two papers [364, 389] discussed large neonates but in the context of additional risk factors for prolonged second stage rather than instrumental or LSCS birth. As a result the findings of this study provide new evidence for consideration in practice.

Having a large neonate was more problematic for primiparous women than those having a subsequent birth. Primiparous women generally were more likely to have an instrumental (OR=1.532) or a LSCS (OR=4.885) birth when having a large neonate but for multiparous women the likelihood was only increased for LSCS (OR=1.831). In the teenage models there was only an increased likelihood for LSCS (OR=2.477) not instrumental. If the teenager was having a rapid repeat birth there was no longer an increased likelihood of LSCS. Having a larger neonate as a teenager, does not result in increased intervention at birth, in contrast to women in their early twenties.

5.8.4.8 Macrosomic Neonate and Perineal Trauma

The incidence of increased perineal trauma when having a large neonate has not been disputed in the literature and it is well established as a risk factor [386, 387, 392, 393]. The findings of this study confirm those of earlier studies in that all women are at an increased risk of perineal trauma when having a large neonate. However, this thesis does add to the evidence as it confirms that teenagers are as likely to have perineal trauma as women in their early twenties. One factor that should be considered is the timing between births, as teenagers having a rapid repeat birth were not statistically at an increased risk of perineal trauma when having a large neonate. An explanation for this is that the perineal body that has recently been distended during childbirth may be more pliable and therefore the risk of trauma is removed.

5.8.4.9 Rapid Repeat Birth and All Outcomes

When conducting the literature review for this thesis, studies examining neonatal outcomes were identified in rapid repeat births but none considered maternal outcomes in rapid repeats. Therefore there is no literature with which to compare the findings of this study. When rapid repeat birth was entered as a risk factor in the multiparous model it reduced the risk of women having an instrumental birth. However, in both the LSCS and perineal trauma model the model was not a good fit and no conclusion could therefore be drawn from the data. However, it is not detrimental for women or teenagers to have a rapid repeat birth for instrumental births, and this supports the view that perhaps it is purely a social rather than a biological problem to have children quickly.

The findings of this chapter have been compared to the published literature and differences highlighted and possible explanations have been presented. Conclusions and recommendations will be presented in Chapter 7.

CHAPTER 6 POSTPARTUM OUTCOMES

6.1 Introduction

The main literature review for this thesis identified that teenage pregnancies have been associated with an increased incidence of low Apgar score at five minutes following birth and low birth weight (LBW). These two conditions will be firstly described and defined. The analysis of data will then be presented in the results section followed by a brief summary of the findings and discussion related to previously published literature.

6.2 Low Apgar Score

The initial assessment of a baby's condition at birth is an important aspect of planning care. The ocusing d tion of this assessment was achieved in the early 1950s by an anaesthetist (Apgar, 1953) which is still employed today in modern day practice. This assessment is the 'Apgar score' and it is comprised of five assessments on; Appearance, Pulse, Grimace, Activity and Respirations. For each of these areas a score of zero, one or two is allocated, providing a maximum score of ten. The assessment is usually undertaken by the attending health professional at the one and five minute interval after birth and if low (≤6) will be repeated at the 10 minute mark. Although the assessment has been ocusing d by some [394] and replaced in part by the more invasive assessment of cord blood analysis [395] the recording of the Apgar score remains common practice in maternity services today when assessing initial perinatal health. The benefits of using the Apgar score rather than other forms of perinatal assessment are that no equipment is needed and it can be undertaken wherever the birth takes place.

A baby with an Apgar of seven or above is judged not to require any intensive resuscitation and therefore is classified as low risk at both the one and five minute stage. Apgar scores of below seven at five minutes are classified as low and used as an indicator of perinatal compromise which may require resuscitative action [160]. The assessment at one minute has been deemed important for resuscitation purposes but is not a good indicator of longterm morbidity for the baby [305, 309]. A more accurate and reliable predictor of long term neonatal morbidity is the five minute assessment [183, 389, 396] and this has been used widely for this purpose. Researchers [14, 160, 293, 305, 309, 310, 363] examining perinatal outcomes have adhered to this by adopting the five minute Apgar as an indicator of poor perinatal outcome/compromise in studies and this assessment time has been adhered to in this thesis.

It is important to note that the use of Apgar score as an indicator of perinatal wellbeing is the end result of the fetal exposure to associated risk factors. The Apgar score assessment is undertaken as stated immediately after birth and therefore the factors attributing to both the fetal and newborn's condition have occurred either during pregnancy or labour. Known factors that can compromise a newborn are numerous but those that are commonly stated are: mothers smoking ocusing [160, 197], being from a minority ethnic group [50, 213, 300, 397, 398], deprivation [94, 399], prematurity [16, 205], analgesia during labour [305, 367, 378], length of second stage [310, 363, 364], type of birth [365, 400], and rapid repeat births [162, 343, 367].

Using Apgar score as a perinatal health indicator in studies has not always included adjustment of associated risk factors in the analysis [309] and therefore has affected the generalisability of the evidence. In addition to this the reporting of low Apgar score in babies has often been a secondary rather than a primary outcome for research studies which has contributed to the poor inclusion of relevant risk factors in the analysis.

6.2.1 Low Apgar Score and Teenagers

For the specific needs of this thesis the addition of maternal age is a central aspect being investigated but only a few studies have focused on perinatal outcomes in teenage women. Studies ocusing on teenage outcomes [14, 16, 160, 183, 293] that included Apgar score as an indicator of perinatal wellbeing were limited. In addition the findings were conflicting and no consensus on the occurrence of low Apgar score in teenage women was achieved. Berenson *et al* [183] found no association between age and low Apgar score while Chen *et al* [14] and Usta *et al* [16] found a higher incidence of low Apgar score in teenagers. This evidence is therefore inconclusive and as Altman [309] observed may be due to the lack of associated risk factors included during the analysis.

While it is acknowledged that Apgar score is not the only method of assessing perinatal wellbeing in the baby, it is an embedded part of practice undertaken by all midwives attending a birth. As such it is important to establish if any consideration needs to be placed on the influences of maternal age on Apgar assessment and whether this needs to be taken into consideration when completing this vital assessment. As a result of this short review it is clear that there is a need for a more indepth analysis of perinatal wellbeing in teenagers when using Apgar score as a primary outcome measure. Conclusions that teenage women have a higher incidence of low Apgar scores currently are disputed and evidence inconclusive. Therefore, this aspect will be addressed in this chapter after adjusting for appropriate risk factors and this aim is reflected in the initial set of hypotheses posed.

6.3 Low Birth Weight

Low birth weight (LBW) has been defined by the United Nations Childrens Fund (UNICEF) and the World Health Organisation (WHO) as:

'when a baby is born at or before term weighing less than 2500 grams'

[401 p. 76].

This definition has been identified as an indicator of possible fetal compromise and as a precursor to future susceptibility to ill health in babies and infants [401]. It is used as a standard descriptor by researchers when undertaking comparisons in perinatal outcomes in different obstetric situations and also by epidemiologists for comparisons between countries and ethnic groups.

Although this definition is widely adopted it is not without criticism as it is said to be too broad and fails to take into consideration the gestation of the baby at birth or the baby's ethnic origins [299]. Natural variations in birth weight have been recorded by several researchers [48, 50, 299, 300, 397, 398, 402] all due to ethnic origin rather than the occurrence of fetal compromise alone.

In some studies [48, 181, 200, 341] an alternative measure of Small for Gestational Age (SGA) has been used as an outcome. This measure takes into account birth weight and gestation in its calculations against a standardised population percentile graph as described by Fraser *et al* [200]. The use of standardised percentile graphs are also not without criticism as they are based on white caucasian populations and fail to take into account ethnic variations in normal birth weights [299, 403]. For many studies the final decision to use either LBW or SGA as an outcome measure is the availability of the required data to calculate an accurate measure and in many cases only the birth weight is complete and other data required to calculate SGA are not complete or unreliable. For comparative reasons the standardisation of the definition is the most important aspect [23] and the definition of LBW stated above is widely adhered to in studies.

As seen for low Apgar score the measure of LBW has a number of factors that are said to be associated with its occurrence. In contrast to Apgar score the exposure to risk factors only occurs in pregnancy and not during the birthing process. There is some commonality between risk factors for Apgar score and LBW during pregnancy. The main risk factors for LBW are : mothers smoking behaviour [160, 162, 197, 404], ethnicity [50, 213, 300, 397, 398, 405], parity [162, 339, 406], deprivation [94, 399], intrauterine growth restriction [49, 200, 205, 407], prematurity [16, 205, 406], and rapid repeat births [162, 226, 339, 343, 367, 406].

6.3.1 Low Birth Weight and Teenagers

When considering the effect that maternal age has on the occurrence of LBW again the evidence is not conclusive as some studies have identified an increased risk of LBW in younger women in comparison to older age groups and others have not found a difference. Increased incidence of LBW in teenagers has been shown in several studies [23, 48, 94, 136, 200, 226, 293, 341, 342, 406] but LBW alone was not the only risk factor being investigated in these studies. Three studies [226, 339, 406] were investigating outcomes in inter pregnancy intervals rather than just LBW in teenagers. In contrast Wilcox [94] was examining the effects of social deprivation on birth weight and Chen [293] paternal rather than maternal age. Several studies [16, 181, 183, 205, 408] found no increased risk for LBW amongst teenagers in comparison to older women. Again this lack of conclusive evidence that being a teenager causes LBW requires further investigation. These studies did not compare initial and subsequent births to teenagers and what effect this may have on birth weight. Therefore, a more indepth enquiry into LBW and its incidence in teenagers is required. The second set of hypotheses posed in this chapter will attempt to address this.

6.4 Hypotheses

Low Apgar

6.1a. Primiparous teenagers have an increased risk of having a neonate with a low Apgar score when compared to primiparous women in their early twenties and this risk is increased further for younger teenagers.

6.1b. Multiparous teenagers have an increased risk of having a neonate with a low Apgar score when compared to multiparous women in their early twenties and this risk is increased further for younger teenagers.

6.1c. Multiparous teenagers have an increased risk of having a neonate with a low Apgar score when compared to primiparous teenagers.

6.1d. Multiparous teenagers having a rapid repeat birth have an increased risk of having a neonate with a low Apgar score when compared to multiparous teenagers not having rapid repeat birth.

Low Birth Weight

6.2a. Primiparous teenagers have an increased risk of having a LBW neonate when compared to primiparous women in their early twenties and this risk is increased further for younger teenagers.

6.2b. Multiparous teenagers have an increased risk of having a LBW neonate when compared to multiparous women in their early twenties and this risk is increased further for younger teenagers.

6.2c. Multiparous teenagers have an increased risk of having a LBW neonate when compared to primiparous teenagers.

6.2d. Multiparous teenagers having rapid repeat births have an increased risk of having a LBW neonate when compared to multiparous teenagers not having rapid repeat births.

Footnote: teenager = women 19 years or under

Younger teenager = women aged 16 years and under

6.5 Analysis

Once data preparation was complete an initial analysis was undertaken on the variables of low Apgar score (< 7 versus ≥ 7) and LBW (< 2500 versus ≥ 2500). As per the recoded dichotomous data defining occurrence of an event this was initially examined in a series of univariate analyses and continuous data were examined using boxplots. Associations between age and selected outcomes were then examined using cross-tabulations and Chi-squared tests for association. Unadjusted logistic regression analysis was completed for each of the outcome measures and associated factors. This was then followed by multivariate manual backward stepwise conditional logistic regression models to test the hypotheses for this chapter. The rationale for selecting logistic regression for analysis has been presented in chapter 2 (page 110). For hypotheses 6.1a, 6.1c and 6.1d, associated risk factors adjusted for in the models were; smoking, ethnicity, epidural, prolonged second stage, operative birth, multiple birth, premature birth and socio-deprivation. For hypothesis 6.1b associated risk factors adjusted for were the same as the previous hypotheses with the addition of rapid repeat birth included. For hypotheses 6.2a, 6.2c and 6.2d, associated risk factors adjusted for in the models were; smoking, late booking, ethnicity, multiple birth, premature birth and socio-deprivation. For hypothesis 6.2b the additional risk factor of rapid repeat birth was included in addition to those already stated.

6.6 Results

Within the initial section for each outcome the findings of univariate analysis for the whole sample have been repeated from chapter 3 to set the scene for the analysis within this chapter.

6.6.1 Low Apgar Score

Details of Apgar score for 98.6% (n=32447/32895) of births were available for analysis. Overall 9.4% (n=3104/32447, 95% CI 9.08 to 9.72) of neonate's had a low Apgar (Apgar score <7). Teenage women had a higher proportion of babies with low Apgars, with 12.4% (n=134/1082 95% CI 10.44 to 14.36) of younger teenagers and 10.5% (n=720/6879 CI 9.77 to 11.23) of older teenagers in comparison to 9.2% (n=2250/24526 CI 8.84 to 9.56) of the comparative group and there was a statistically significant ($\chi^2 = 21.607$ (df=2), $p \leq 0.001$) difference between age groups. A post-hoc Chi-squared test indicated this was only significant between the teenage groups and the comparative group (≤16 versus 20-25, $\chi^2 = 12.651$ (df=1), $p \leq 0.001$; 17-19 versus 20-25, $\chi^2 = 19.379$ (df=1), $p \leq 0.001$).

Unadjusted logistic regression analyses found that older teenagers were 1.17 times (OR=1.165, 95% CI 1.066 to 1.273, p= 0.001) more likely to have a neonate with a low Apgar score in comparison to the comparative group. For younger teenagers the risk of having a neonate with a low Apgar score was increased to 1.4 times (OR=1.399, 95% CI 1.162 to 1.686, p≤0.001) when compared to the comparative group.

6.6.2 Low Birth Weight

Details of birth weight for 99.5% (n=32724/32895) of index births were available for analysis. Overall 8.2% (n=2693/32724, 95% CI 7.9 to 8.5) of babies were classified as LBW. Teenage women had higher rates of LBW, with 9.4% (n=103/1098 95% CI 7.67 to 11.13) of younger teenagers and 8.7% (n=600/6876 CI 8.00 to 9.40) of older teenagers in comparison to 8.0% (n=1990/24750 CI 7.66 to 8.34) of the comparative group but there was no statistically significant (χ^2 = 5.343 (df=2), p= 0.069) difference between age groups.

Unadjusted logistic regression analyses found that teenage women were not at an increased risk (≤16 years OR=1.184, 95% CI 0.962 to 1.458, p= 0.112; 17-19 years OR=1.093, 95% CI 0.994 to 1.203, p= 0.067) of having a LBW neonate in comparison to women aged 20-25 years.

Known risk factors included in the multivariate analysis in this chapter have been described on page 55 of this thesis. Within the following section the proportion of these risk factors will be presented for women who have had a neonate with a low Apgar score or a LBW neonate and then compared with the proportions found in the overall population.

6.6.3 Presence of Associated Risk Factors for Women Having a Neonate with a Low Apgar Score at Birth

Women having a neonate with a low Apgar score were identified for analysis and the presence of associated risk factors in these births has been summarised in Table 6.3, Figure 6.1 and Table 6.5. All unadjusted logistic regression analyses were undertaken on women having either a neonate with a low Apgar score or not.

Primiparous births – the proportion of women having a neonate with a low Apgar score that were primiparous was 52.3% (n=1624/3104, 95% CI 50.54 to 54.06). This was higher than the overall population (45.1%) and the proportion was higher in all age groups (≤16 89.6% v 87.3%, 17-19 68.9% v 63.2%, 20-25 44.8% v 38.1%). Unadjusted logistic regression analysis for women who had a neonate with either a low Apgar score or not, found that primiparous women were more likely (OR=1.384, CI 1.285 to 1.491; p≤0.001) to have a neonate with a low Apgar score than women having a subsequent birth.

Smoking status– the proportion of women having a neonate with a low Apgar score that were smokers was 25.9% (n=583/2253, 95% CI 24.08 to 27.72). This was lower than the overall population (35.9%) and the proportion was lower for each age group (≤16 27.9% v 38.9%, 17-19 32.2% v 44.9%, 20-25 23.6% v 32.9%). Unadjusted logistic regression analysis on women who had either a neonate with a low Apgar score or not, found that women who smoked during pregnancy were not at an increased risk (OR=0.970, CI 0.879 to 1.071;

p=0.544) of having a neonate with a low Apgar score than women who did not smoke.

Ethnicity – the proportion of women having a neonate with a low Apgar score that were from a minority ethnic group was 11.4% (n=348/3054, 95% CI 10.27 to 12.53). This was lower than the overall population (12.2%) and higher only in the younger teenagers (≤16 11.5% versus 9.1%, 17-19 8.7% versus 10.6%, 20-25 12.0% versus 12.8%). Unadjusted logistic regression analysis on women who had a neonate with a low Apgar score or not found that women from a minority ethnic group had a similar statistical risk (OR=0.900, CI 0.800 to 1.114; p=0.076) of having a neonate with a low Apgar score when compared with other women.

Epidural Analgesia – the proportion of women having a neonate with low Apgar score that had used an epidural was 45.8% (n=839/1833, 95% CI 43.52 to 48.08). This was higher than the overall population (40.8%) and was higher in all age groups (≤16 60.8% v 55.0%, 17-19 48.6% v 46.1%, 20-25 44.0% v 38.6%). Unadjusted logistic regression analysis for women who had a neonate with either a low Apgar score or not, found that women using an epidural were more likely (OR=1.243, CI 1.128 to 1.369; p≤0.001) to have a neonate with a low Apgar score than women not using an epidural.

Prolonged second stage – the proportion of women having a neonate with low Apgar score that had a prolonged second stage was 12.9% (n=303/2356, 95% CI 11.55 to 14.25). This was higher than the overall population (10.2%) and remained the case for all age groups (≤16 7.1% v 9.3%, 17-19 12.4% v 9.3%, 20-25 13.3% v 10.3%). Unadjusted logistic regression analysis on women who had either a neonate with low Apgar score or not found that women who had a prolonged second stage were at an increased risk (OR=1.327, CI 1.168 to 1.507; p≤0.001) of having a neonate with a low Apgar score when compared to a woman having a normal length second stage.

Operative Birth – the proportion of women having a neonate with low Apgar score that had an operative birth was 46.3% (n=133/2986, 95% CI 44.51 to 48.09). This was a third higher than the overall population (29.2%) and remained the case for all age groups (≤16 44.7.0% v 28.2%, 17-19 45.9% v 28.1%, 20-25 46.6% v 29.5%). Unadjusted logistic regression analysis on women who had either a low Apgar neonate score or not found that women who had an operative birth were 2.3 times more likely (OR=2.280, CI 2.112 to 2.461; p≤0.001) to have a neonate with a low Apgar score when compared to a woman having a normal birth.

Multiple births – the proportion of women having a neonate with a low Apgar score that had a multiple birth was 1.2% (n=37/3104, 95% CI 0.81 to 1.59). This was similar to the overall population (1.0%) and remained the case for all age groups with no multiple births occurring in the younger teenagers (≤16 0% v 0.3%, 17-19 0.7% v 0.6%, 20-25 1.4% v 1.1%). Unadjusted logistic regression analysis on women who had either a low Apgar score neonate or not found that women who had a multiple birth were not at an increased risk

(OR=1.329, CI 0.940 to 1.878; p=0.107) of having a neonate with a low Apgar score when compared to a woman having a singleton birth.

Premature Birth – the proportion of women having a neonate with low Apgar score that had a premature birth was 19.9% (n=616/3097, 95% CI 18.49 to 21.31). This was double that found in the overall population (9.9%) and this remained approximately the case for all age groups (≤16 21.6% v 10.9%, 17-19 19.2% v 9.9%, 20-25 20.0% v 8.6%). Unadjusted logistic regression analysis on women who had either a low Apgar score neonate or not found that women who had a premature birth were three times more likely (OR=3.157, CI 2.861 to 3.484; p≤0.001) to have a neonate with a low Apgar score when compared to a woman having a neonate at term.

Rapid repeat births – the proportion of women having a neonate with a low Apgar score that had a rapid repeat birth was 8.5% (n=126/1480, 95% CI 7.08 to 9.92). This was lower than the overall population (9.5%). There was a variation for age groups when compared with the overall population. The proportion was higher for teenagers (≤16 14.3% v 8.6%, 17-19 15.2% v 14.5%) but marginally lower in the comparative group (7.2% v 8.6%). Unadjusted logistic regression analysis on women who had either a neonate with a low Apgar score or not, found that women who had a rapid repeat birth were not at an increased risk (OR=0.892, CI 0.737 to 1.078; p=0.236) of having a neonate with a low Apgar score when compared to a multiparous woman who had not had a rapid repeat birth.

Deprivation – for women having a neonate with a low Apgar score the Jarman enumeration district score was calculated for 93.81% (n=2912/3104, 95% CI 92.95 to 94.65) of women. The range in Jarman score was between -22.00 and 56.50 with a mean deprivation score of 11.05 (SD=16.23), which was higher than the mean Jarman score for the overall population ($\bar{x}$=10.52 [SD=16.37]). A boxplot was used to examine differences between the age groups for Jarman deprivation score and has been illustrated in Figure 6.1. When comparing age groups younger teenagers had a marginally lower mean Jarman score than in the overall population (≤16 $\bar{x}$=12.18 [SD=16.59] versus 12.5 [SD=16.16]). Women having a neonate with a low Apgar score in the two older age groups both came from more deprived backgrounds than the overall population (17-19, $\bar{x}$=13.43 [SD=16.15] versus $\bar{x}$=13 [SD=16.08]; 20-25, $\bar{x}$=10.2 [SD=16.16] versus $\bar{x}$=9.7 [SD=16.37).

Unadjusted logistic regression analysis on women who had either a neonate with a low Apgar score or not, found that a woman from a deprived background had an increased risk (OR=1.002, CI 1.000 to 1.005; p=0.050) of having a neonate with a low Apgar score when compared to a women from a less deprived background. For each increase of one in the deprivation score a woman from a deprived background was 1.002 times more likely to have a low Apgar score neonate than not.

Figure 6.1 Boxplot of Jarman Enumeration Score by Age Group In Women having a Neonate with a Low Apgar Score

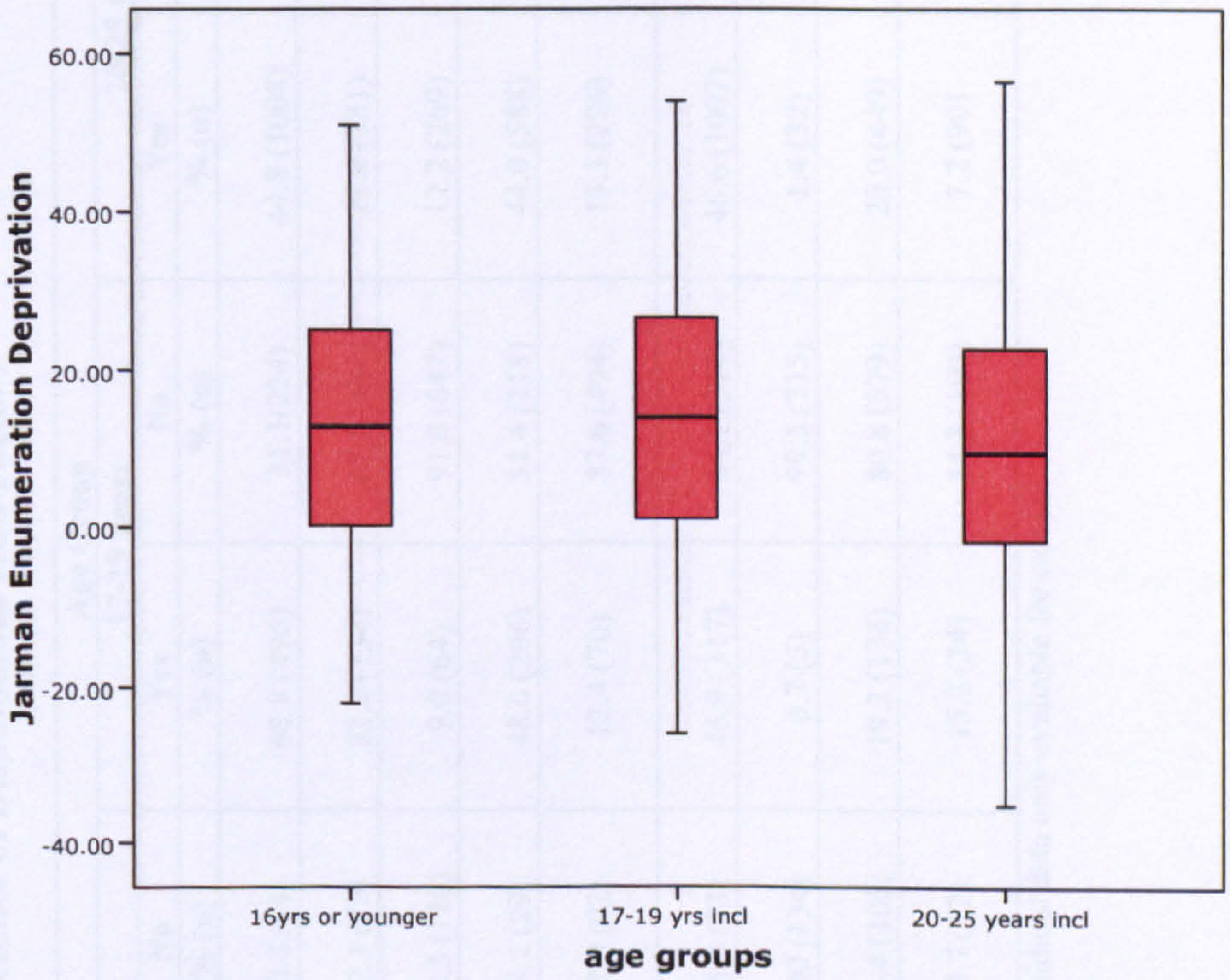


Table 6.1 Neonate with a Low Apgar Score by Age Group: Presence of Dichotomous Risk Factors

Factors Affecting Birth Outcome	Total		Age Group					
			≤16 years		17-19 years		20-25 years	
	Yes	No	Yes	No	Yes	No	Yes	No
	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)
Primiparous n=3104	52.3 (1624)	47.7 (1480)	89.6(120)	10.4 (14)	68.9 (496)	31.1(224)	44.8 (1008)	55.2 (1242)
Smoking* n=2253	25.9 (583)	74.1 (1670)	27.9 (29)	72.1 (75)	32.2 (134)	67.8 (364)	23.6 (381)	76.4 (1231)
Ethnicity n=3054	11.4 (348)	88.6 (2706)	11.5 (15)	88.5 (116)	9.0 (64)	91.0 (647)	12.2 (269)	87.8 (1943)
Epidural* n=1833	45.8 (839)	54.2 (994)	60.8(45)	39.2 (29)	48.6 (206)	51.4 (218)	44.0 (588)	56.0 (747)
Prolonged second stage n=2356	12.9 (303)	87.1 (2053)	7.1 (7)	92.9 (92)	12.4 (70)	87.6 (494)	13.3 (226)	86.7 (1467)
Operative birth n=2986	46.3 (1383)	53.7 (1603)	44.7 (59)	55.3 (73)	45.9 (317)	54.1 (374)	46.6 (1007)	53.4 (1156)
Multiple births n=3104	1.2 (37)	98.8 (3067)	0.0(0)	100 (134)	0.7 (5)	99.3 (715)	1.4 (32)	98.6 (2218)
Premature birth§ n=3097	19.9 (616)	80.1 (2481)	21.6 (29)	78.4 (105)	19.2 (138)	80.8 (579)	20.0 (449)	80.0 (1797)
Rapid repeat birth§ n=1008	8.5 (126)	91.5 (1354)	14.3 (2)	85.7 (12)	15.2 (34)	84.8 (190)	7.2 (90)	92.8 (1152)

*Complete smoking data only available from 1996 to 2001 within the dataset and Epidural data only available for one site

§ inclusion of multiparous women only

6.6.4 Presence of Associated Risk Factors for Women having a Neonate with a Low Birth Weight

Women having a LBW neonate were identified for analysis and the presence of associated risk factors in these births has been summarised in Table 6.2, Figure 6.2 and Table 6.3. All univariate logistic regression analysis was undertaken on women having either a LBW or not.

Primiparous births – the proportion of women having a LBW neonate that were primiparous was 49.8% (n=1340/2693, 95% CI 47.91 to 51.69). This was higher than the overall population (45.1%) and this remained the case for all age groups (≤16 87.4% versus 87.3%, 17-19 63.5% versus 63.2%, 20-25 43.7 versus 38.1%). Univariate logistic regression analysis on women who had either a LBW neonate or not, found that primiparous women were 1.23 times more likely (OR=1.230, CI 1.137 to 1.331; $p \leq 0.001$) to have a LBW neonate than a woman having a subsequent birth.

Smoking status– the proportion of women having a LBW neonate that were smokers was 34.0% (n=701/2060, 95% CI 31.95 to 36.05). This was lower than the overall population (35.9%) and the proportion was lower for each age group (≤16 35.8% versus 38.9%, 17-19 41.3% versus 44.9%, 20-25 31.7% versus 32.9%). Univariate logistic regression analysis on women who had either a LBW neonate or normal weight neonate, found that women who smoked during pregnancy were 1.5 times more likely (OR=1.491, CI 1.355 to 1.641; p≤0.001) to have a LBW neonate than women who did not smoke.

Late booking – the proportion of women having a LBW neonate that booked late for care was 24.4% (n=616/2520, 95% CI 22.72 to 26.08). This was higher than the overall population (15.4%) and the proportion was approximately a third higher for each age group (≤16 45.7% versus 30.0%, 17-19 27.6% versus 18.9%, 20-25 22.4% versus 13.7%). Univariate logistic regression analysis on women who had either a LBW neonate or normal weight neonate, found that women who booked late for care were twice as likely (OR=1.895, 95% CI 1.720 to 2.086; p≤0.001) to have a LBW neonate than a woman who booked early for care.

Ethnicity – the proportion of women having a LBW neonate from a minority ethnic group was 18% (n=469/2604, 95% CI 16.52 to 19.48). This was higher than the overall population (12.2%) and the proportion was higher for each of the age groups, (≤16 13.3% v 9.1%, 17-19, 16.8 v 10.6%, 20-25 18.6% v 12.8%). Univariate logistic regression analysis on women who had either a LBW neonate or not, found that women from minority ethnic groups were 1.8 times more likely (OR=1.622, CI 1.459 to 1.803; p≤0.001) to have a LBW neonate when compared to other women.

Multiple births – the proportion of women having a LBW neonate that had a multiple birth was 6.6% (n=177/2692, 95% CI 5.66 to 7.54). This was over six times higher than the overall population (1.0%) and remained higher for all age groups (≤16 2.9% v 0.3%, 17-19 3.0% v 0.6%, 20-25 7.8% v 1.1%). Univariate logistic regression analysis on women who had either a LBW neonate or not, found that women who had a multiple birth were 15.7 times more likely (OR=15.702, CI 12.499 to 19.724; p≤0.001) to have a LBW neonate when compared to a woman having a singleton birth.

Premature Birth – the proportion of women having a LBW neonate that had a premature birth was 72.4% (n=1932/2669, 95% CI 70.7 to 74.1). This was seven times higher than that found in the overall population (9.9%) and this remained approximately the case for all age groups (≤16 78.4% v 10.9%, 17-19 72.8% v 9.9%, 20-25 72.0% v 8.6%). Unadjusted logistic regression analysis on women who had either a LBW neonate or not found that women who had a premature birth were 78 times more likely (OR=78.354, CI 70.454 to 87.139; p≤0.001) to have a LBW neonate when compared to a woman having a neonate at term.

Rapid repeat births – the proportion of women having a LBW neonate that had a rapid repeat birth was 13.1% (n=177/1353, 95% CI 11.30 to 14.90). This was higher than the overall population (9.5%) and this remained approximately the case for all age groups (≤16 23.1% v 8.6%, 17-19 20.5% v 14.5%, 20-25 11.5% v 8.6%). Univariate logistic regression analysis on women who had either a LBW neonate or not, found that women who had a rapid repeat birth were 1.5 times more likley (OR=1.495, CI 1.265 to 1.765; p≤0.001) to have a LBW neonate when compared to a multiparous woman who had not had a rapid repeat birth.

Deprivation - Within the dataset Jarman enumeration district was calculated for 91.2% (n=2457/2693, 95% CI 90.13 to 92.27) of women. The range in Jarman score was between -20.00 and 56.50 with a mean deprivation score of 15.89 (SD=16.59), which was higher than the mean Jarman score for the overall population ($\bar{x}$=10.52 [16.37]). A boxplot was used to examine differences between the age groups for Jarman deprivation score and has been illustrated in Figure 6.2. When comparing the mean Jarman scores for age groups in women having a LBW neonate with those for the overall population, women in all age groups came from a more deprived background than those in the overall population (≤16 $\bar{x}$=15.89[SD=15.88] versus $\bar{x}$=12.5 [16.16], 17-19 $\bar{x}$=15.02 [SD=15.79] versus $\bar{x}$=13 [SD=16.08], 20-25 $\bar{x}$=12.3 [SD=16.61] versus $\bar{x}$=9.7 [16.37]). Univariate logistic regression analysis on women who had either a LBW neonate or not, found that a woman from a more deprived background had an increased risk of having a LBW neonate (OR=1.010, CI 1.008 to 1.013; p≤0.001) when compared to a women from a less deprived background. For each increase of one in the deprivation score a woman from a deprived background was 1.01 times more likely to have a LBW neonate than not during pregnancy.

Figure 6.2 **Boxplot of Jarman Enumeration Score by Age Group for Women Having a Low Birth Weight Neonate**

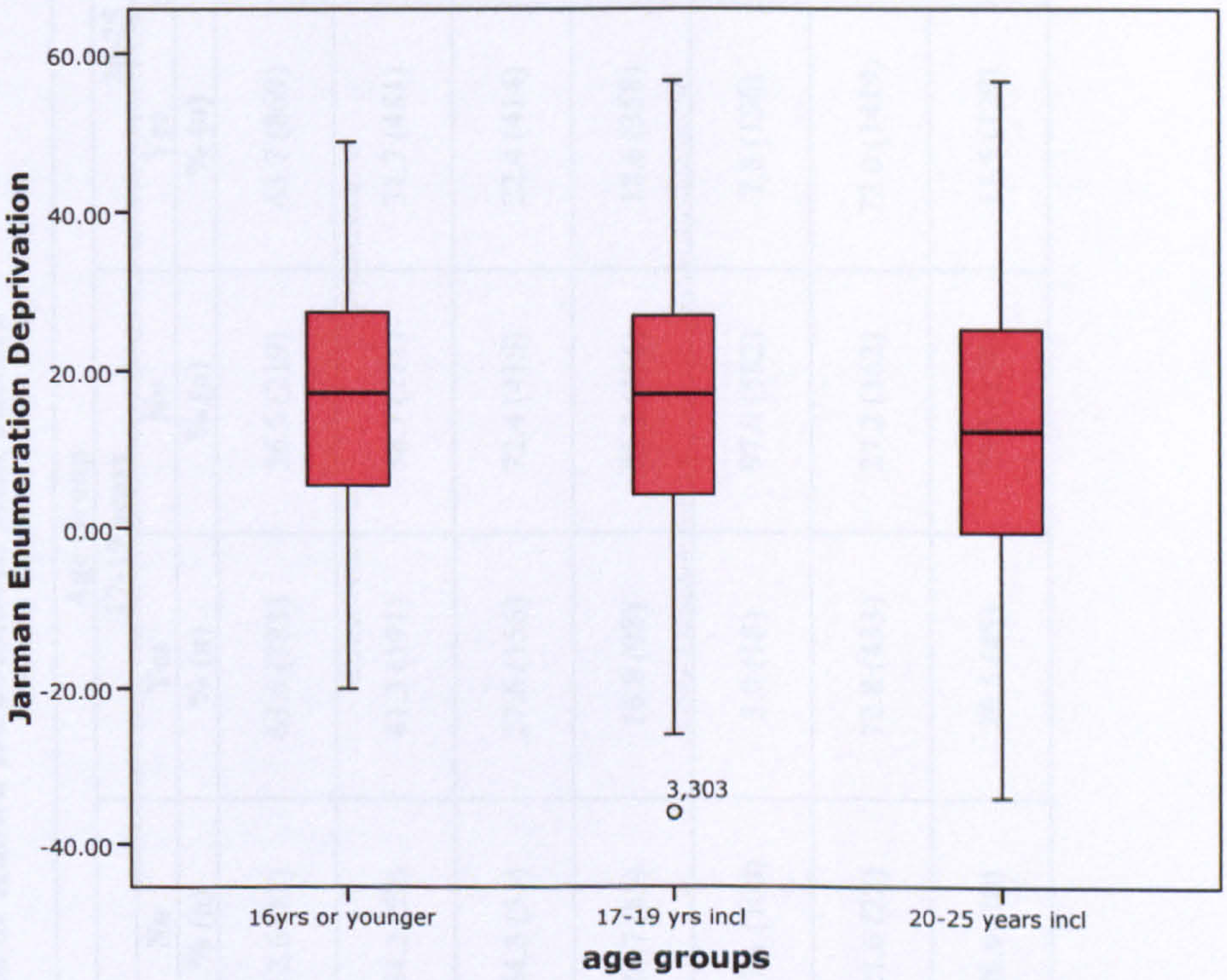


Table 6.2 Low Birth Weight Neonate by Age Group: Presence of Known Dichotomous Risk Factors

Factors Affecting Birth Outcome	Total		Age Group					
			≤16 years		17-19 years		20-25 years	
	Yes	No	Yes	No	Yes	No	Yes	No
	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)
Primiparous n=2693	49.8 (1340)	50.2 (1353)	87.4 (90)	12.6 (13)	63.5 (381)	36.5 (219)	43.7 (869)	56.3 (1121)
Smoking* n=2060	34.0 (701)	66.0 (1359)	35.8 (29)	64.2 (52)	41.3 (191)	58.7 (271)	31.7 (481)	68.3 (1036)
Late booking n=2520	24.2 (616)	75.6 (1904)	45.7 (43)	54.3 (51)	27.6 (156)	72.4 (410)	22.4 (414)	77.6 (1443)
Ethnicity n=2604	18.0 (469)	82.0 (2135)	13.3 (13)	86.7 (85)	16.8 (98)	83.2 (486)	18.6 (358)	81.4 (1564)
Multiple births n=2932	6.6 (177)	93.4 (2515)	2.9 (3)	97.1 (100)	3.0 (18)	97.0 (582)	7.8 (156)	92.2(1833)
Premature birth n=2669	72.4 (1932)	27.6 (737)	78.4 (80)	21.6 (22)	72.8 (433)	27.2 (162)	72.0 (1419)	28.0 (533)
Rapid repeat birth § n=1353	13.1 (177)	86.9 (1176)	23.1 (3)	76.9 (10)	20.5 (45)	79.5 (174)	11.5 (129)	88.5 (992)

*Complete smoking data only available from 1996 to 2001 within the dataset

§ inclusion of multiparous women only

6.6.5 Unadjusted Odds Ratios for Associated Risk Factors by Outcome of Interest

Unadjusted odds ratios were undertaken for all associated risk factors individually for low Apgar compared to normal Apgar and LBW neonate compared to normal weight neonate. These have been reported in the text and presented in Table 6.3. A summary of data type for associated risk factors has been provided below:

- Primiparous- Yes/No
- Smoking- Yes/No
- Minority ethnic group- Yes/No
- Epidural- Yes/No
- Prolonged second stage- Yes/No
- Operative birth- Yes/No
- Multiple birth- Yes/No
- Premature birth- Yes/No
- Deprivation- Continuous
- Rapid repeat birth- Yes/No

Table 6.3 Unadjusted Odds Ratios for Associated Risk Factors for Low Apgar Score and Low Birth Weight

Associated Risk Factor	Outcome of Interest	
	Low Apgar Score Odds Ratio (95% CI)	LBW Neonate Odds Ratio (95% CI)
Primiparous	**1.384 (1.285 – 1.491) $p \leq 0.001$**	**1.230 (1.137 – 1.331) $p \leq 0.001$**
Smoking*	0.970 (0.879 – 1.071) $p=0.544$	**1.491 (1.355 – 1.641) $p \leq 0.001$**
Late booking	Not analysed	**1.895 (1.720 – 2.086) $p \leq 0.001$**
Minortiy ethnic group	0.900 (0.800 – 1.114) $p=0.076$	**1.622 (1.459 – 1.803) $p \leq 0.001$**
Epidural*	**1.243 (1.128 – 1.369) $p \leq 0.001$**	Not analysed
Prolonged second stage	**1.327 (1.168 – 1.507) $p \leq 0.001$**	Not analysed
Operative birth	**2.280 (2.112 – 2.461) $p \leq 0.001$**	Not analysed
Multiple birth	1.329 (0.940 – 1.878) $p=0.107$	**15.702 (12.499 – 19.724) $p \leq 0.001$**
Premature birth	**3.157 (2.861 – 3.484) $p \leq 0.001$**	**78.354 (70.454 – 87.139) $p \leq 0.001$**
Deprivation	**1.002 (1.000 – 1.005) $p=0.05$**	**1.010 (1.008 – 1.013) $p \leq 0.001$**
Rapid repeat birth§	0.892 (0.737 – 1.078) $p=0.236$	**1.495 (1.265 – 1.765) $p \leq 0.001$**

* complete smoking data was only available from 1996 to 2001 and Epidural data was only available from one site

§ analysis undertaken on multiparous women only

6.6.6 Multivariate Logistic Regression Analysis for Neonate Outcomes

Within this section backward manual conditional logistic regression will be undertaken for each of the models developed to address the hypotheses posed in this chapter .

The associated risk factors responsible for the large number of missing cases in the models were smoking status and epidural use. As a result each of the models has been repeated excluding smoking status and epidural use from the model and any differences in findings have been stated within the text and within the relevant tables of results.

Models examining Hypothesis 6.1a

Hypothesis 6.1a

'Primparous teenage women have an increased risk of having a neonate with a low Apgar score when compared to primiparous women in their early twenties, and this risk is increased further for younger teenagers'.

After identifying primiparous women a backward manual stepwise conditional logistic regression model was run with having a neonate with low Apgar score or not as the outcome. Age group remained in the model regardless of significance and the other explanatory variables included in the model were:

- Smoking status- Yes/No
- Ethnicity- Yes/No
- Epidural- Yes/No
- Prolonged second stage- Yes/No

- Operative birth- Yes/No
- Multiple birth- Yes/No
- Premature birth- Yes/No
- Jarman enumeration district- Continuous

Women having their first birth (n=14824) were selected for analysis with variables being entered into the model. At the initial stage 4248 (28.7%) cases were entered into the model and after completing the regression model the final model contained 14437 (97.4%) cases. The first variable to be removed from the model was multiple birth (OR=0.355, 95% CI 0.046 to 2.767; p=0.323), followed by smoker (OR=0.856, 95% CI 0.676 to 1.083; p=0.195), epidural use (OR=1.091, 95% CI 0.916 to 1.299; p=0.328), prolonged second stage (OR=0.857, 95% CI 0.713 to 1.028; p=0.097), ethnicity (OR=0.919, 95% CI 0.775 to 1.091; p=0.079) and deprivation (OR=1.003, 95% CI 0.999 to 1.006; p=0.110). All other risk factors remained significant at the 0.05 level and therefore remained in the model. The findings of the analysis can be found in Table 6.4.

Being a primiparous teenager increased a woman's risk of having a neonate with a low Apgar score after adjusting for operative birth and prematurity when compared to the comparative group. For younger teenagers this risk was slightly higher (OR= 1.356) than for older teenagers (OR= 1.152). For primiparous women having an operative birth or having a premature birth there was an increased risk (OR=1.932.080, OR=2.737 respectively) of having a neonate with a low Apgar score.

Using the Nagelkerke R Squared test the model explained 5% of the variance and the Hosmer and Leweshow Test (χ^2 = 5.755 (df=4), p=0.218) indicated the model was a good fit. The final model correctly classified 89.2% of cases and this was not increased on completion of the model.

> By removing smoking and epidural from the initial model this increased the number of cases included initially (n=11628) but the findings remained the same as before.

Table 6.4 Model for Hypothesis 6.1a Examining Low Apgar Score in Primiparous Women

Factor	Unadjusted OR for primiparous Women (95% CI)	Adjusted OR for primiparous women (95% CI) n=14437
20-25 years	1.00	1.00
≤ 16 years	1.203 (0.983– 1.473) p=0.073	**1.356 (1.102 – 1.669) p=0.004**
17-19 years	1.072 (0.956 – 1.201) p=0.233	**1.152 (1.023 – 1.297) p=0.020**
Smoking status* – yes/no	0.937 (0.808 – 1.087) p=0.392	
Ethnicity* – yes/no	0.950 (0.810– 1.114) p=0.526	
Epidural – yes/no	1.120 (0.979 – 1.280) p=0.098	
Prolonged second stage – yes/no	1.120 (0.958 – 1.311) p=0.156	
Operative birth – yes/no	**2.115(1.902 – 2.351) p≤0.001**	**2.080 (1.867 – 2.316) p≤0.001**
Multiple birth – yes/no	1.362 (0.812 – 2.284) p=0.241	
Premature birth – yes/no	**3.102 (2.697 – 3.569) p≤0.001**	**2.737 (2.364 – 3.168) p≤0.001**
Deprivation – yes/no	**1.002 (1.000 – 1.005) p=0.05**	

* complete smoking data was only available from 1996 to 2001 and Epidural data was only available from one site

Bold indicates significant result in table

Models examining Hypothesis 6.1b

Hypothesis 6.1b

'Multiparous teenage women have an increased risk of having a neonate with a low Apgar score when compared to multiparous women in their early twenties and this risk is increased further for younger teenagers'.

After identifying multiparous women a backward manual stepwise conditional logistic regression model was run with having a baby with a low Apgar or not as the outcome. Age group remained in the model regardless of significance and the other explanatory variables included in the model were:

- Smoking status- Yes/No
- Ethnicity- Yes/No
- Epidural- Yes/No
- Prolonged second stage- Yes/No
- Operative birth- Yes/No
- Multiple birth- Yes/No
- Premature birth- Yes/No
- Jarman enumeration district- Continuous
- Rapid repeat birth- Yes/No

Women having a subsequent birth (n=18071) were selected for analysis with variables being entered into the model. At the initial stage 4980 (27.6%) cases were entered into the model and after completing the regression model the final model contained 16919 (93.6%) cases. The first variable to be removed from the model was epidural use (OR=0.999, 95% CI 0.766 to 1.293; p=0.970), followed by length of second stage (OR=0.996, 95% CI 0.731 to 1.358; p=0.922), smoker (OR=0.984, 95% CI 0.850 to 1.139; p=0.826), multiple birth (OR=0.751, 95% CI 0.451 to 1.250; p=0.271) and rapid birth (OR=0.858, 95%

CI 0.699 to 1.053; p=0.143). All other risk factors remained significant at the 0.05 level and therefore remained in the model. The findings of the analysis can be found in Table 6.5. Multiparous teenagers were not at an increased risk of having a neonate with a low Apgar score after adjusting for ethnicity, operative birth, prematurity and deprivation when compared to the comparative group. For multiparous women being from a deprived background (OR=1.004), having an operative birth (OR=2.082), or having a premature birth (OR=2.636) increased the risk of having a neonate with a low Apgar score. If the women came from a minority ethnic background the risk was reduced (OR=0.809).

Using the Nagelkerke R Squared test the model only explained 4.5% of the variance and the Hosmer and Leweshow Test (χ^2 = 15.638 (df=8), p=0.048) indicated the model was not a good fit. The final model correctly classified 92% of cases.

> By removing smoking and epidural from the initial model this did not change the number of cases included (n=16919) and did not change the results.

Table 6.5 Model for Hypothesis 6.1b Examining Low Apgar Score in Multiparous Women

Factor	Unadjusted OR for multiparous Women (95% CI)	Adjusted OR for multiparous women (95% CI) n=16919
20-25 years	1.00	1.00
≤ 16 years	1.268 (0.727– 2.210) p=0.402	1.186 (0.662 – 2.124) p=0.567
17-19 years	1.096 (0.944 – 1.272) p=0.229	1.061 (0.970 – 1.242) p=0.458
Epidural – yes/no	**1.184 (1.019 – 1.375) p=0.027**	
Smoking status – yes/no	1.058 (0.925 – 1.209) p=0.413	
Ethnicity – yes/no	**0.836 (0.703– 0.994) p=0.042†**	**0.809 (0.674 – 0.942) p=0.024†**
Prolonged second stage – yes/no	**1.528 (1.221 – 1.911) p≤0.001**	
Operative birth – yes/no	**2.181(1.949 – 2.441) p≤0.001**	**2.082 (1.848 – 2.346) p≤0.001**
Multiple birth – yes/no	1.353 (0.848 – 2.160) p=0.204	
Premature birth – yes/no	**3.231 (2.810 – 3.714) p≤0.001**	**2.636 (2.263 – 3.069) p≤0.001**
Rapid repeat birth – yes/no	0.892 (0.737 – 1.078) p=0.236	
Deprivation – yes/no	**1.003 (1.000 – 1.007) p=0.046**	**1.004 (1.000 – 1.007) p=0.043**

* complete smoking data was only available from 1996 to 2001 and Epidural data was only available from one site

† indicates a reduced risk of low Apgar score in the results table

Bold indicates significant result in table

Models examining Hypothesis 6.1c

Hypothesis 6.1c

'Multiparous teenage women have an increased risk of having a neonate with a low Apgar score when compared to primiparous teenage women'.

After identifying teenage women a backward manual stepwise conditional logistic regression model was run with having either a neonate with low Apgar score or not as the outcome. Whether first or subsequent birth remained in the model regardless of significance and the other explanatory variables included in the model were:

- Smoking status- Yes/No
- Ethnicity- Yes/No
- Epidural- Yes/No
- Prolonged second stage- Yes/No
- Operative birth- Yes/No
- Multiple birth- Yes/No
- Premature birth- Yes/No
- Jarman enumeration district- Continuous

Teenage women (n=8028) were identified for analysis with variables being entered into the model. At the initial stage 2510 (31.3%) cases were entered into the model and after completing the regression model the final model contained 7825 (97.5%) cases. The first variable to be removed from the model was epidural (OR=1.103, CI 0.816 to 1.492; p=0.523) followed by multiple birth (OR=1.189, CI 0.337 to 4.199; p=0.788), deprivation (OR=1.004, CI 0.998 to 1.010; p=0.240), smoker (OR=0.859, CI 0.697 to 1.058; p=0.152), length of second stage (OR=0.821, CI 0.620 to 1.089;

p=0.171) and ethnicity (OR=0.825, CI 0.639 to 1.066; p=0.141). Findings of the analysis can be found in Table 6.6.

Being a multiparous teenager reduced the risk of a woman having a neonate with a low Apgar score (OR= 0.782) in comparison to being a primiparous teenager after adjusting for operative and premature birth. For teenage women having an operative or premature birth increased the risk (OR=2.247 and OR=2.246 respectively) of having a neonate with a low Apgar score.

Using the Nagelkerke R Squared test the model explained 4.9% of the variance and the Hosmer and Leweshow Test (χ^2 = 2.918 (df=3), p=0.404) indicated the model was a good fit. The final model correctly classified 89.5% of cases and this was not increased on completion of the model.

> By removing smoking and epidural from the initial model this increased the number of cases included initially (n=6641) but did not change the overall findings.

Table 6.6 Model for Hypothesis 6.1c Examining Low Apgar Score in Teenage Women

Factor	Unadjusted OR for teenage women (95% CI)	Adjusted OR for teenage women (95% CI) n=7825
Multip – yes/no	**0.742 (0.634 – 0.868) p≤0.001 †**	**0.782 (0.664 – 0.921) p=0.003†**
Smoking status – yes/no	0.866 (0.726 – 1.032) p=0.107	
Ethnicity – yes/no	0.874 (0.685– 1.115) p=0.278	
Epidural – yes/no	1.135 (0.942 – 1.367) p=0.183	
Prolonged second stage – yes/no	1.189 (0.925 – 1.529) p=0.177	
Operative birth – yes/no	**2.374 (2.049 – 2.750) p≤0.001**	**2.247 (1.936 – 2.609) p≤0.001**
Multiple birth – yes/no	1.035 (0.407 – 2.629) p=0.943	
Premature birth – yes/no	**2.693 (2.229 – 3.254) p≤0.001**	**2.246 (1.834 – 2.750) p≤0.001**
Deprivation - continuous	1.001 (0.997 – 1.006) p=0.624	

* complete smoking data was only available from 1996 to 2001 and Epidural data was only available from one site

† indicates a reduced risk of low Apgar score in the results table

Bold indicates significant result in table

Models examining Hypothesis 6.1d

Hypothesis 6.1d

'Multiparous teenage women having rapid repeat births have an increased risk of having a neonate with a low Apgar score when compared to multiparous teenage women not having a rapid repeat birth'.

After identifying multiparous teenage women a backward manual stepwise conditional logistic regression model was run with having either having a neonate with low Apgar score or not as the outcome. The variable depicting rapid repeat birth remained in the model regardless of significance and the other explanatory variables included in the model were:

- Smoking status- Yes/No
- Ethnicity- Yes/No
- Epidural- Yes/No
- Prolonged second stage- Yes/No
- Operative birth- Yes/No
- Multiple birth- Yes/No
- Premature birth- Yes/No
- Jarman enumeration district- Continuous

Multiparous teenage women (n=2687) were identified for analysis with variables being entered into the model. At the initial stage 768 (28.6%) cases were entered into the model and this number increased to 2623 (97.6%) after completing the regression model. The first variable to be removed from the model was epidural (OR=0.956, CI 0.520 to 1.757; p=0.885) followed by length of second stage (OR=0.811, CI 0.407 to 1.617; p=0.551); multiple birth (OR=1.237, CI 0.329 to 4.648; p=0.753); ethnicity (OR=0.818, CI 0.480 to 1.392; p=0.458); deprivation (OR=0.996, CI 0.986 to 1.006; p=0.392) and smoker (OR=0.811, CI 0.587 to 1.123; p=0.207). The remaining variable remained significant at the 0.05 level and therefore remained in the model. The findings of the analysis can be found in Table 6.7.

Multiparous teenagers having a rapid repeat birth had the same statistical risk of having a neonate with a low Apgar score as a multiparous teenager not having a rapid repeat birth after adjusting for operative and premature birth. Multiparous teenage women having either an operative or premature birth (OR= 1.949 and OR 2.120 respectively) were more likely to have a neonate with a low Apgar score.

Using the Nagelkerke R Squared test the model explained only 3.3% of the variance and the Hosmer and Leweshow Test ($\chi^2 = 0.276$ (df=2), p=0.871) indicated the model was a good fit. The final model correctly classified 91.3% of cases and this was not increased at the end of the model.

> By removing smoking and epidural from the initial model this increased the number of cases included initially (n=2247) but did not change the overall findings.

Table 6.7 Model for Hypothesis 6.1d Examining Low Apgar Score in Teenage Women Having a Rapid Repeat Birth or Not.

Factor	Unadjusted OR for teenage women having or not having a rapid repeat birth (95% CI)	Adjusted OR for teenage women having or not having a rapid repeat birth (95% CI) n=2623
Rapid repeat birth – yes/no	1.087 (0.749 – 1.577) p=0.662	1.071 (0.723 – 1.588) p=0.731
Smoking status* – yes/no	0.832 (0.608 – 1.137) p=0.247	
Ethnicity – yes/no	0.938 (0.598– 1.471) p=0.781	
Epidural* – yes/no	0.814 (0.550 – 1.205) p=0.303	
Prolonged second stage – yes/no	1.174(0.686 – 2.010) p=0.558	
Operative birth – yes/no	**2.060 (1.543 – 2.750) $p \leq 0.001$**	**1.949 (1.451 – 2.619) $p \leq 0.001$**
Multiple birth – yes/no	1.704 (0.498 – 5.826) p=0.396	
Premature birth – yes/no	**2.648 (1.897 – 3.697) $p \leq 0.001$**	**2.120 (1.484 – 3.030) $p \leq 0.001$**
Deprivation - continuous	0.996 (0.987 – 1.005) p=0.367	

*complete smoking data was only available from 1996 to 2001 and Epidural data was only available from one site

Bold indicates significant result in table

Models examining Hypothesis 6.2a

Hypothesis 6.2a

'Primparous teenage women have an increased risk of having a LBW neonate when compared to primiparous women in their early twenties and this risk is increased further for younger teenagers'.

After identifying primiparous women a backward manual stepwise conditional logistic regression model was run with having a LBW neonate or not as the outcome. Age group remained in the model regardless of significance and the other explanatory variables included in the model were:

- Smoking- Yes/No
- Late booking- Yes/No
- Ethnicity- Yes/No
- Multiple birth- Yes/No
- Premature birth- Yes/No
- Jarman enumeration district- Continuous

Women having their first birth (n=14824) were selected for analysis with variables being entered into the model. At the initial stage 10342 (69.8%) cases were entered into the model, all associated risk factors remained significant at the 0.05 level and stayed in the model with the number of cases remaining the same. The findings of the analysis can be found in Table 6.8.

Being a primiparous teenager did not increase a woman's risk of having a LBW neonate after adjusting for smoking, ethnicity, multiple birth, premature birth and deprivation when compared to the comparative group. For primiparous women being a smoker (OR=1.816); booking late for care

(OR=1.357); being from a minority ethnic group (OR=2.522); having a multiple birth (OR=12.272); having a premature birth (OR=73.617) and coming from a deprived background (OR=1.009) increases a woman's risk of having a LBW neonate.

Using the Nagelkerke R Squared test the model explained 49.5% of the variance and the Hosmer and Leweshow Test (χ^2 = 13.925 (df=8), p=0.084) indicated the model was a good fit. The final model correctly classified 94.7% of cases and this was an increased of 2.9% on completion of the model.

An initial model excluding smoking and epidural was repeated and although the number of cases included was increased (n=13672) the overall results were unchanged.

Table 6.8 Model for Hypothesis 6.2a Examining Low Birth Weight in Primiparous Women

Factor	Unadjusted OR for primiparous women (95%CI)	Adjusted OR for primiparous women (95% CI) n=10452
20-25 years	1.00	1.00
≤ 16 years	1.021 (0.812 - 1.282) p=0.861	0.788 (0.546 - 1.138) p=0.204
17-19 years	0.947 (0.835 - 1.074) p=0.399	0.843 (0.682 - 1.041) p=0.113
Smoking status*- yes/no	**1.300 (1.120 - 1.509) p=0.001**	**1.736 (1.391 – 2.167) p≤0.001**
Late booker- yes/no	**1.911 (1.662 – 2.198) p≤0.001**	**1.357 (1.077 – 1.709) p=0.010**
Ethnicity– yes/no	**1.829 (1.578 - 2.120) p≤0.001**	**2.487 (1.952 – 3.169) p≤0.001**
Multiple birth– yes/no	**23.809 (16.171 - 35.053) p≤0.001**	**10.939 (5.255 – 22.771) p≤0.001**
Premature birth- yes/no	**85.951 (73.472 – 100.550) p≤0.001**	**75.807 (62.384 – 92.118) p≤0.001**
Jarman enumeration district- continuous	**1.010 (1.007 to 1.014) p≤0.001**	**1.010 (1.004 to 1.016) p=0.001**

*complete smoking data was only available from 1996 to 2001

Bold indicates significant result in table

Models examining Hypothesis 6.2b

Hypothesis 6.2b

'Multiparous teenage women have an increased risk of having a LBW neonate when compared to multiparous women in their early twenties and this risk is increased further for younger teenagers'.

After identifying multiparous women a backward manual stepwise conditional logistic regression model was run with having a LBW neonate or not as the outcome. Age group remained in the model regardless of significance and the other explanatory variables included in the model were:

- Smoking status- Yes/No
- Ethnicity- Yes/No
- Multiple birth- Yes/No
- Premature birth- Yes/No
- Jarman enumeration district- Continuous
- Rapid repeat birth- Yes/No

Women having a subsequent birth (n=18071) were selected for analysis with variables being entered into the model. At the initial stage 12961 (71.7%) cases were entered into the model and after completing the regression model no further cases were added to the model. Having a rapid repeat birth (OR=0.959, CI 0.739 to 1.250; p=0.758) was the only associated risk factor to be removed from the model all other variables remained significant at the 0.05 level and therefore remained in the model. The findings of the analysis can be found in Table 6.9.

Multiparous teenagers were not at an increased risk of having a LBW neonate after adjusting for smoking, late booking, ethnicity, multiple birth, prematurity and deprivation when compared to the comparative group. For multiparous women being either a smoker (OR=1.814), booking late for care (OR=1.264); coming from a minority ethnic group (OR=1.857), having a multiple birth (OR=3.313), having a premature birth (OR=71.883) and coming from a deprived background (OR=1.007) increases the woman's risk of having a LBW neonate.

Using the Nagelkerke R Squared test the model only explained 50.4% of the variance and the Hosmer and Leweshow Test (χ^2 = 6.342 (df=8), p=0.609) indicated the model was a good fit. The final model correctly classified 94.6% of cases an increase of 2.3%.

> By removing smoking from the initial model this increased the number of cases included (n=17221) but did not change the overall findings and both variance and fit statistics were altered very little by removing smoking.

Table 6.9 Model for Hypothesis 6.2b Examining Low Birth Weight in Multiparous Women

Factor	Unadjusted OR for multiparous women (95%CI)	Adjusted OR for multiparous women (95% CI) n=13068
20-25 years **≤ 16 years** **17-19 years**	1.00 1.307 (0.736 to 2.230) p=0.361 **1.200 (1.031 to 1.396) p=0.018**	1.00 0.817 (0.350 to 1.903) p=0.639 0.898 (0.708 to 1.138) p=0.374
Smoking status*- yes/no	**1.705 (1.501 to 1.937) p≤0.001**	**1.814 (1.509 to 2.181) p≤0.001**
Late booking- yes/no	**1.876 (1.642 to 2.143) p≤0.001**	**1.264 (1.023 to 1.562) p=0.030**
Ethnicity–.yes/no	**1.430 (1.227 to 1.666) p≤0.001**	**1.857 (1.460 to 2.362) p≤0.001**
Multiple birth– yes/no	**12.579 (9.387 to 16.838) p≤0.001**	**3.313 (1.930 to 5.688) p≤0.001**
Premature birth- yes/no	**73.848 (63.821 to 85.450) p≤0.001**	**71.883 (60.247 to 85.766) p≤0.001**
Jarman enumeration district- Continuous	**1.012 (1.008 to 1.015) p≤0.001**	**1.007 (1.001 to 1.012) p=0.018**
Rapid Rrepeat birth- yes/no	**1.495 (1.265 to 1.765) p≤0.001**	

* complete smoking data was only available from 1996 to 2001

Bold indicates significant result in table

Models examining Hypothesis 6.2c

Hypothesis 6.2c

'Multiparous teenage women have an increased risk of having a LBW neonate when compared to primiparous teenage women'.

After identifying teenage women a backward manual stepwise conditional logistic regression model was run with having either a LBW neonate or not as the outcome. Whether first or subsequent birth remained in the model regardless of significance and the other explanatory variables included in the model were:

- Multip- Yes/No
- Smoking status- Yes/No
- Ethnicity- Yes/No
- Multiple birth- Yes/No
- Premature birth- Yes/No
- Jarman enumeration district- Continuous

Teenage women (n=8028) were identified for analysis with variables being entered into the model. At the initial stage 5989 (74.6%) cases were entered into the model and after completing the regression model the number of cases remained the same. Only one variable was removed from the model and that was late booking (OR=1.237, 95% CI 0.938 – 1.633; p=0.132). Findings of the analysis can be found in Table 6.10.

Being a multiparous teenager reduced the risk of a woman having a LBW neonate (OR= 0.760) in comparison to being a primiparous teenager after adjusting for smoking, ethnicity, multiple birth, premature birth and deprivation. For teenage women being a smoker (OR=1.726); coming from a minority ethnic group (OR=1.966); having a multiple birth (OR=6.626); having a premature birth (OR=68.023) or coming from a deprived background (OR=1.009) increased the risk of a woman having a LBW neonate whether it is the women's first or subsequent birth.

Using the Nagelkerke R Squared test the model explained 49.4% of the variance and the Hosmer and Leweshow Test (χ^2 = 12.849 (df=8), p=0.117) indicated the model was a good fit. The final model correctly classified 94.5% of cases and this was an increase of 2.2%.

By removing smoking from the initial model this increased the number of cases included (n=7890). Late booking (OR=1.105, 95% CI 0.860 to 1.421; p=0.434) and deprivation (OR=1.006, 95% CI 1.000 to 1.013; p=0.067) were removed from the model but the remaining associated risk factors reached the 0.05 significance level and remained in the model. The findings did not differ from the original model and the variance and fit were similar.

Table 6.10 Model for Hypothesis 6.2c Examining Low Birth Weight in Teenage Women

Factor	Unadjusted OR for teenage women (95%CI)	Adjusted OR for teenage women (95% CI) n=5989	Adjusted OR for teenage women (95% CI) without smoking n=7890
Multip – yes/no	0.976 (0.828 to 1.151) p=0.777	**0.760 (0.587 to 0.982) p=0.036†**	**0.767 (0.612 to 0.959) p=0.020†**
Smoker* – yes/no	**1.339 (1.119 to 1.603) p=0.001**	**1.810 (1.401 to 2.338) p≤0.001**	Removed for analysis
Ethnicity – yes/no	**1.769 (1.423 to 2.198) p≤0.001**	**1.966 (1.392 to 2.777) p≤0.001**	**1.940 (1.431 to 2.630) p≤0.001**
Multiple birth – yes / no	**10.146 (5.551 to 18.544) p≤0.001**	**6.626 (2.156 to 20.366) p=0.001**	**5.382 (2.078 to 13.942) p=0.001**
Premature birth – yes/no	**71.546 (58.142 to 88.041) p≤0.001**	**68.023 (53.166 to 87.033) p≤0.001**	**70.482 (56.975 to 87.191) p≤0.001**
Jarman enumeration district - continuous	**1.009 (1.004 to 1.014) p≤0.001**	**1.009 (1.001 to 1.016) p=0.030**	

* complete sdata was only available from 1996 to 2001

† indicates a reduced risk of LBW in the results table

Bold indicates significant result in table

Models examining Hypothesis 6.2d

Hypothesis 6.2d

'Multiparous teenage women having rapid repeat births have an increased risk of having a LBW neonate when compared to multiparous teenage women not having a rapid repeat birth'.

After identifying multiparous teenage women a backward manual stepwise conditional logistic regression model was run with having either a LBW neonate or not as the outcome. The variable depicting rapid repeat birth remained in the model regardless of significance and the other explanatory variables included in the model were:

- Smoker- Yes/No
- Ethnicity- Yes/No
- Multiple birth- Yes/No
- Premature birth- Yes/No
- Jarman enumeration district- continuous

Multiparous teenage women (n=2687) were identified for analysis with variables being entered into the model. At the initial stage 2045 (76.1%) cases were entered into the model and this number increased to 2136 (79.5%) after completing the regression model. The first variable to be removed from the model was multiple birth (OR=0.742, CI 0.191 to 2.880; p=0.666) followed by deprivation (OR=0.997, CI 0.984 to 1.010; p=0.655) and late booking (OR=1.458, CI 0.931 to 2.285; p=0.100). The findings of the analysis can be found in Table 6.11.

Multiparous teenagers having a rapid repeat birth did not have an increased risk of having a LBW neonate in comparison to multiparous teenagers not having a rapid repeat birth after adjusting for smoking, ethnicity and having a premature birth. For multiparous teenage women who smoked (OR= 1.577); came from a minority ethnic group (OR=1.993) or had a premature birth (OR=60.359) there was an increased risk of having a LBW neonate rather than not.

Using the Nagelkerke R Squared test the model explained 48.8% of the variance and the Hosmer and Leweshow Test (χ^2 = 10.310 (df=4), p=0.036) indicated the model was not a good fit. The final model correctly classified 93.5% of cases and this was an increase of 2.1%.

> By removing smoking from the initial model the number of cases included increased to (n=2580). Multiple birth (OR=1.200, 95%CI 0.368 to 3.913; p=0.737), deprivation (OR=0.997, 95%CI 0.985 to 1.009; p=0.621) and later booking (OR=1.403, 95% CI 0.935 to 2.104; p=0.102) were removed from the model but the remaining associated risk factors reached the 0.05 significance level and remained in the model. The findings did not differ from the original model and the variance and fit were similar.

Table 6.11 Model for Hypothesis 6.2d Examining Low Birth Weight in Multiparous Teenage Women Having a Rapid Repeat Birth or Not

Factor	Unadjusted OR for multiparous teenagers (95%CI)	Adjusted OR for multiparous teenagers having or not having a rapid repeat birth (95% CI) n=2136	Adjusted OR for multiparous teenagers having or not having a rapid repeat birth (95% CI) without smoker n=2657
Rapid Repeat Birth – yes/no	**1.661 (1.184 to 2.329) p=0.003**	1.258 (0.760 to 2.081) p=0.372	1.167 (0.735 to 1.853) p=0.514
Smoker* – yes/no	**1.579 (1.166 to 2.138) p=0.003**	**1.577(1.055 to 2.360) p=0.026**	Removed for analysis
Ethnicity – yes/no	**1.583 (1.074 to 2.333) p=0.020**	**1.993 (1.111 to 3.577) p=0.021**	**1.774 (1.038 to 3.031) p=0.036**
Multiple birth – yes /no	**7.220 (2.921 to 17.848) p≤0.001**		
Premature birth – yes/no	**64.911 (45.431 to 92.745) p≤0.001**	**60.359 (40.422 to 90.129) p≤0.001**	**64.357 (44.894 to 92.259) p≤0.001**
Jarman enumeration district - continuous	1.003 (0.994 to 1.012) p=0.514		

* complete smoking data was only available from 1996 to 2001

Bold indicates significant result in table

6.6.7 Summary of Findings

6.6.7.1 Univariate Analysis

Overall 9.6% (n=3104) of women in the study had a neonate with a low Apgar score and 8.2% (n=2693) of women had a low birth weight (LBW) neonate. When comparing by age, teenagers had a higher proportion of low Apgar scores and LBW than women in the comparative group. When comparing teenage groups, younger teenagers had a higher proportion of babies with a low Apgar score and LBW than older teenagers.

6.6.7.2 Multivariate Analysis

When models were completed adjusting for associated risk factors, primiparous teenagers remained more likely to have a neonate with a low Apgar score and if the teenager was younger this likelihood was increased (≤ 16 years OR=1.356, 17-19 years OR=1.152). In the multiparous model teenagers had a similar statistical risk of having a neonate with a low Apgar score as women in the comparative group. When comparing teenagers a multiparous teenager was less likely (OR=0.782, p=0.003) to have a neonate with a low Apgar score than a primiparous teenager. In the final model teenagers having a rapid repeat birth had a similar statistical risk of having a neonate with a low Apgar score as a teenager waiting longer between births.

Both primiparous and multiparous teenagers had a similar statistical risk as women in the comparative group of having a neonate with LBW. When comparing teenage groups, multiparous teenagers were less likely (OR=0.760, p=0.036) to have a LBW neonate than primiparous teenagers. Teenagers having a rapid repeat birth had a similar statistical risk of having a neonate with a LBW as teenagers delaying a subsequent birth. The hypotheses posed in this chapter have been addressed and the acceptance or rejection of these hypotheses has been presented in Table 6.12.

Table 6.12 Summary of Hypothesis for Low Apgar Score (LAS) and Low Birth Weight (LBW)

Hypothesis Tested *Primiparous teenage women have an increased risk of adverse maternal and neonatal outcomes when compared with primiparous women in their early twenties and this risk is increased further for a younger teenager.*		
Population: Primiparous Women	**Outcomes Examined**	
Comparison Groups (compared with 20-25 year old women)	**LAS**	**LBW**
All teenagers	Accepted	Rejected
Under 16 year olds	Accepted	Rejected
Hypothesis Tested *Multiparous teenage women have an increased risk of adverse maternal and neonatal outcomes when compared with multiparous women in their early twenties and this risk is increased further for a younger teenager.*		
Population: Multiparous Women	**Outcomes Examined**	
Comparison Groups (compared with 20-25 year old women)	**LAS**	**LBW**
All teenagers	Rejected	Rejected
Under 16 year olds	Rejected	Rejected
Hypothesis Tested *Multiparous teenage women have an increased risk of adverse maternal and neonatal outcomes when compared to primiparous teenage women*		
	Outcomes Examined	
Population: All Teenagers	**LAS**	**LBW**
Multiparous teenagers more likely than primiparous teenagers	Rejected	Rejected
Hypothesis Tested *Multiparous teenage women having a rapid repeat birth have an increased risk of adverse maternal and neonatal outcomes when compared to multiparous teenagers not having a rapid repeat birth.*		
	Outcomes Examined	
Population: Multiparous Teenagers	**LAS**	**LBW**
Rapid repeat births more likely than Non Rapid	Rejected	Rejected

6.6.7.3 Associated Risk Factors Entered into the Models

When smoking was entered into the models it was not significantly associated with low Apgar score but for LBW models it increased the risk of a woman having a neonate with a LBW regardless of age, in all models. Late booking was only entered into the model for LBW and with the exception of the primiparous model, did not increase the risk of a woman having a neonate with a LBW. Late booking increased the risk of primiparous women having a neonate with LBW when considering associated risk factors.

Having a multiple birth did not remain significant in any of the models for low Apgar score but increased the risk of having a LBW neonate with the exception of the rapid repeat model. Deprivation increased the risk of a multiparous woman having a neonate with a low Apgar score but was not significant in the primiparous or teenage models. With the exception of teenagers having a rapid repeat birth, deprivation increased the risk of a woman having a neonate with a LBW. Having an epidural or a prolonged second stage was only entered into the low Apgar score models but neither was significant. However, operative birth increased the risk of a woman having a neonate with a low Apgar score.

Premature birth remained significant in all models for both outcomes and increased the woman's risk of having a neonate with a low Apgar score or having a LBW neonate. The risks were markedly higher for LBW weight in comparison to low Apgar score when a premature birth occurred.

6.7 Discussion

6.7.1 Low Apgar Score

The use of the five minute Apgar score as an assessment of neonatal wellbeing was recorded for over 98% of the population in this study. This demonstrates the widespread use of this assessment in local practice and why from a clinical perspective this form of assessment was used as an indicator of neonatal wellbeing.

A higher proportion of teenagers in this study had a neonate with a low Apgar score than women in their early twenties and univaraite analysis confirmed that teenagers were at an increased risk (≤16 years OR=1.399, 17-19 years 1.165). In some studies [183, 341] the conclusions that have been published did not adjust for associated risk factors and therefore presented an over pessimistic picture for teenagers generally.

The multivariate analysis undertaken in this study has shown that not all teenagers have the same risk of having a neonate with a low Apgar score. Primiparous teenagers were at an increased risk of having a neonate with a low Apgar score when compared to women in their twenties and also compared to multiparous teenagers. In primiparous teenagers age was also a factor as younger teenagers had a further increase in risk (OR=1.36) in comparison to their older peers (OR=1.15). These findings are similar to those of Chen *et al* [14] but contradicted findings of other researchers [16, 183, 205]. Both Berenson *et al* [183] and Chen *et als* [14] studies focussed on primiparous women only, as a result excluding a vital aspect to be investigated that of parity.

Analysis undertaken on multiparous teenagers found a different outcome than for primiparous teenagers. Multiparous teenagers were not statistically at an increased risk of having a neonate with a low Apgar score. The studies undertaken by Geist *et al* [182] and Usta *et al* [16] included both primiparous and multiparous teenagers in the analysis but did not differentiate between the two in the presentation of their findings. Within the multivariate models it was clear that the age of the teenager was not the main factor affecting the risk of having a neonate with a low Apgar score. It was the number of births the teenager had and the effect of certain associated risk factors in the models.

No previous studies were identified that considered the influence of parity on a teenager's risk of having a neonate with a low Apgar and this was also the case for timing between births. Previous studies [225, 409] have looked at the incidence of stillbirth and other neonatal morbidity but not Apgar score. The influence of parity is not easily explained especially when first rather than subsequent births appear to be more problematic. Governmental publications [27-29, 77] have inferred that subsequent births to teenagers have poorer outcomes than first births but this was not the case for perinatal outcomes at the time of birth. In all models two additional risk factors that were considered and remained significant were operative birth and premature birth and will be discussed as they may help to explain this issue.

6.7.2 Associated Risk Factors for Low Apgar Score

6.7.2.1 Smoking and Low Apgar Score

The associated risk factors of smoking, using an epidural and having a prolonged second stage were entered into all models during multivariate analysis. None of these factors remained significant in any of the models. The negative impact of smoking on fetal development has been identified within the literature review of this thesis (p35) but it does not appear to have a direct effect on initial fetal compromise but, has more long term rather than short term consequences for the neonate [410, 411]. This is against the general consensus that smoking during pregnancy compromises the fetus and is associated with birth complications [348]. This thesis did not have access to data on the number of cigarettes that were smoked by the individual women; therefore the women in the sample may not have been heavy smokers. The degree of complications seen in neonates when mothers are smokers has a dose response with the number of cigarettes consumed, therefore if the sample were lighter smokers this may account for these findings and requires further investigation.

6.7.2.2 Epidural and Low Apgar Score

The use of epidural analgesia has been associated with an increase in instrumental and LSCS births which have been shown in this chapter to be associated with an increased risk of low Apgar score. The direct effect of the epidural is not associated with a depression of the respiratory function of the neonate as seen if opiates are used as pain relief. The findings of this study confirm those of Leighton and Halpern [305] that epidural does not impact on Apgar regardless of the woman's age.

6.7.2.3 Prolonged Second Stage/Operative Birth and Low Apgar Score

Having a prolonged second stage of labour was not a risk factor for low Apgar score and this confirmed the findings of other researchers [309, 310, 363, 389]. The analysis presented in Chapter 5 found that women having a prolonged second stage were at an increased risk of both instrumental or LSCS birth therefore within the Apgar models operative birth was adjusted for. This may explain why having a prolonged second stage did not statistically increase the risk of having a low Apgar within the model.

6.7.2.4 Operative Birth and Low Apgar Score

Operative birth was included in all four models with low Apgar score as the outcome. In every model operative birth remained significant and increased a woman's risk of having a neonate with a low Apgar score. This was regardless of age, parity or timing between births.

The complication of operative birth has been noted by previous researchers and authorities [365, 400] as being associated with a compromised neonate and this is confirmed by this study. Operative births are usually a result of a clinical indication mainly on the identification of a compromised neonate [365, 400].

In all models if the woman had an operative birth they were approximately twice as likely to have a neonate with a low Apgar score as a woman having a normal birth. From the current study it is not possible to establish whether it was the condition of the fetus prior to birth or the undertaking of the operative birth or a combination of both, that has resulted in a low Apgar score. This could only be answered by undertaking a prospective study identifying relevant data.

6.7.2.5 Premature Birth and Low Apgar Score

Babies that are born prematurely are already compromised with respiratory complications one of the key concerns [195]. As respiration is one of the five assessment areas for Apgar score it is therefore not a surprise that premature birth is associated with an increased risk of a low Apgar score. In all models women having a premature birth were between 2.1 and 2.7 times more likely to have a neonate with a low Apgar score. Primiparous women had the highest risk (OR=2.7) with multiparous teenagers having a rapid repeat birth the lowest risk (OR=2.1). Although on completion of multivariate analysis primiparous teenagers were not at an increased risk of premature birth, but if a primiparous teenager has a premature birth they are at an increased risk of low Apgar score.

6.7.2.6 Deprivation and Low Apgar Score

Deprivation was associated with low Apgar score, only for multiparous women from a deprived background, as deprivation did not remain in the three other models. The link between deprivation and poor neonatal outcomes are not consistently presented in the literature [94] and this study adds further to the debate. What this study does establish is that teenagers from deprived backgrounds are not necessarily at an increased risk of low Apgar score when other risk factors are taken into consideration.

6.7.2.7 Ethnicity and Low Apgar Score

During multivariate analysis being a multiparous woman from a minority ethnic background was associated with a reduced risk of a multiparous woman having a neonate with a low Apgar score. Ethnicity was not a risk factor for primiparous women or teenagers when considering low Apgar score. Earlier studies have highlighted the association between certain ethnicities and low Apgar score [300, 398] for all women but this study disputes those findings and adds to the debate by identifying differences between first and subsequent births.

6.7.3 Low Birth Weight

Birth weight was recorded for almost 100% (n=32724, 99.5%) of neonates in this study and indicates the completeness of data for analysis [247 p. 18]. LBW remains a key target to be tackled internationally [401] and for teenage births it has been continually highlighted as a problem [23, 27, 28, 35, 94, 200].

Teenagers had a similar statistical risk of having a LBW neonate as women in their twenties (≤16 years OR=1.184, p=0.112, 17-19 OR=1.093, p=0.067). This confirms the findings of some researchers [16, 183, 205, 408] but contradicts others [14, 23, 36, 94, 200].

On completion of the multivariate analysis and after adjusting for associated risk factors, the findings remained unchanged and teenagers were not at an increased risk of having a LBW neonate. However, when comparing teenagers' only, multiparous teenagers were less likely to have a LBW neonate than their primiparous peers but time between births did not affect the risk of LBW in teenagers.

6.7.4 Associated Risk Factors and Low Birth Weight

6.7.4.1 Smoking and Low Birth Weight

Smoking increased the risk of having a neonate with a LBW in all women in all models. Primiparous and multiparous women generally were 1.8 times more likely to have a neonate with a LBW when they smoked confirming the findings of previous studies [408, 412]. These studies were general studies that included all women and did not focus on teenagers. For teenagers the risks associated with smoking were slightly lower (OR=1.73) and fell further if the teenager had a rapid repeat birth (OR=1.57). The targets set in policy documents [106, 411, 413] for reducing smoking in women should be applied to teenagers as robustly as to older women when providing support for stopping smoking.

6.7.4.2 Late Booking and Low Birth Weight

Poor antepartum care has been associated with LBW in teenagers [14, 35, 36] but studies investigating this association have included both late booking and poor attendance for ongoing care as factors. Both primiparous (OR=1.35) and multiparous (OR=1.26) women in this study were at an increase risk of LBW if booking late for care but late booking was not a risk for teenagers or those having a rapid repeat birth. The effect of booking late for care was varied for outcomes included in this thesis and provides justification for further enquiry in this area. The data of routine care was not available for this study but a prospective study would allow for data collection to be gathered from both the hospital and primary care setting.

6.7.4.3 Multiple Birth and Low Birth Weight

Although teenagers have a reduced rate of multiple births in comparison to the general population [334] the risk of LBW was still markedly increased if a teenager had a multiple birth. Primiparous teenagers having a multiple birth were twice as likely (OR=6.6) to have a LBW neonate as multiparous women (OR=3.3) but had half the risk of primiparous women generally (OR=12.2.). For teenagers having a rapid repeat birth, multiple births did not remain significant in the model. The finding that multiple births increase the risk of having a LBW neonate is not unexpected because of the increased number resulting in a premature birth. Although the interpretation of these results should be treated with a degree of caution as there were only 318 multiple births recorded in the dataset and majority were in the older age group (≤16 n=3, 17-19 n=44). The variations between the risks for teenagers and that of other women may in part be explained by the small number of teenagers having a multiple birth in the study, particularly in the case of rapid repeat births.

6.7.4.4 Deprivation and Low Birth Weight

When adjusting for other associated risk factors, coming from a deprived background consistently increased the risk of having a LBW neonate regardless of age or parity within the study. These findings are similar to other studies [10, 94, 141, 391]. Deprivation in women having a rapid repeat birth did not remain significant within the models.

6.7.4.5 Ethnicity and Low Birth Weight

The incidence of low birthweight varies between social class, age of the mother and also ethnic group [403]. Women from an ethnic minority in this study were approximately twice as likely to have a LBW neonate regardless of their age or parity and confirmed the findings of earlier research [48, 213, 397]. Whether this is detrimental to the child is debatable as Gardosi [299] points out what is abnormal for some women is the norm for others. The key finding of this study is teenagers from an ethnic minority have a similar risk as women in their early twenties from an ethnic minority of having a LBW neonate.

6.7.4.6 Premature Birth and Low Birth Weight

As stated above premature birth and LBW neonates are inseparable so the fact that in all the models having a premature birth drastically increased the woman's risk of having a LBW neonate was not surprising. Although other factors had been taken into consideration the degree of risk was marked. Teenagers having a rapid repeat birth were again least affected (OR=60.34) with teenagers generally, slightly more at risk (OR=68.0). Primiparous women were most at risk (OR=73.6), the protection of having a subsequent birth again reduces the woman's risk of adverse outcomes regardless of the woman's age.

The conclusions and recommendations for this chapter will be presented in Chapter 7.

CHAPTER 7 CONCLUSIONS AND IMPLICATIONS OF THE FINDINGS

7.1 Introduction

This chapter draws together the main findings of the thesis and discusses their implications for practice. Four tables summarising all seven outcomes addressing each of the overarching hypotheses have been presented in Appendix 4. The final two sections of this chapter contain the overall conclusions and make recommendations for future research and practice.

7.2 Outcomes of Primiparous Models

Primiparous teenage women have an increased risk of suffering adverse maternal and neonatal outcomes when compared with primiparous women in their early twenties and this risk is increased further for a younger teenager.

Of the 32895 index births in the study population, 14824 (45.1%) primiparous births were identified, of which 5341 (36.03%) were to teenagers. The majority of younger teenagers (87.3% n=965/1105) and older teenagers (63.2% n=4376/6923) were primiparous and overall 66.5% (n=5341/8028) of teenagers were primiparous. In the comparative group the percentage of primiparous women was far less (38.1% n=9483/24867). National statistics on teenage births do not distinguish between initial and subsequent births so comparisons with national data are difficult to make with this study. However, a large epidemiological study undertaken by Smith and Pell [162] on women aged 15-

19 years found 88.8% were primiparous which is higher than that found in this study (66.5%).

7.2.1 Maternal Outcomes.

When examining obstetric outcomes all primiparous teenagers were at an increased risk of APH compared to women in their early twenties and this risk was greater for younger teenagers ($OR=1.67$ $p\leq0.001$) than older teenagers ($OR=1.48$ $p\leq0.001$). In contrast during birth primiparous teenagers had favourable outcomes in comparison to women in their early twenties. A higher proportion of younger and older primiparous teenagers had a normal birth than the comparative group and on completion of the multivariate analysis, primiparous teenagers were less likely to have either an instrumental birth (≤16 $OR=0.64$ $p\leq0.001$, 17-19 $OR=0.708$ $p\leq0.001$) or suffer perineal trauma (≤16 $OR=0.63$ $p\leq0.001$, 17-19 0.667 $p\leq0.001$). When examining LSCS both younger and older primiparous teenagers had a similar statistical risk (≤16 $OR=0.643$ $p=0.343$, 17-19 0.638 $p=0.078$) of having a LSCS as the comparative group.

7.2.2 Neonatal Outcomes

Primiparous teenagers had a similar statistical risk both of premature birth (≤16 $OR=1.139$ $p=0.287$, 17-19 $OR=1.481$ $p=0.674$) and of LBW (≤16 $OR=0.788$ $p=0.204$, 17-19 0.843 $p=0.113$) as the comparative group. However, the risk of low Apgar score was increased in teenagers when compared to the comparative group and this risk was highest for younger teenagers ($\leq$16 OR=1.356 p=0.004, 17-19 OR=1.152 p=0.020).

7.2.3 Implications for Practice

The findings suggest that primiparous teenagers are at an increased risk of APH. APH remains one of the major causes of maternal and neonatal morbidity [186] and continues to be a focus for health professionals when providing care. In previous studies the risk of APH has been associated with higher parity [329] older women [324, 332] and poor fetal growth [329], none of which are characteristics of the teenagers included here. As a result in practice currently this risk may be overlooked as a potential complication for this group of women. This study suggests that extra vigilance should be practised by midwives when caring for primiparous teenagers, especially those that come from a deprived background. The completed analysis did not allow identification of whether an APH had occurred during the antenatal or intrapartum period and what type of APH had occurred. Further work is required to provide clarity in this area for primiparous teenage women. As an interim action, midwifery services should highlight the potential problem for teenagers by providing additional education to primiparous teenagers about the warning signs of APH and encourage them to report any symptoms at an early stage so that major complications may be prevented.

Complications during birth should not be anticipated when providing care for primiparous teenagers with the exception of low Apgar score and these findings add further to the growing body of evidence to support this view [181, 189, 205, 360]. It is therefore important for policy makers and managers of maternity services to recognise that primiparous teenagers should not be classified as a 'high risk group' when choosing place of birth and services should adhere to the latest NICE guidelines on intrapatrum care [204] where being younger is not classified as being at high risk. Teenagers should be informed and supported when making choices during the birthing process and this may lead to a reduction in the use of epidural analgesia and the associated complication of a prolonged second stage [305, 306] as seen in the current study. By providing information and empowering primiparous teenagers to make informed choices, as with all women this may have a positive impact on further increasing the normal birth rate in teenagers.

The neonatal findings add to the established debate of whether teenagers are at an increased risk of low Apgar score. Previous studies by Chen *et al* [14] and Usta *et al* [16] agree with the findings presented here but others do not [183]. As the risk of low Apgar score was increased in primiparous teenagers it is important for the midwife attending the birth to take this into consideration when planning care. Low Apgar score can be caused by both antenatal and intrapartum fetal compromise and as a result routine observations may provide an indication of the potential complication. Associated risk factors were considered when undertaking analysis and as expected the occurrence of operative and premature birth when included in the Apgar model, increased the risk of a low Apgar score. This area requires further investigation and by undertaking a more indepth study of teenagers who have this complication additional risk factors may be identified that contribute to this complication.

7.3 Outcomes of Multiparous Models

Multiparous teenage women have an increased risk of suffering adverse maternal and neonatal outcomes when compared with multiparous women in their early twenties and this risk is increased further for a younger teenager.

Of the 32895 index births in the study population, 18071 (54.9%) multiparous births were identified, and 2687 (33.47%) of these were to teenagers. The proportion of multiparous index births to teenage women was lower than in the comparative group, with only 12.7% (n=140/1105) of younger teenagers and 36.8% (n=2547/6923) of older teenagers being multiparous in comparison to 61.9% (n=15384/24867) the comparison group.

7.3.1 Maternal Outcomes

On completion of the multivariate analysis multiparous teenagers were not at an increased risk of maternal complications. Comparisons between multiparous teenagers and multiparous women in their early twenties found a similar statistical risk for both APH (≤16 OR=0.966 p=0.934, 17-19 OR=1.140 p=0.190) and having a LSCS birth (teenagers OR=0.956 p=0.895). Younger multiparous teenagers had a similar statistical risk of having either an instrumental birth (0.629 p=0.447) or perineal trauma (OR=0.709 p=0.306) as women in their early twenties. If the teenager was older the risk was reduced for both of these outcomes when compared with the comparative group (instrumental OR=0.711 p=0.007 and perineal OR=0.863 p=0.037).

7.3.2 Neonatal Outcomes

Complications originating in the antenatal period were more problematic for multiparous teenagers than those occurring during birth. Multiparous teenagers had an increased risk of premature birth (≤16 OR=1.934 p=0.012, 17-19 OR=1.227 p=0.013) regardless of age although younger teenagers were at an increased risk. Neonatal outcomes following birth were not an issue for multiparous teenagers with both age groups having a similar statistical risk of low Apgar score (≤16 OR=1.185 p=0.569, 17-19 1.067 p=0.418) or having a neonate with a LBW (≤16 OR=0.843 p=0.691, 17-19 0.915 p=0.460) as the comparative group.

7.3.3 Implications for Practice

Multiparous teenagers were at an increased risk of only one of the seven outcomes investigated in this study, that of premature birth and a reduced risk for LBW. The risk of premature birth for multiparous teenagers was reported by Basso *et al* [339] and Smith and Pell [162] and differences between teenager age groups for outcomes was established at an earlier stage by DuPlessis [199]. The recommendations of a systematic review by Stevens-Simon *et al* [202] on younger teenagers, identified the need for tailored interventions to address this problem and the evidence presented from this study provides additional weight to this argument. Although evidence has been available for a number of years, the impact on practice has been limited as no additional monitoring or interventions are currently undertaken with multiparous teenagers. The association of genital tract infections with preterm birth has been reported by previous researchers [414, 415] and has formed part of the basis for the introduction of routine Chlamydia screening for under 25 year olds in the UK since 2005 [416]. As this screening programme was introduced after the data collection period for this study, its impact on the risk of premature birth in teenagers has yet to be established but should be monitored carefully in further investigations.

The favourable intrapartum and remaining neonatal outcomes for multiparous teenagers suggest that these teenagers are ready for childbirth and that specific service provision for multiparous teenagers around the time of birth may not be required. What this study does present is a rationale to target finite resources to provide services where most benefit can be achieved. This does not negate the need for continued support to address social compromise and support that many of these young women need [96, 417, 418].

7.4 Outcomes of Teenage Models

Multiparous teenage women have an increased risk of suffering adverse maternal and neonatal outcomes when compared to primiparous teenage women.

A total of 8028 (24.4% n=32895) index births occurred to teenagers during the ten year study period, this was comprised of 1105 (13.7%) to younger teenagers and 6923 (86.3%) to older teenagers. The city in which this study was conducted had the sixth highest teenage conception rate (74 per 1000) in England and Wales at the end of the data collection period, over two thirds higher than that found nationally (45 per 1000). In addition only 30% of local teenage conceptions resulted in an abortion in comparison to 45% nationally; resulting in a higher proportion of conceptions leading to births providing an ideal setting for the study [31].

7.4.1 Obstetric Outcomes

When comparing teenagers only, multiparous teenagers had the same statistical risk of APH as primiparous teenagers. For intrapartum outcomes multiparous teenagers were at a reduced risk of instrumental birth (OR=0.429 $p \leq 0.001$) and perineal trauma (OR=0.668 $p \leq 0.001$) but the risk of LSCS was similar whether or not it was the teenagers first or subsequent birth (OR=1.167 p=0.660).

7.4.2 Neonatal Outcomes

The risk of having a premature birth was increased for multiparous teenagers (OR=1.269 p=0.009) but having a neonate with low Apgar score or a LBW was reduced for multiparous teenagers in comparison to primiparous teenagers (OR=0.782 p=0.003, OR=0.760 p=0.036, respectively).

7.4.3 Implications for Practice

Overall, multiparous teenagers were not at an increased risk of poor outcomes in comparison to primiparous teenagers and in many cases there was a reduced risk of a poor outcome. The exception to this is premature birth which remains an increased risk for multiparous teenagers when compared with primiparous teenagers. Previous studies [200, 419] investigating different outcomes were consistent with those presented here but alternative longitudinal studies have not been conclusive [162, 218]. When making comparisons between first and subsequent births to teenagers, the overall conclusion is that teenagers do not differ from the majority of women in that subsequent births are easier when considering maternal outcomes. These findings add to the debate of whether teenagers should be discouraged to continue their childbearing from the maternal perspective as the biological outcomes of teenage birthing appear unproblematic [12, 20]. In clinical practice the close monitoring of fetal compromise and identification of additional risk factors for premature birth should be implemented for multiparous teenagers. This may reduce the incidence of premature birth in this group of women.

7.5 Outcomes of Rapid Repeat Models

Multiparous teenage women having a rapid repeat birth have an increased risk of suffering adverse maternal and neonatal outcomes when compared to multiparous teenagers not having a rapid repeat birth.

In total there were 7307 multiple entries to individual women in the dataset and of these 1711 (23.4%) had a birth within 18 months of a previous birth in the dataset. The proportions of rapid repeat births varied according to age group, with the highest proportion occurring in the younger teenagers (66.6% n=12/18), followed by the older teenagers (42.97% n=370/861) and the smallest proportion in the comparison group (20.67% n=1329/5099). The findings presented here have resulted from the analysis of teenage births only.

7.5.1 Maternal Outcomes

Only two of the models could be completed for the maternal outcomes for rapid repeat births as both the LSCS and perineal models were a poor fit and therefore the results were inconclusive. Teenagers having a rapid repeat birth were at a reduced risk of instrumental birth (OR=0.32 p=0.037) with a similar risk of APH (OR=0.826 p=0.450) as teenagers who delayed a subsequent birth.

7.5.2 Neonatal Outcomes

From a neonatal perspective teenagers having a rapid repeat birth were at an increased risk of having a premature birth (OR=1.617 p=0.006) than a teenager who delayed a further birth. Teenagers who had a rapid repeat birth had a similar statistical risk of having a neonate with a low Apgar scores (OR=1.071 p=0.731) or a LBW (OR=1.258 p=0.372) as teenagers waiting longer between births.

7.5.3 Implications for Practice

The final aspect examined in this thesis was to establish if outcomes were worse for teenagers when they had a rapid repeat birth over delaying a further birth. Two previous studies [154, 224] identified that teenagers having rapid repeat births were at an increased risk of premature birth and LBW but in this study only an increased risk for premature birth was found. The complication of premature birth remains a feature of all analysis undertaken in this thesis on multiparous teenagers and reinforces that this is an area that requires further investigation. Teenagers having a rapid repeat birth were at a higher risk (OR=1.617 p=0.006) of having a premature birth than teenagers having non-rapid births but the risk was less than when comparing younger multiparous teenagers with women in their early twenties (OR=1.934 p=0.012). From these findings age appears to have an influence on the risk for teenagers and further studies are required to investigate this further.

The impact of teenagers having a rapid repeat birth on biological birth outcomes does not appear to be as negative as stated in policy documents with the exception of premature birth. Teenagers appear to have the same risk factors as other women having rapid repeat births [226, 339, 406] and as such age should not be labelled as the only cause of this increased risk.

7.6 The Role of Associated Risk Factors

During the multivariate analysis pertinent associated risk factors were entered into the models and some of these risk factors remained significant in most if not all models. The associated risk factors were included in the models after being identified in the literature as being associated with the outcome being investigated. It was not certain whether these associated risk factors would remain significant and affect the outcome for women with differing obstetric and social histories. Some of these associated risk factors were pertinent to all women but varied according to the outcome, therefore, no general consensus can be stated. However, common risk factors such as deprivation, time of booking, multiple birth, epidural use, prolonged second stage, macrosomic neonate and to a lesser extent smoking and ethnicity can increase the risk of teenagers having poor outcomes but this is similar for all women.

7.7 Strengths and Limitations of the Study

7.7.1 Identifying data for the study

Inclusion and exclusion criteria were identified for the initial data extraction from the hospital computerised system but this was not completed by the researcher personally. Therefore the researcher could not validate the accuracy of the data extracted at the time for completeness. After extraction the data was compared with the full hospital episode statistics for all women giving birth at the two units involved and the data was comparable with that identified for the study.

7.7.2 Data Quality

The data used in this thesis was inputted by health care professionals undertaking the care and was not collected to address the specific outcomes examined in this study. The accuracy of that data was therefore difficult to assess, as many of the fields call for clinical judgements to diagnose a condition. The internal auditing systems mentioned on page 103 validated a percentage of the data entry but not all data would have been subject to this close scrutiny. Acknowledging this, the researcher used a validated tool [247] to assess the quality of the data and whilst undertaking the data cleaning process checked the data for obvious inaccuracies by completing descriptive statistics of all variables used. Data that were not feasible were either recoded if triangulation methods allowed or recorded as missing data and excluded from analysis.

7.7.3 Changes in Data Collection

The two main changes to data collection during the study time period were the classification of stillbirth described on page 106, and the introduction of smoking data at different times in the two units. The stillbirth issue was addressed by manually checking the gestation of stillbirths recorded in the dataset and then recoding the categorisation from miscarriage to stillbirth for babies born dead after the 24^{th} week of gestation.

Following descriptive analysis it was clear that the smoking data was not complete prior to 1996 in both units used in the study. Analysis involving smoking was rerun to check if the incomplete data had any effect on the findings. In the majority of cases this was not the case.

Data were categorised differently between the units for example the perineal trauma data. At one unit the degree of trauma was recorded in detail but at the other unit it was not categorised. For analysis it was therefore decided to group together all recorded perineal trauma into one dichotomised variable, trauma or not. The researcher acknowledges that there are marked differences between a third degree tear or episiotomy and a first degree tear for the woman's morbidity. However, by including any perineal trauma the proportions of women recorded with perineal trauma would have been over estimated that would over estimate the risk of trauma in women. For this reason the results should be treated with a degree of caution.

These issues would be addressed if the study was repeated with more recent data. Current data collection is more detailed and enables the identification of type of APH, degree of perineal trauma, invasive measures of fetal distress (Ph and base excess), the collection of biographics to calculate small for gestational age neonates and obesity in mothers and the recording of all types of analgesia used during birth. By including this more detailed data in a repeat study this would address some of the shortfalls identified above.

7.7.4 Variations in Data Recorded

It was not known at the start of this study that only one unit recorded the use of epidurals for pain relief. The reporting of epidural use within the study was limited to one unit rather than both units that provided data for the study. Post data collection the rates of epidural use were compared over a three month period between the two units and epidural use was very similar. As a result the effect of missing epidural data was tested by repeating each of the models where epidural was entered. In majority of cases this did not impact on the findings of the initial models.

7.7.5 Identification of Rapid Repeat Births

The process of identifying rapid repeat births has been explained on page 158 using data that was contained within the woman's original records. These data were then used to derive the variable of rapid repeat birth for analysis. The derivation of this variable has assumed that all women disclosed a full and accurate past obstetric history to the health professional taking the booking history. This in part could be validated when multiple entries for the same woman were identified in the dataset by manually sorting the cases and checking the histories given in subsequent pregnancies. The researcher does acknowledge that if past births were not disclosed then this could impact on the models using the rapid repeat variable for analysis.

7.7.6 Age of the Data

The researcher does acknowledge that the data analysed within this study may be considered as 'old' (1st January 1992 and the 31st December 2001) by some researchers. Part of the rationale for using retrospective data was the ability to track women through a substancial period of time to examining recurring births. This could not have been achieved if 'older' data had not been used. This should be taken into consideration when applying these findings to current service provision but as stated in section 7.8 of this chapter the findings are still generalisable to current populations.

7.7.7 The Impact of Terminations on Findings

The variations in the uptake of terminations by the more affluent sections of the population may have impacted on the outcomes examined within this study. Teenagers from more affluent backgrounds would not be exposed to some of the issues that teenagers from deprived backgrounds contend with while giving birth ie, booking late and deprivation factors. However, unless this study was undertaken in a country where all teenagers who conceived continued with their pregnancies, such an impact on outcomes could not be assessed.

7.7.8 Summary

The limitations identified have to be considered in conjunction with the strengths of the study. The study population was representative of teenagers found throughout England and therefore the results are generalisable to the wider population. The size of the population included in the study reduces the risk of both Type I (alpha) and Type II (beta) error when testing hypotheses. Data available for this study was extensive allowing associated risk factors to be included within the models addressing the criticism made of other studies.

7.8 Overall Conclusions and Recommendations for Future Research

Teenage pregnancies and births are a feature of childbearing in England and current indications from national data show that this situation is not going to change in the near future [31]. This is particularly relevant in the local area, where teenage conceptions at the end of the data collection period were the fifth highest in the country, with 73.8 per 1,000 teenagers conceiving compared to the national average of 42.5 per 1,000. The latest figures published by the teenage pregnancy unit show that although local rates have reduced slightly (71.6 per 1,000) this has not been as marked as in other areas, with the city now placed third highest in the country. This situation is compounded further by the relatively low local abortion rate, which has remained static over the same period at 35%, whilst national levels are 49% [31]. Therefore, this study is timely to inform both local and national policy and service provision. Previous local government [272] and national policy documents [28, 34, 420, 421] have identified the need for more indepth information on teenage childbearing and this study helps to address that need. The repeated use of the same outcome in subgroups within a population allows for the identification of common risk factors and poor outcomes across and within groups. The evidence provided by previous studies has failed to approach the subject in this way thus providing only limited evidence on which to base policy and practice.

Against a wealth of evidence regarding the societal implications of teenage pregnancy and birth there is a relatively small amount of evidence on negative biological aspects of teenage childbirth. The evidence available does not always take into account the obstetric history of the teenager before drawing general conclusions about risk. This study has addressed some of that shortfall. The findings of this study indicate that generally maternal and neonatal outcomes are good in teenagers and this is not affected by the parity of the teenager or timing between births. Teenagers who continue their childbearing during these early years have favourable outcomes throughout the childbirth experience, with many having a reduced risk of complications in comparison to first births to teenagers. Policy documentation in developed countries over the last thirty years has been dominated by the social implications of early childbearing rather than the biological aspects of teenage childbearing. This has resulted in a negative attitude to all aspects of teenage childbearing and the findings of this study go some way to correct this. The findings of this study supports the view of Hoffman [20] that teenagers should not be treated as a homogenous group when planning services, as complications affecting teenagers vary according to age and whether it is an initial or subsequent pregnancy or birth. This should be reflected in the policy documents and the formation of new services for these women.

Some of the complications identified in this study have been stated previously such as premature birth but others are new for example the identification of the risk of APH and low Apgar score in primiparous teenagers. This study has also provided evidence that some outcomes thought to affect all teenagers ie LBW are inaccurate and should be challenged. All teenagers within this study after adjusting for associated risk factors had a similar risk of LBW as women in their early twenties and there was only a difference between groups in the teenage model. In the teenage model multiparous teenagers had a reduced risk in comparison to their primiparous peers. This study provides evidence that it is not age per se that is a risk factor for LBW but the presence of associated risk factors within these womens lives that should be considered.

In conclusion the view regarding teenage childbearing has changed drastically over the last 60 years from being an accepted natural occurrence to being labelled a 'problem'. The evidence for this change of view has clearly not emerged from close examining of maternal and neonatal complications. It is more a societal change that has impacted on the acceptance of teenage childbearing rather than changes in biological evolution. This change has parallels with continued change in the provision of maternity services that has continued since this data was collected. New initiatives have been introduced to target teenage conceptions and provide appropriate services for teenagers continuing with their pregnancies [27, 28, 34, 35]. However, there is always room for improvement in the challenge of maintaining a high quality service as stated by Lord Darzi [422] and the findings of this study can be incorporated into using finite resources in the most appropriate way.

When completing a study there are always new areas that emerge that require further investigation and this is true of this study. Further research is required to clarify areas that were limited due to the quality of the data available for analysis. These include first, the primary outcomes of APH and perineal trauma that because of the lack of detail in the data the findings have to be treated with a degree of caution. As a result practice interventions are less targeted. Second, hospital activity data has been refined since the data collection period and more indepth data is now routinely collected which could be analysed based on the methodology undertaken in this study. Third, there are areas that although a risk factor has been identified, there are no explanations for its occurrence, for example a low Apgar score in primiparous teenagers. This requires further study before full conclusions can be drawn.

In the closing paragraph of the literature review, it was identified that there was a need for an indepth examination of both maternal and neonatal birth outcomes in teenagers. This need has been addressed by completing this study for the seven outcomes identified but there is still work to be done. Teenagers will continue to give birth and it is the responsibility of the health professionals attending them to enable them to do so safely, based on good practice and level of evidence. Although this study provides some of that evidence other areas, as identified above, require attention.

The Researchers Journey

Prior to commencing this study the researcher had worked for several years as a midwife in both the secondary and primary care setting. Throughout this clinical experience she had cared for numerous young women giving birth during their teenage years. Throughout this experience she had observed in the main positive outcomes for both the mother and the child which made her question the negative outcomes often stated within the published literature. Following her clinical experience she worked for a period of time as a research midwife in the Division of Public Health Medicine and Epidemiology were she first observed the use of secondary analysis for addressing complex research questions. On securing a permenant position as a lecturer in midwifery she chose to combine the area of interest, that of teenage birth outcomes and the methodology of secondary analysis resulting in the current study.

The undertaking of this study has enabled the researcher to gain new skills in the use of secondary analysis, data extraction, data cleaning and logistic regression modelling. The process has been a steep learning curve but the skills gained will be influential when undertaking further research. There are a limited number of midwifery researchers that use epidemiological approaches when addressing clinical questions they identify in practice and the findings presented here hopefully will encourage other midwives to consider this approach in their research in the future.

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APPENDIX 1

Stewart Framework (1982 page 18 & 19)

1. *What was the purpose of the study? Why was the information collected?*
2. *Who was responsible for collecting the information? What qualifications, resources, and potential biases are represented in the conduct of the study?*
3. *What information was actually collected? How were units and concepts defined? How direct were the measures used? How complete was the information? Are there any differences in the quality of different variables?*
4. *When was the information collected? Is the information still current, or have events made the information obsolete? Were there specific events occurring at the time the data were collected that may have produced the particular results obtained?*
5. *How was the information obtained? What was the methodology employed in obtaining the data?*
6. *How consistent is the information with other sources?*

APPENDIX 2

Nottingham City Hospital NHS
NHS Trust

Research and Development
Hucknall Road
Nottingham
NG5 1PB

Direct Dial: 0115 9627913
Tel: 0115 969 1169 ext 45356
Fax: 0115 9627788
e-mail: kasher@ncht.trent.nhs.uk
Minicom: 0115 962 7749
www.ncht.org.uk

Please ask for: Karen Asher

Ref: KA/

17 January, 2002

Mrs K Watts
Academic Division of Midwifery
Postgraduate Medical Education Centre
Nottingham City Hospital NHS Trust
Hucknall Road
Nottingham NG5 1PB

APPENDIX 3

Dear Mrs Watts

Longitudinal investigation of the terms 'unmarried mother' in predicting obstetric outcome: secondary analysis of a ten year database of deliveries in NHS hospitals in an East Midlands city.
Project Registration Number: 01MA02. Ethics Committee Number: EC01/167

The above project has been approved by the R&D Director, subject to Ethics Committee approval. It has been given the above Project Registration Number on the R&D database.

The National Research Register (NRR) is a database of research projects which are taking place throughout the country. Information is kept on the Department of Health's website, which is freely available to the general public. As the Trust is in receipt of NHS R&D Support funding, it is required to submit quarterly to the National Research Register (NRR) all active projects in receipt of NHS, public or charitable funding or any project which is of primary benefit to the NHS or the health of the nation. From the information submitted, it appears that this project qualifies for submission.

Details of your project are listed on the attached sheet. I would be grateful if you would make any changes or corrections to this information and return this to me with your signature to confirm that the details are correct. I can then release these details to the NRR.

The NRR can be accessed via the internet on http:/www.doh.gov.uk/research/nrr.htm.

Should you have any queries, regarding the entry, please contact me.

Yours sincerely

Karen Asher.

Karen Asher
Research and Development Manager

APPENDIX 3

Definition of Syntax

Syntax is described by Kinnear and Gray (2008) as:

"the writing of instructions in an SPSS control language" (p.556).

This process has been used throughout this thesis along with conventional windows operating system. Below are some examples of the syntax used to clean data and derive new variables used in analysis.

This was used to calculate the gestation by deducting the date of delivery from EDD:

```
SORT CASES BY
 q_501 (A) .
RECODE
 q_501
 (ELSE=Copy) INTO q_501a .
VARIABLE LABELS q_501a 'gestation calculated from date of delivery and
EDD'.
EXECUTE .
RECODE
 q_501
 (ELSE=Copy) INTO q_501a .
VARIABLE LABELS q_501a 'gestation calculated from date of delivery and
EDD'.
EXECUTE .
COMPUTE vvvv = TIME.DAYS(q_493)-TIME.DAYS(q_95) .
```

```
EXECUTE .

COMPUTE vvvvv = cTIME.DAYS(q_493)-cTIME.DAYS(q_95) .

EXECUTE .

COMPUTE vvvvvv = (cTIME.DAYS(q_493)-cTIME.DAYS(q_95))/7 .

EXECUTE .

COMPUTE vv2 =q_501 + (cTIME.DAYS(q_493)-cTIME.DAYS(q_95))/7 .

EXECUTE .

COMPUTE vvx2 =40 + (cTIME.DAYS(q_493)-cTIME.DAYS(q_95))/7 .

EXECUTE .

COMPUTE q_gest = q_501 .

EXECUTE .

IF (SYSMIS(q_501)) q_gest = vvx2 .

EXECUTE .

DESCRIPTIVES

 VARIABLES=q_501 q_gest vvx2

 /STATISTICS=MEAN STDDEV MIN MAX .
```

Used to convert string data into date of birth for mother and for neonate:

```
/* these three variables are made to simply place an intermediate stage in.
/*these lines must be run and do not need any amending at all*/
STRING DAY1 (A2).
STRING MO1 (A2).
STRING YR1 (A4).
Var label mo1 'temp month variable for conversion from string'.
Var label yr1 'temp year variable for conversion from string'.
Var label day1 'temp day variable for conversion from string'.

/* these three lines split the string date into three numeric bits, day, month and year*/
/*here you need to enter the existing string varaible name in where it currently says dob*/

COMPUTE DAY1=(SUBSTR(dob,1,2)).
COMPUTE MO1=(SUBSTR(dob,4,2)).
COMPUTE YR1=(SUBSTR(dob,7,4)).

/*this command then joins the three separate numeric bits from the previous command together to make a numeric date*/
/*the new proper date variable name needs to be put in where it currently says dob2*/

COMPUTE dob2=NUMBER(concat(day1,"/",mo1, "/", YR1),EDATE10).
```

```
EXECUTE.

FORMATS dob2 (EDATE10).

EXECUTE.

Var label dob2 'dob in date format'.
```

Used to calculate the total length for each stage of labour in hours the data is in fractions of hours i.e 6 minutes is 0.10 = 1/10 of an hour:

```
COMPUTE stage1 = (q_stag1a  / 60) .
EXECUTE .
COMPUTE stage2 = (q_stag2a  / 60) .
EXECUTE .
COMPUTE stage3 = (q_stage3  / 60) .
EXECUTE .
COMPUTE Lab_fin = (Labour / 60) .
EXECUTE .

RECODE
  q_stag2a
  (0.00 thru 120.00=0)  (121.00 thru 240.00=1)  (241.00 thru 360.00=2) (-1=-1)
  INTO  len2_gp .
VARIABLE LABELS len2_gp 'Grouped length of second stage in minutes'.
EXECUTE .
FREQUENCIES
  VARIABLES=len2_gp
  /ORDER=  ANALYSIS .

COMPUTE labour =  (q_stag1a + q_stag2a + q_stage3) .
VARIABLE LABELS labour 'length of labour' .
EXECUTE .
```

This syntax was used to calculate the time lapse between births for individual women and identify rapid repeat births:

```
RECODE
hosp
(1=0) (2=1)  INTO  hosp .
VALUE LABELS hosp 0 'city' 1 'qmc' .
EXECUTE.

COMPUTE del_days = CTIME.DAYS(q_474) .
EXECUTE .

SORT CASES BY
 new_hosp (A) q_5 (A) q_474 (A) .

IF ((LAG(new_hosp)=new_hosp) &( LAG(q_5)=q_5)) lag_days =
LAG(del_days)-del_days .
EXECUTE .

IF (new_hosp=LAG(new_hosp)) gap = (del_days-LAG(del_days))/365 .
EXECUTE .

/548 DAYS = 18 MONTHS/
RECODE
 lag_days
```

```
(-548 thru -1=1) (ELSE=0) INTO rapid.
VARIABLE LABEL rapid ' next birth within 18 months'.
VALUE LABELS rapid 1 'yes' 0 'no'.
EXECUTE .
/365 days = 12 months/
RECODE
  lag_days
  (-365 thru -1=1) (ELSE=0) INTO rapid3.
VARIABLE LABEL rapid3 ' next birth within one year'.
VALUE LABELS rapid3 1 'yes' 0 'no'.
EXECUTE .
RECODE
  lag_days
  (-465 thru -1=1) (ELSE=0) INTO rapid4.
VARIABLE LABEL rapid4 ' next birth within 15 months'.
VALUE LABELS rapid4 1 'yes' 0 'no'.
EXECUTE .
IF (rapid2 = 1) rapid =1.
IF (rapid2 =0) rapid =0 .
VARIABLE LABEL rapid ' rapid birth or not'.
VALUE LABELS rapid 1 'yes' 0 'No' .
EXECUTE .
```

Appendix 4

Variables Used in Multivariate Analysis

Dependent Dichotomous Variables	Definition
APH	Antepartum Haemorrhage defined as bleeding from the genital tract after the 22^{nd} week of pregnancy
Premature Birth	A birth occurring before the 37^{th} completed week of pregnancy
Instrumental Birth	Assisted vaginal delivery using either forceps or ventouse extraction
LSCS Birth	Abdominal delivery of neonate either as elective or emergency procedure
Perineal Trauma	Any degree of trauma to the gential track during the birth process
Low Apgar Score	An Apgar score of <7 5 minutes after birth
Low Birth Weight	Neonate weighing < 2500 grams at birth regardless of gestation

Independent Dichotomous Variables Adjusted for in the Models	**Definition**
Primiparous	Whether first or subsequent index birth
Smoker	Smoker or not at the time of birth
Late Booking	Booking for antenatal care after 20 weeks gestation
Multiple Birth	Giving birth to more than one neonate from the same pregnancy
Deprivation	Classified as from a deprived background if has a positive Jarman Score
Ethnicity	Classified as being in a minority ethnic group if non-white
Epidural	Use of epidural at any point during birth for pain relief
Prolonged Second Stage	Having a second stage of labour that has exceeded 120 minutes
Operative Birth	Birth by either forceps, ventouse or LSCS
Previous LSCS	Whether a multiparous women has had one or more LSCS in previous pregnancies.
Rapid Repeat Birth	A further birth occurring within 18 months of a previous birth in the dataset.
Macrosomic Neonate	Neonate weighing 4 kgs or over at birth
Premature Birth	See definition used for dependent variable.

Appendix 5

In all tables included in this Appendix * p≤ 0.001, Red † protective in table

Table 1 Primiparous Women

Age Group	APH	Premature Birth	Instrumental	LSCS	Perineal Trauma In Normal Births	Apgar	Low Birth Weight
20-25 years	1.00	1.00	1.00	1.00	1.00	1.00	1.00
≤ 16 years	1.676 (1.262 to 2.227)*	1.139 (0.896 to 1.449); p=0.287	0.640 (0.499 to 0.819)*	0.643 (0.258 to 1.601); p=0.343	0.630 (0.534 to 0.745)*	1.356 (1.102 to 1.669); p=0.004	0.788 (0.546 to 1.138; p=0.204
17-19 years	1.481 (1.253 to1.751)*	1.031 (0.985 to 1.186); P=0.674	0.708 (0.622 to 0.807)*	0.638 (0.387 to 1.052); p=0.078	0.667 (0.608 to 0.734)*	1.152 (1.023 to 1.297); p=0.020	0.843(0.682to 1.041); p=0.113
Smoking	Not significant removed from model	Not significant removed from model				Not significant removed from model	1.736 (1.391 to 2.167)*
Late booking	0.664 (0.521 to 0.846)*	1.799 (01.545 to 2.094)*					1.357 (1.0071 to 1.709) p=0.010
Multiple birth	Not significant removed from model	16.110 (10.684 to 24.293)*				Not significant removed from model	10.939 (5.255 to 22.771)*
Deprivation	1.005 (1.000 to 1.010); p=0.031	1.005 (1.000 to 1.009); p=0.014				Not significant removed from model	1.010 (1.004 to 1.016); p=0.001
Ethnicity						Not significant removed from model	2.487 (1.952 to 3.169)*
Epidural			3.170 (2.789 to 3.603)*	7.174 (3.398 to 15.147)*	Not significant removed from model	Not significant removed from model	
Prolonged second stage			5.474 (4.763 to 6.291)*	17.750 (11.391 to 27.659)*	1.514 (1.271 to 1.803)*	Not significant removed from model	
Operative birth						2.080 (1.867 to 2.316)*	
Macrosomic neonate			1.532 (1.247 to 1.883)*	4.885 (3.045 to 7.835)*	1.861 (1.540 to 2.249)*		
Premature birth						2.737 (2.364 to 3.168)*	75.807 (62.384 to 92.118)*

Table 2 Multiparous Women

Age Group	APH	Premature Birth	Instrumental	LSCS	Perineal Trauma In Normal Births	Apgar	Low Birth Weight
20-25 years	1.00	1.00	1.00	1.00	1.00	1.00	1.00
≤ 16 years	0.966 (0.423 to 2.206); p=0.934	1.934 (1.153 to 3.243); p=0.012	0.629 (0.190 to 2.077); p=0.447		0.709 (0.368 to 1.369); p=0.306	1.186(0.662 to 2.124); p=0.567	0.817 (0.350 to 1.903); p=0.639
17-19 years	1.140 (0.934 to 1.390); p=0.190	1.227 (1.043 to 1.442); p=0.013	0.711 (0.555 to 0.912); p=0.007†*		0.863 (0.752 to 0.991); p=0.037†*	1.061 (0.70 to 1.242); p=0.458	0.898 (0.708 to 1.138); p=0.374
≤ 19 years				0.956 (0.490 to 1.864); p=0.895			
Smoking	1.259 (1.079 to 1.469); p=0.003	1.392 (1.225 to 1.582)*				Not significant removed from model	1.814 (1.509 to 2.181)*
Late booking	0.777 (0.626 to 0.966); p=0.023†*	1.921 (1.662 to 2.220)*					1.264 (1.023 to 1.562)*
Multiple birth	Not significant removed from model	14.344 (10.141 to 20.290)*				Not significant removed from model	3.313 (1.930 to 5.688)*
Deprivation	Not significant removed from model	1.007 (1.003 to 1.011)*				1.004 (1.000 to 1.007); p=0.043	1.007 (1.001 to 1.012); p=0.018
Ethnicity						0.809 (0.640 – 0.972); p=0.024†*	1.857 (1.460 to 2.362)*
Rapid birth	Not significant removed from model	1.402 (1.174 to 1.673)*	0.282 (0.174 to 0.459) †*	Not significant removed from model	0.738 (0.629 to 0.867) †*	Not significant removed from model	Not significant removed from model
Previous LSCS	Not significant removed from model	1.467 (1.212 to 1.776)*	2.410 (1.762 to 3.296)*	Not significant removed from model	1.314 (1.035 to1.669); p=0.025		
Epidural			5.636 (4.709 to 6.744 *	2.674 (1.429 to 5.003); p=0.002	1.284 (1.153 to 1.430)*	Not significant removed from model	
Prolonged second stage			12.022 (9.679 to 14.931)*	35.648 (20.103 to 63.212)*	2.301 (1.691 to 3.129)*	Not significant removed from model	
Operative birth						2.082 (1.848 to 2.346)*	
Macrosomic neonate			Not significant removed from model	1.831 (1.010 to 3.318); p=0.046	1.625 (1.402 to 1.840)*		
Premature birth						2.636 (2.263 to 3.069)*	71.883 (60.247 to 85.766)*

Table 3 Multiparous Teenagers versus Primiparous Teenagers

Age Group	APH	Premature Birth	Instrumental	LSCS	Perineal Trauma In Normal Births	Apgar	Low Birth Weight
Multiparous Teenagers	1.044 (0.863to 1.263); p=0.660	1.269 (1.061 to 1.517); p=0.009	0.429 (0.339 to 0.541) †*	1.167 (0.585 to 2.329); p=0.660	0.668 (0.595 to 0.750) †*	0.782 (0.664 to 0.921); p=0.003†	0.760 (0.587 to 0.982); p=0.036†
Smoking	Not significant removed from model	1.231 (1.028 to 1.474); p=0.024				Not significant removed from model	1.726 (1.340to 2.224)*
Late booking	0.672 (0.522 to 0.864); p=0.002†	2.065 (1.711 to 2.494)*					
Multiple birth	Not significant removed from model	10.301 (5.206 to 20.380)*				Not significant removed from model	6.626 (2.156to 20.366); p=0.001
Deprivation	Not significant removed from model	1.009 (1.003 to 1.014)*				Not significant removed from model	1.009 (1.001 to 1.016); p=0.030
Ethnicity						Not significant removed from model	1.966 (1.392 to 2.777)*
Epidural			3.636 (2.956 to 4.471)*	3.969 (1.589 to 9.916); p=0.003	Not significant removed from model	Not significant removed from model	
Prolonged second stage			7.599 (6.051 to 9.544)*	4.148 (2.140 to 8.040)*	1.725 (1.316 to 2.262)*	Not significant removed from model	
Operative birth						2.247(1.936 to 2.609)*	
Macrosomic neonate			Not significant removed from model	2.477 (1.141 to 5.380); p=0.022	1.812 (1.441 to 2.280)*		
Premature birth						2.246(1.834 to 2.750)*	68.023 (53.166 to 87.033)*

Table 4 Multiparous Teenagers Having Rapid Repeat Births versus Multiparous Teenagers not having a Rapid Repeat

Age Group	APH	Premature Birth	Instrumental	LSCS	Perineal Trauma In Normal Births	Apgar	Low Birth Weight
Rapid birth	0.826 (0.525 to 1.330); p=0.450	1.617 (1.150 to 2.272); p=0.006	0.320 (0.110 to 0.931); p=0.037†			1.071 (0.723 to 1.588); p=0.731	1.258 (0.760 to 2.081); p=0.372
Smoking	Not significant removed from model	1.516 (1.149 to 1.999); p=0.003				Not significant removed from model	1.577 (1.055 to 2.360); p=0.026
Late booking	Not significant removed from model	1.794 (1.321 to 2.437)*					
Multiple birth	Not significant removed from model	16.499 (5.926 to 45.937)*				Not significant removed from model	Not significant removed from model
Deprivation	1.012 (1.002 to 1.023) p=0.024	Not significant removed from model				Not significant removed from model	Not significant removed from model
Ethnicity						Not significant removed from model	1.993 (1.111 to 3.577); p=0.021
Previous LSCS	Not significant removed from model	Not significant removed from model	Not significant removed from model				
Epidural			3.492 (2.084 to 5.853)*			Not significant removed from model	
Prolonged second stage			15.344 (9.131 to 25.785)*			Not significant removed from model	
Operative birth			Not entered			1.949 (1.451 to 2.619)*	
Macrosomic neonate			Not significant removed from model				
Premature birth						2.120 (1.484 to 3.030)*	60.359 (40.442 to 90.129)*