ABNORMAL BIRTH WEIGHT AMONG TERM GESTATION INFANTS IN NEWFOUNDLAND AND LABRADOR: TRENDS AND DETERMINANTS

NICOLE M. EDWARDS

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by

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ABSTRACT

Birth registration data were used to describe birth weight trends for term singletons born to residents of Newfoundland and Labrador from 1992-2005, and identify maternal and neighbourhood-level risk factors for high and low birth weight outcomes. A significant decrease in low birth weight from 1992 to 1995 was accompanied by significant increases in mean birth weight and high birth weight. Low birth weight was significantly associated with female infants, mothers aged 35+, mothers not legally married, separated, widowed or divorced, mothers living in neighbourhoods in the lowest socioeconomic status decile, mothers having less than high school education, hypertension, and smoking during pregnancy. High birth weight was significantly associated with parity, education beyond high school, and mothers who were anemic or had insulin dependent diabetes mellitus. Rates of high birth weight will likely continue to rise given current trends.

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

Pregnancy and birth are the first of several definitive life events that shape health outcomes within the course of an individual's lifetime (Larson, 2007). Within this context, a child's weight is one of the most important factors influencing health and is a significant determinant of infant mortality and morbidity. Birth weight has become among the most frequently employed indicators of population health status and is considered important by groups such as the World Health Organization for monitoring global progress in health (Ng and Wilkins, 1994).

The availability of reliable vital statistics data in countries around the world has allowed for the monitoring of birth weight trends over the past several decades. Vital statistics data from Canada for the years 1961 to 2000 indicate an overall increase in mean birth weight, decrease in rates of low birth weight, and increase in rates of high birth weight (Ng and Wilkins, 1994; Nault, 1997; Ananth and Wen, 2002; Wen et al., 2003; and Health Canada, 2003). While birth weight appears to be increasing in industrialized nations, less developed countries continue to report high rates of infants born below the optimal weight range.

Researchers have rigorously investigated the factors influencing birth weight outcomes. Studies have focused on the factors that influence gestational age at birth and fetal growth. Categories of factors found to be associated with birth weight include genetic factors; environmental characteristics; demographic, social and cultural characteristics; nutritional variables; medical factors; and maternal practices.

1.2 Rationale

The relative contribution of factors influencing birth weight varies from one population to the next and must be examined within individual populations. Population-specific knowledge of these factors can have important implications for perinatal programming and planning and is the most effective means by which birth weight outcomes, and in turn health, can be improved in any given population. Information on birth weight trends in Newfoundland and Labrador is limited due to the unavailability of electronic birth weight data prior to 1992. A population-based study of this kind has not been conducted in Newfoundland and Labrador. This research will contribute to the overall understanding of birth weight trends and factors contributing to birth weight outcomes in Newfoundland and Labrador. This information may influence the delivery of prenatal care by focusing on women who may be at higher risk for having high or low birth weight infants. The study can also guide initiatives aimed at improving birth weight outcomes and in turn improve the health of infants, children, and adults in Newfoundland and Labrador.

1.3 Objectives

1. To describe the distribution of birth weight and explore trends in birth weight rates in Newfoundland and Labrador for infants born between 1992 and 2005.
2. To investigate whether any observed trends in birth weight are accompanied by changes in maternal socio-demographic characteristics, including age, marital status, education, and parity.
3. To identify individual and community-level risk factors for low birth weight and high birth weight in Newfoundland and Labrador.

1.4 Outline

Following this introductory chapter, Chapter 2 will summarize a variety of research including birth weight as a health indicator, Canadian and international trends in birth weight, birth weight as a determinant of child health, and the factors influencing birth weight outcomes. Chapter 3 will outline the methodology used in conducting this research including a description of the data source, study population, independent and dependant variables, and methods used for analysis. Chapter 4 will present the results including a description of the study population, geographic and temporal trends in birth weight, and predictors of low and high birth weight outcomes in Newfoundland and Labrador. Chapter 5 will follow with a discussion of the results with comparisons and contrasts to previous work in this area and a discussion of the strengths and limitations of the study. Chapter 6 will conclude with a summary of findings, recommendations for the public health community, and reference to possible future work in this area.

CHAPTER 2

LITERATURE REVIEW

2.1 Definitions of Adverse Birth Weight

Birth weight is the weight of an infant at the time of birth. Low birth weight is defined internationally as birth weight less than 2,500 grams or 5.5 pounds (World Health Organization, 1993). The establishment of a widely accepted, standard definition for high birth weight has been problematic (Boulet, Alexander, Sakihu and Pass, 2003). The two most common definitions found in the literature are birth weight greater than 4,000 grams (8.8 pounds) and birth weight greater than 4,500 grams (9.9 pounds). Weight-for-gestational-age charts have also been used to classify the size of infants at birth with infants whose weights lie below the 10^{th} percentile for their gestational ages considered small-for-gestational-age and infants weighing above the 90^{th} percentile considered large-for-gestational-age. All these definitions are widely utilized in perinatal epidemiology.

2.2 Determinants of Birth Weight

Birth weight is governed by two major processes: duration of gestation and intrauterine growth rate (Kramer, 1987). An understanding of the determinants of birth weight must therefore take into account factors that influence these two processes. It is now widely acknowledged that the causality of birth weight is multifactorial and is influenced by the following groups of factors: genetic factors; demographic and psychosocial factors; obstetric factors; nutritional variables; maternal morbidity during pregnancy; toxic exposures due to maternal practices; and prenatal care (Kramer, 1987). Some of these factors are non-preventable, such as genetic factors, whereas others are modifiable factors such as nutritional factors. Public health communities often focus their intervention efforts on the modifiable risk factors as the best means of improving birth weight outcomes and in turn promote overall health of individuals and populations.

2.2.1 Demographic Factors

Most studies examining the determinants of birth weight acknowledge the influence of socio-demographic factors, in particular the effects of mother's age, marital status, educational attainment, and income on fetal growth. However, the ability of individual jurisdictions to study these factors is varied. In general, birth registries are valid sources for data on mother's age and martial status, however, information on mother's education and income are not as readily available. Canadian birth registrations contain no data on income, and data on maternal education are only available in the provinces of Quebec and Newfoundland and Labrador (Luo, Wilkins, and Kramer, 2006). Luo et al. (2006) report that small-area income can be considered a proxy for individual income and is often used when individual-level data are unavailable. Despite the lack of a complete set of data, a number of Canadian studies have used vital statistics data to examine the impact of social and demographic factors on birth weight.

Ng and Wilkins (1994) examined maternal demographic characteristics and rates of low birth weight in Canada from 1961 to 1990 using data extracted from the Canadian Vital

Statistics Database, a database maintained by Statistics Canada using vital statistics data from each of Canada's provinces and territories. They found that the rate of low birth weight was higher among unmarried mothers compared to married mothers (7.3% vs. 5.0%), and greater among teenage mothers as compared to those aged 20 to 34 years (6.7% vs. 5.4%). Newfoundland and Labrador was excluded from the analysis since official vital statistics during the study period did not provide information on mother's age or the child's birth weight. Another study using the Canadian Vital Statistics Database examined the incidence of low birth weight in Canada from 1975 to 1995 (Nault, 1997). The study revealed similar findings to those of Ng and Wilkins: that low birth weight was higher among mothers less than 20 years of age (6.7%) compared to mothers aged 20 to 34 years (5.5-6.0%), and that the rate of low birth weight was higher among unmarried mothers (6.8%) compared to married mothers (5.1%). Nault also found higher rates of low birth weight among mothers aged 35 to 39 years (6.5%) and 40 years and older (8.2%) compared to those aged 20 to 34 years (5.5-6.0%). Newfoundland and Labrador was again excluded from the analysis due to the unavailability of data.

Vital statistics data have also been used to examine variation in birth weight for individual Canadian provinces. A study conducted by Crosse, Alder, Ostbye and Campbell (1997) examined the geographic distribution of low birth weight by socioeconomic variables for infants born in London, Ontario from 1984 to 1988. Using census data from 1986, levels of income, education and employment were calculated for 31 census tract clusters. There was a statistically significant association between low birth weight and census tract clusters with low income, unemployment, and low education. The study also found that younger mothers tended to give birth to lighter babies and that low birth weight was significantly more likely among unwed mothers. Tough, Svenson, Johnston and Schopflocher (2001) examined the impact of infant and maternal factors on preterm delivery and low birth weight in Alberta between 1994 and 1996. They found that the odds of delivering a low birth weight infant were higher among unmarried mothers (Odds Ratio (OR) = 1.18, 95% Confidence Interval (CI) = 1.08-1.29) and mothers aged 35 years or older (OR = 1.60, 95% CI = 1.40-1.94). In a follow-up study by Tough et al. (2002), maternal age of 35 years or greater was again associated with low birth weight (RR 1.2, 95% CI 1.1-1.2).

Researchers have also used data extracted from antenatal and medical charts to study the effects of maternal demographic factors on perinatal outcomes. In an investigation of the perinatal effects of delayed childbearing in Nova Scotia , Joseph et al. (2005) found that, relative to mothers aged 20 to 24 years, women aged 30 to 34 years were more likely to have a small for gestational age infant (adjusted RR 1.11, 95% CI 1.04-1.18). The rate ratio increased to 1.29 (95% CI 1.17-1.42) for women aged 35 to 39 years, and to 1.66 (95% CI 1.35-2.04) for women aged 40 years or greater. Another study conducted in Nova Scotia obtained women's family income as a measure of socioeconomic status, through a linkage to income tax records, to determine the effect of socioeconomic status on perinatal outcomes (Joseph, Liston, Dodds, Dahlgren, and Allen, 2007). The investigators found that those in the lowest income group had a significant higher rate of small-for-gestational-age live births (adjusted RR 1.34, 95% CI 1.18-1.53) compared to women in the highest family income group.

As previously stated, community-level measures are often used to determine the association between socio-demographic factors and birth weight outcomes. Using birth registration data in Quebec, Luo, Wilkins and Kramer (2006) examined the associations of maternal education and neighbourhood income with birth outcomes, including small-for-gestational age. Information on maternal education was obtained directly from birth registration certificates, whereas neighbourhood income levels were derived using maternal postal codes reported on birth registrations that were linked to census enumeration areas. The research team created neighbourhood income quintiles to reflect the relative socioeconomic status of the neighbourhood in which the mothers lived, as compared with other neighbourhoods within the same census metropolitan area or census agglomeration. A neighbourhood income quintile was assigned to each birth based on the enumeration area of the mother's place of residence. The study found that mothers living in poorer neighbourhoods were much more likely to be unmarried, younger than 20 years of age, and not to have graduated from high school, and they were much less likely to be 35 years of age or older. Compared with women in the highest neighbourhood income quintile, women in the lowest quintile were significantly more likely to have a small-for-gestational age baby (OR 1.18, 95% CI 1.15-1.21) and low birth weight baby (OR 1.38, 95% CI 1.34-1.41). Furthermore, compared with mothers who had post-secondary education, mothers who had not completed high school were also significantly more likely to have a small-for-gestational age infant (OR 1.86, 95% CI 1.82-1.91). The investigators concluded that individual, and to a lesser extent neighbourhood-level, socioeconomic status measures are indicators for subpopulations at risk of adverse birth outcomes.

Not surprisingly, studies of determinants of macrosomia (high birth weight) revealed opposite findings to those of low birth weight. A study out of the United States (US) compared macrosomic infants weighing greater than 4,500 grams to a control group of infants whose weights were between 2,500 grams and 3,499 grams and found that mothers of macrosomic infants were more likely to be older compared to mothers of control children (Spellacy, Miller, Winegar and Peterson, 1985). A second study conducted in the US also found that macrosomia was associated with advanced maternal age (35 to 49 years) in addition to mothers being married (Boulet, Alexander, Salihu, and Pass, 2003). These findings were supported by Orskou, Henricksen, Kesmodel and Secher (2003) in an investigation of over 24,000 pregnancies in Denmark from 1990 to 1999 whereby mother's age of 30 or more years was associated with higher birth weight infants. No significant associations have been found with paternal age and birth weight (Tough, Faber, Svenson, and Johnston, 2003).

2.2.2 Maternal Morbidity during Pregnancy

The health of the mother has obvious influence on pregnancy outcomes. A woman's health during pregnancy is dependent upon a number of factors including nutritional status, lifestyle factors, and socioeconomic status, all which have associations with birth outcomes, including birth weight. Several medical conditions present before and during pregnancy have been associated with birth weight outcomes, most notably, diabetes, hypertension, and anemia. Some conditions work to lower birth weight outcomes while others have the opposite effect and tend to increase infant weight. Hypertensive disorders are most commonly known for their association with low birth weight. This is reflected in a study by Xiao, Sorensen, Williams and Luthy (2003) who examined the effect of pre-eclampsia on fetal growth. Pre-eclampsia was defined as sustained pregnancy-induced hypertension with proteinuria. Compared with normotensive women, those with pre-eclampsia were 3.8 times more likely to have a low birth weight infant (95% CI 1.9-7.5). The authors acknowledge that decreased placental blood flow associated with hypertension has been attributed for this influence on fetal growth. Iron deficiency anemia, a nutritional deficiency associated with low levels of hemoglobin or iron, is common among women in their reproductive years. Increased iron is required during pregnancy to increase red cell mass, expand the plasma volume and allow for the growth of the fetal-placental unit (Scholl, 2005). A woman that is anemic during pregnancy has been found to have a higher risk of delivering a low birth weight infant (Lone, Qureshi and Emanuel, 2004; Mahajan, Singh, Shah, Gupta and Kochupillai, 2004).

Diabetes has been found to be associated with the occurrence of high birth weight infants. In 2003, Boulet, Alexander, Salihu and Pass published findings of a study that examined maternal risk factors for macrosomia. Using a reference group weighing 3,000-3,999 grams, maternal diabetes mellitus was prevalent among 3.7% of infants weighing 4,000-4,499 grams, 6.2% of infants weighing 4,500-4,999 grams, and 11.8% of infants weighing 5,000 grams or more.

2.2.3 Obstetric Factors

Among the range of obstetric factors that have been studied for their association with birth weight, prior pregnancy outcomes and sexual activity, parity (number of children a woman has delivered) and birth weight of previous children appear to have direct associations with intrauterine growth. A woman who has given birth to one child is referred to as primiparous, whereas a woman who has had two or more children is known as multiparous. As it relates to birth weight outcomes, increasing parity is usually associated with higher birth weight (Dougherty and Jones, 1982; Ng and Wilkins, 1994; Tough, Svenson, Johnston and Schopflocher, 2001; Orskou, Henriksen, Kesmodel and Secher, 2003). Primiparous women have been found to have 1.75 times higher risk of having a low birth weight infant (95% CI 1.60-1.91) (Tough et al., 2001), whereas multiple parity has been associated with nearly twice the risk of having a high birth weight infant (OR 1.90, 95% CI 1.75-2.06) (Orskou et al., 2003).

2.2.4 Toxic Exposures due to Maternal Lifestyle and Behaviours

Some argue that lifestyle and behavioural factors, including smoking, alcohol consumption, illicit drug use, diet and nutrition, exert the greatest influence on birth weight. Smoking, the most commonly studied of all lifestyle factors, has been found to have a deleterious effect on birth weight (Dougherty and Jones, 1982; Brooke, Anderson, Bland, Peacock and Stewart, 1989; McCormick et al., 1990; Bonellie, 2001; Tough, Svenson, Johnston and Schopflocher, 2001; Dickute et al., 2002; Orskou, Henriksen, Kesmodel and Secher, 2003; Kennare, Heard and Chan, 2005). In 1989, Brooke et al. (1989) investigated the effects of smoking on the birth weight of over 1,500 infants born in London, England. The study found that smoking was the most important single factor affecting birth weight and that smoking significantly reduced birth weights of infants. A cohort study by Bonellie (2001) of almost 180,000 singleton live births in the UK found that babies born to mothers who admitted to smoking through pregnancy were on average 284 grams lighter than babies born to mothers who had never smoked. Other studies have revealed that women who smoke during pregnancy are at two to three times higher risk for delivering a low birth weight infant compared to women who did not smoke during pregnancy (Tough, Svenson, Johnston and Schopflocher, 2001; Dickute et al., 2002).

Alcohol consumption, and to a lesser extent illicit drug use, have also been implicated as playing important roles in the causation of low birth weight (Brook et al., 1989; Visscher, Feder, Burns, Brady and Bray, 2003; Okah, Cai and Hoff, 2005; Kennare, Heard and Chan, 2005; Mariscal et al., 2006). Kennare, Heard and Chan (2005) found that substance users were more likely to be single and of lower socio-economic status, themselves risk factors for lower weight infants.

2.2.5 Prenatal Care

Prenatal care in pregnancy is an important part of ensuring healthy outcomes for both mothers and babies. Early prenatal care is important for targeting such factors as gestational caloric intake, cigarette smoking, and alcohol consumption (Kramer, 1987). Prenatal care might also be effective in reducing the adverse effects of pregnancy complications, such as toxemia and pregnancy-induced hypertension, and assist in providing monitoring for women with chronic conditions, such as diabetes (Kramer, 1987). Although little is published in the literature, there appears to be preliminary evidence that prenatal care is associated with birth weight outcomes. Maupin et al. (2004) compared the characteristics and pregnancy outcomes of women with no prenatal care and women receiving care using data found in medical records in the United States. They found that women who received no prenatal care were more likely to be multiparous, less educated, uninsured, smokers, and have a history of drug abuse. In addition, low birth weight was more common among women who received no prenatal care. Reichman and Teitler (2005) examined the effects of prenatal care and the timing of its initiation on birth weight among women in New York State. They found that mean birth weight decreased with later prenatal care initiation and initiation of prenatal care in the first trimester was associated with a 56 gram advantage in birth weight ($p = 0.01$) compared to no care.

2.2.6 Relative Importance of Established Risk Factors

Kramer (1987) states that in the developed country setting, the most important single factor affecting intrauterine growth, by far, is cigarette smoking. This is followed by poor gestational nutrition, low pre-pregnancy weight, primiparity, female sex, and short stature. He points out that the three leading factors are all potentially modifiable and therefore, a large proportion of existing fetal growth restriction may be preventable.

2.3 Trends in Birth Weight

The availability of hospital records and reliable vital statistics data permit the investigation of birth weight trends over the past several decades. Monitoring and investigating these trends allows researchers and public health officials to determine whether the trend is the result of changes in the gestational age of infants at birth, changes in intrauterine growth, or due to changes in the determinants of birth weight, such as changes in smoking rates. The answers to these questions allow health professionals and planners to modify and improve prenatal programs accordingly.

Examinations of birth weight in many countries over the past several decades have made one point clear: infants are getting bigger. Low birth weight rates have declined and mean birth weight and high birth weight rates have increased significantly. These findings have been observed in several countries, including Canada (Ng and Wilkins, 1994; Ananth and Wen, 2002; Kramer et al., 2002; Wen et al., 2003; Health Canada, 2003), Chile (Amigo, Vargas and Rona, 2005), Denmark (Orskou, Kesmodel, Henriksen and Secher, 2001), England (Bell, 2008), and Sweden (Surkan, Hsieh, Johansson, Dickman and Cnattingius, 2004).

In 1994, Statistics Canada reported birth weight rates in Canada from 1961 to 1990 using vital statistics data. The authors, Ng and Wilkins, reported that over the three decades the number of low birth weight infants dropped by 34% and the proportion of live births of low birth weight fell from 7.2% in 1961 to 5.5% in 1990. Births registered in Newfoundland and Labrador were excluded from the study due to the unavailability of birth weight data. The report stated that the low birth weight rate remained about 1.4 times higher in the lowest income neighbourhoods as compared to the highest. The proportion of babies born to unmarried mothers rose from 1 in 25 births in 1961 to almost 1 in 4 births in 1990. Due to greater social acceptance of unmarried mothers and an increase in common-law unions, the low birth weight rate among this group declined, as it declined for all demographic groups.

Studies by Wen et al. (2003) and Ananth and Wen (2002) examined birth weight trends over the last two decades using the Canadian Vital Statistics Database. Both studies also concluded that babies in Canada are getting bigger. The studies found that not only were rates of low birth weight decreasing, but rates for high birth weight were increasing, as reflected in an upward shift in mean birth weight. These changes occurred despite an increase in the proportion of infants born pre-term, suggesting that the increase in birth weight was due to increased fetal growth.

Several studies have sought to explain why babies are getting bigger (Ford and Nault, 1996; Kramer et al., 2002; Wen et al., 2003,). Wen et al. (2003) observed substantial demographic changes among pregnant women in Canada from 1981 to 1997, including an increased proportion of mothers aged 35 years or greater (4.6% to 12.7%). This finding reflects a cultural trend of women waiting longer before starting a family. A hospital-based cohort study of over 60,000 live births at a McGill University teaching hospital in Montreal from 1978 to 1996 found significant increases in mean birth weight from 3,419 grams to 3,476 grams (Kramer et al., 2002). The study observed that this shift was related to increased maternal weight for height (BMI), increased gestational weight gain, changes in socio-demographic factors, and decreased rates of smoking. Births to teenaged mothers decreased from 4.4% in 1978 to 1.0% in 1996; the percentage of births to women 35 years or greater nearly tripled from 7.8% to 20.1%; the percentage of births to legally unmarried women quadrupled from 4.5% to 17.0%; maternal education increased substantially with the percentage of women completing 16 years or more of schooling rising from 17.0% to 36.6%; the percentage of births to women who were overweight or obese increased from 11.8% to 19.6%; and significant reductions were seen in the percentage of women who smoked during pregnancy, particularly among those who smoked 11 or more cigarettes per day (12.7%-5.6%). Similar increases in maternal age 35 years and older (7.0% to 12.9%) and decreases in smoking (32.7% to 25.1%) have been observed in Nova Scotia (Fell et al., 2005).

Other notable studies seeking to identify factors associated with increased birth weight have been carried out in Sweden and Denmark. Orskou, Kesmodel, Henricksen and Secher (2001) studied 43,561 birth records of infants born at a Danish hospital between 1990 and 1999. They concluded that mean birth weight increased for all infants born during this time period and that the percentage of infants born with birth weight above 4,000 grams increased from 16.7% in 1990 to 20.0% in 1999. Orskou et al. (2003) found a statistically significant increase in the risk of giving birth to high birth weight infants for women with high prepregnancy weight, nonsmokers, and among women with higher levels of education. Surkan, Hsieh, Johansson, Dickman & Cnattingius (2004) conducted a population-based study of almost 875,000 births in Sweden from 1992 to 2001. Increases in mean birth weight were explained by increased prevalence of overweight and obese mothers (from 25% to 36%) and decreased prevalence of smoking (from 23% to 11%) during the same period. The study was unable to consider mother's education as a determining factor due to the unavailability of this information.

The United States has not experienced the same decline in rates of low birth weight as have other developed countries. In fact, studies have indicated that rates of low birth weight have increased in the US over the past few decades along with rates of preterm births (Branum and Schoendorf, 2002; Yang, Greenland, and Flanders, 2006). Increased rates of low birth weight and preterm birth have been observed mainly among Caucasian infants whereas rates among African American infants have remained relatively stable (Branum and Schoendorf, 2002).

The monitoring of birth weight trends in Newfoundland and Labrador has only been made possible over the past 15 years with the availability of data on birth weight. Although birth weight was recorded on the Live Birth Notification form since 1983, it was not recorded electronically until 1992. The series of reports titled *Live Birth Trends* has documented rates of low birth weight and high birth weight in Newfoundland and Labrador since 1994, as well as changes in maternal characteristics including age and parity (Newfoundland and Labrador Centre for Health Information, 2000; Newfoundland and Labrador Centre for Health Information, 2001; Newfoundland and Labrador Centre for Health Information, 2003; Newfoundland and Labrador Centre for Health Information, 2006). Low birth weight decreased from 6.3% in 1994 to 5.8% in 2004; and mean birth weight rose from 3,448 grams in 1994 to a high of 3,488 grams in 2002 then decreased to 3,453 grams by 2004. Mean age of mothers in the province steadily increased from 26.5 years in 1994 to 28.7 years in 2004, and the percentage of births to first time mothers rose from 46.2% in 1994 to 49.1% in 2004.

Examinations of temporal trends in birth weight over the past thirty years have concluded that the overall mean birth weights of infants are increasing in many countries world wide, with corresponding decreases in the rates of low birth weight and increases in the rates of high birth weight. Research suggests that changes to socio-demographic and lifestyle factors including higher maternal education, increased maternal age, increase in the proportion of women who are overweight or obese, and decreased smoking rates are associated with this shift.

2.4 The Influence of Birth Weight on Health

Healthy child development lays the foundation for health status later in life and is therefore included among the determinants of health. Although the physical, social and psychological environment after birth may have the largest impact on the health status of children, attributable risk of excessive morbidity associated with adverse birth weight is striking and does have implications for the overall health of the population (Overpeck, Moss, Hoffman, and Hendershot, 1989). High and low birth weight influence healthy child development and health status of individuals from adolescence to adulthood. The relationship of birth weight with a range of health conditions, particularly asthma, heart disease, various cancers, overweight, and epilepsy, has been well documented.

A review of the literature published from 1951 to 1984 found that low birth weight is associated with neurodevelopmental handicaps, such as cerebral palsy and seizure disorders, congenital anomalies, lower respiratory tract conditions, increased physician visits and illness in general (McCormick, 1985). A comparison of childhood health status of normal birth weight and low birth weight infants in the United States revealed that low birth weight children (less than 2,500 grams) generally had more chronic conditions, more hospitalizations, more days in bed because of illness, more limitations of activity, poorer health status as perceived by parents, and more school days lost because of illness, compared to children who were born within the normal birth weight range (defined in the study as 2,500 grams or more) (Overpeck et al., 1989).

A series of investigations commencing in the 1980's suggested that low birth weight is linked to deaths from coronary heart disease. The theory that events *in utero* may be linked with the development of chronic disease later in life was first postulated by Barker, Winter, Osmond, Margetts, and Simmonds (1989) in a study of the relationship of birth weight and weight in infancy and death from ischaemic heart disease. The study was conducted following an earlier investigation of death from coronary heart disease in different parts of England and Wales by Barker and Osmond (1986) who observed that differences in rates of death from heart disease in 1968 to 1978 paralleled previous differences in death rates among newborn babies in 1921 to 1925. The investigators speculated that impaired growth and development in prenatal and early postnatal life may be an important risk factor for ischaemic heart disease in adulthood. Using birth weight data recorded on birth registrations, a follow-up study (Barker et al., 1989) traced 5,654 men born during 1911 and 1930, and found that men with the lowest weights at birth had the highest death rates from ischaemic heart disease. The study led to what is now known as the *fetal origins theory* to describe the connection between intrauterine growth and incidence of coronary heart disease. Years of subsequent testing of this theory has concluded that undernutrition *in utero* permanently changes the body's structure, function and metabolism in ways that lead to coronary heart disease in later life (Barker, 2007). A systematic review of 18 studies conducted from 1993 to 2005 in the UK, Sweden, Finland, Denmark, Iceland and Holland, reported a 10 to 20 percent lower risk of ischaemic heart disease per kilogram increase in birth weight (Huxley et al., 2007).

Low birth weight has also been linked with the development of asthma. A study conducted in the United States examined the effect of birth weight on asthma among children less than four years of age (Brooks, Byrd, Weitzman, Auinger, and McBride, 2001). Using the 1988 National Maternal-Infant Health Survey and the 1991 Longitudinal Follow-up Survey to follow a sample of three-year olds, the study found a strong independent association between low birth weight and asthma with children of very low birth weight (<1,500 g) having nearly three times the risk of physician-diagnosed asthma compared with those weighing 2,500 grams or more (OR 2.9, 95% CI 2.3-3.6). Similar findings were found in a study conducted by Dik, Tate, Manfreda and Anthonisen (2004) in Manitoba using physician claim data from 1980 to 1996. The study, which followed-up 170,960 children from birth to age six years, found that asthma was more likely in those with lower birth weights. Children weighing less than 3,100 grams had an adjusted hazard ratio of 1.08 (95% CI 1.04-1.13) compared to the reference group weighing 3,500 to 3,790 grams. To a lesser extent, research has also examined the impact of high birth weight on asthma. A recent meta-analysis by Flaherman and Rutherford (2006) of nine studies conducted in Germany, Canada, New Zealand, the United Kingdom, and the United States from 1966 and 2004 examined the effect of high body weight at birth on risk of asthma. High birth weight, defined as infants weighing

3,800 grams or more, was associated with a pooled relative risk of 1.2 for future asthma (95% CI 1.1-1.3).

A relationship has also been identified between birth weight and type 2 diabetes. A meta-analysis of 14 studies conducted in Finland, Sweden, the United States, Canada, India, the United Kingdom, and Taiwan from 1966 and 2005 found that both low and high birth weight were associated with increased risks of type 2 diabetes (Harder, Rodekamp, Schellong, Dudenhausen, and Plagemann, 2007). Using normal birth weight (2,500-4,000 grams) as the reference category, pooled estimates revealed an OR of 1.47 for low birth weight (95% CI 1.26-1.72) and 1.36 for high birth weight (95% CI 1.07-1.73). The results indicated that the relation between birth weight and type 2 diabetes is U-shaped and not linearly inverse as previously suggested.

A cohort study of 1.4 million singletons born in Denmark from 1979 and 2002 explored the risk of epilepsy as a function of gestational age, birth weight, and fetal growth (Sun et al., 2008). The incidence of epilepsy increased with decreasing birth weight. Compared with children whose birth weight was 3,000 to 3,999 grams, those whose weight was <2,000 grams had an Incidence Rate Ratio of epilepsy of 5.09 (95% CI 4.34-5.96) in the first year of life and 1.73 (95% CI 1.24-2.41) between the ages of 15 and 24 years.

Over the past decade there has been an abundance of research into the association of early life factors, including birth weight, on the development of cancers. In particular, attention has focused on birth weight as a risk factor for childhood leukemia. A meta-analysis conducted by Hjalgrim et al. (2003) summarized eighteen studies published between 1962 and 2002 and included information on more than 10,000 children with leukemia. The analysis revealed that children weighing 4,000 grams or more at birth had a 26% higher risk of developing acute lymphoblastic leukemia than children weighing less (OR = 1.26, 95% CI 1.17-1.37). Results were consistent with a dose-response-like effect whereby odds ratios increased across higher birth weight strata. Studies of acute myeloid leukemia indicated a similar increase in risk for children weighing 4,000 grams or more at birth (OR = 1.27, 95% CI 0.73-2.20) as well as a dose-response-like effect of increased risk across increasing birth weight strata. More recent studies comparing risk of developing childhood leukemia between children who weighed more than 4,000 grams at birth compared to those who were born in the normal birth weight range (2,500 to 4,000 grams) also found that risk for leukemia is greater for high birth weight children compared to those born with normal birth weights (Okcu et al., 2002; Podvin, Kuehn, Mueller, and Williams, 2006). It has been suggested that the biological mechanism behind the association of high birth weight and childhood leukemia may involve insulin-like growth factor I (IGF-I), which is associated with high birth weight. IGF-I may act by increasing the absolute number of stem cells available for transformation, stimulating the growth of cells that are already transformed, or a combination of effects (Tower and Spector, 2007).

An association between high birth weight and cancer has also been identified for prostate and breast cancers. In a cohort study of men born in 1913 in Sweden and followed through to 1993, the incidence of prostate cancer was found to be about five times higher in the highest quartile of birth weight compared to the other birth weight groups (Tibblin, Eriksson, Cnattingius, and Ekbom, 1995). A review of studies on birth weight and risk of breast cancer published from 1988 to 2005 found that the relative risk for breast cancer comparing women who had high birth weight (greater than 4,000 grams) to women who were low birth weight (less than 2,500 grams) was 1.23 (95% CI 1.13-1.34) (Michels and Xue, 2006).

Traditionally, research on the effect of birth weight and health status has focused on the implications of low birth weight, although in recent years there has been increase study of high birth weight and health status. Aside from the potential for birth trauma, such as clavicle and humerus fractures and brachial and facial paralysis (Oral et al., 2001), high birth weight has also been found to put individuals at higher risk for adverse consequences that extend to later stages of life, including the development of overweight (Whitaker and Dietz, 1998; Dietz, 2004).

Overall, there is sufficient evidence that birth weight effects health status of individuals at birth, during childhood, and into adulthood. Therefore, the promotion of children born within what is considered to be a healthy birth weight range is of great public health importance.

2.5 Summary of Literature Review

Birth weight is one of the most important indicators in population health and plays a large role in healthy child development. The determinants of birth weight are multi-factorial and include demographic characteristics, medical factors, obstetric factors, and maternal lifestyle practices. Studies that have analyzed birth weight trends over the past several decades have concluded that birth weight is increasing in many parts of the developed world and that these changes are linked to shifts in maternal factors, such as increasing maternal age, higher levels of education, and decreased smoking status. Both low and high birth weights have been linked with adverse health conditions throughout the life span. Since the distribution of infant birth weight and the relative contribution of the factors influencing it vary from one population to the next, it is important to examine birth weight and its determinants in individual populations.

CHAPTER 3

METHODS

3.1 Data sources

The Live Birth System was the primary data source for the study. The database is maintained by the Newfoundland and Labrador Centre for Health Information (the Centre). Data for the system is obtained from Live Birth Notification forms completed in provincial health care facilities at the time of birth. The forms contain both clinical and demographic data for all births that occur in the province. Live Birth Notification forms are completed by health care staff and sent to the Vital Statistics Division of the Department of Government Services, Government of Newfoundland and Labrador. A copy of the form is provided to the Centre, and data from the form is entered into the Live Birth System.

At the time of this study, data from the Live Birth System were available for the years 1992 to 2005. The Centre had fourteen separate SPSS data files, one for each calendar year. Each file contained approximately four thousand live birth records with the number of variables ranging from 83 to 114. For the purposes of this analysis, it was necessary to merge the fourteen data files. To achieve this, each data file first had to be standardized. Standardizing the files involved ensuring that each year of data contained the same number of variables, and that these variables were consistent with labeling and format.

The Live Birth System required considerable effort to standardize. Since its introduction in 1986, the Live Birth Notification form has been revised several times to accommodate the need to capture new data and to eliminate fields that were no longer relevant. Some revisions were minor while others were more significant. From 1992-2001, the Live Birth Notification form remained largely unchanged. However, in 2002, the form underwent significant revision which included the elimination of two sections, and revisions to all remaining sections. Due to the addition and elimination of data fields over the fourteen year period, standardizing the data files entailed adding variables where necessary so that each file contained the same record layout. This ensured that data that was collected for some years, and not others, would not be lost. As a result, some birth files contained fields with no data. For example, for the years 2002 to 2005, the Live Birth Notification form included a section on lifestyle factors that captured, among other factors, the smoking status of mothers during pregnancy. This field was added to the birth files for the years 1992 to 2001 although no data was available thus allowing for a consistent record layout for all years of data. In addition, some data fields required recoding to reflect modifications in the form from one year to the next. For example, the section of the form that collected data on the mode of delivery changed several times from 1992 to 2005. On the 1992 and 1993 Live Birth Notification Forms options for mode of delivery were:

1) Spontaneous Vertical
2) 1st C/Section
3) 2nd or more C/Section
4) Forceps Vertical-Low
5) Breech (Vaginal)
6) Forceps Vertical-Mid

7) Vacuum Extraction
8) Vaginal Birth after C/Section

From 1994 to 2001, options for mode of delivery were:

1) Spontaneous
2) C/Section
3) Forceps
4) Vacuum

From 2002 to 2005, options for mode of delivery were:

1) Vaginal Spontaneous
2) Vaginal Assisted
3) C/Section

To standardize the mode of delivery from 1992 to 2005 a number of coding changes were made. For the 1992 and 1993 data: Spontaneous Vertical, Breech (Vaginal), and Vaginal Birth after C/Section were recoded as *Vaginal Spontaneous*; Forceps Vertical-Low, Forceps Vertical-Mid, and Vacuum Extraction were recoded as *Vaginal Assisted*; and 1st C/Section and 2nd or more C/Section were recoded as *C/Section*. Similarly, for the 1994 to 2001 data, Forceps and Vacuum were recoded as *Vaginal Assisted* while Spontaneous and C/Section were unchanged. Standardization of the Live Birth System took three months to complete. A summary of fields standardized for the Live Birth System is presented in Appendix A.

In addition to standardizing and merging the live birth data files, there were a number of major data edit tasks required. For example, data for 'total number of infants in this delivery', which captures whether the birth was a single birth or multiple birth, were not keyed in 2003, 2004 or 2005. This variable was required so that infants that were part of a multiple birth could be excluded from the study. Live Birth Notification forms were obtained from Vital Statistics for these three years and data for this variable were manually entered into the dataset.

The Live Birth System contained postal codes for mother's usual place of residence for births that occurred from 1992 to 2002. Postal codes had not been entered for 2003, 2004 or 2005. Postal codes for 2003 and 2004 were added to the Live Birth System by linking the Live Birth files for these years to Vital Statistics birth files using registration number as the key linkage variable. The Vital Statistics birth files first had to be edited since they contained many duplicate records. The duplicate records were removed from the file. In addition, approximately 500 postal codes were either missing or incomplete. The forms for these births were reviewed and if the postal code was listed on the form then it was entered. In cases where the postal code was missing on the form but the address was recorded, the Canada Post web site was used to look-up the postal codes. Furthermore, hundreds of postal codes had been entered in error whereby the number '0' was entered instead of the letter 'O' or vice versa. Syntax was written and applied to the file to convert the letters to numbers and numbers to letters where necessary. All postal codes for 2005 were entered manually into the dataset.

From 1992 to 2005, mother's education was captured in two different ways on the Live Birth Notification Form. From 1992 to 2001, the actual number of years of education completed by the mother was recorded on the form and entered as a numeric value into the data files. From 2002 to 2005, this field was changed to a categorical format so that mother's education was recorded as either: not graduated high school, graduated high school, beyond high school, or college or university degree. For analysis purposes, education data for 1992 to 2005 were grouped into three categories: has not graduated high school, graduated high school, and education beyond high school. The data for 1992 to 2001 were categorized into these three groupings after careful consideration. Mothers who were born before 1966 would have graduated high school in Newfoundland and Labrador after completing grade 11. The first graduating class of grade 12 was 1984 so mothers who were born in or after 1966 would have completed high school after completing grade 12. Distribution of the data by mother's year of birth confirmed a shift between 11 years of education to 12 years of education for mothers born on or after 1966 so 11 years of education was considered completed high school for women born before 1966 and 12 years of education was considered completed high school for women born in or after 1966. Number of years of education less than or greater than these numbers were considered less than high school and beyond high school, respectively. Re-grouping this variable was based on a number of assumptions, such as mothers went to school in Newfoundland and Labrador. It does not account for persons who may have skipped a grade, repeated a grade, or were educated outside of the province.

From 1992 to 2002, gestational age was recorded on the Live Birth Notification Form as the number of completed weeks with no indication for whether it was based on last menstrual period (LMP) or ultrasound. From 2003 to 2005, the Live Birth Notification Form provided space to record the gestational age in completed weeks based on both LMP and ultrasound. In cases where gestational age was provided for both measures, the ultrasound measurement was used since it is deemed to be a more accurate measure of fetal age.

3.1.1 Socioeconomic Status

A measure of socioeconomic status (SES) was obtained for each record that had a valid Newfoundland and Labrador postal code by linking to a dataset of socioeconomic status scores developed by Audas, Cirtwill, and O'Keefe (2007). The score is a composite value based on a number of measures related to social and economic conditions, including employment, education, and income, from the 2001 Census of Population (Appendix B). A SES score, ranging from -24.3279 to 23.74699 was available for each of the 10,784 postal codes in Newfoundland and Labrador. A higher score suggests a higher level of social affluence. The data file containing SES scores for each postal code was linked to the live birth data file using postal code as the linkage variable.

3.2 Study Population

All singletons born at term to women who were residents of Newfoundland and Labrador were included in the study. From 1992 to 2005, there were 74,863 live births in Newfoundland and Labrador. Infants were excluded if they were part of a multiple birth (N = 1,801), were born preterm (before 37 weeks completed gestation) or post term (greater than 41 weeks of completed gestation) (N = 6,567), were born to women who were not residents of Newfoundland and Labrador (N = 609), or if there were no data available for birth weight (N = 70) or gestational age (N = 250). The total number of live births included in the study was 66,638. Socioeconomic data were successfully linked to 65,145 live birth records (97.8%).

3.3 Ethics Approval

The study was approved by the Human Investigation Committee of Memorial University of Newfoundland on April 27, 2006 (Appendix C). Annual updates were provided to the Human Investigation Committee on May 15, 2007 and May 14, 2008.

3.4 Study Variables

The study had one outcome variable, birth weight group, and a series of covariates grouped as demographic factors, lifestyle issues, and clinical factors.

3.4.1 Outcome Variable

Birth weight was classified into three categories: low, normal and high. Low birth weight was defined using the standard definition of infant weight less than 2,500 grams (World Health Organization, 1993). For the purposes of this study, infants were categorized as normal birth weight if they weighed 2,500 to 4,000 grams and were categorized as high birth weight if they weighed more than 4,000 grams.

3.4.2 Demographic Factors

The following demographic factors were included in the analysis: infant sex, maternal age, maternal education, legal marital status of mother, Census Division for mother's usual place of residence, and mother's socioeconomic status. Data on each of the demographic factors were available for the years 1992 to 2005. Maternal age was computed based on mother's date of birth and infant's date of birth to determine mother's age as of her last birthday. Maternal age was grouped into three categories: less than 20 years, 20 to 34 years, and 35 years or older. Maternal education was categorized as high school incomplete, high school complete, and beyond high school. Mother's legal marital status was categorized into three groups: single; married; and separated, widowed or divorced. Census Division for mother's usual place of residence was computed from Census Subdivision. Socioeconomic status scores were grouped into 10 deciles using cut points based on the scores of the study population.

3.4.3 Lifestyle Issues

The Live Birth System captures substance use during the periconceptional period (from before conception to early pregnancy) and during pregnancy. The data are self-reported by mothers and recorded by health care staff on the Live Birth Notification form. For the purposes of this study the term 'substance use' refers to smoking, alcohol use, or illicit drug use. Data were available for the years 2002 to 2005.

3.4.4 Clinical Factors

Clinical factors included parity, initiation of prenatal care, toxaemia or hypertension, anemia, and insulin dependent diabetes mellitus (IDDM). For this study, parity was considered the number of children ever born to the mother, including the current birth. Parity was categorized as one, two, three, and four or greater. Data were available for the years 1992 to 2005. Initiation of prenatal care was categorized as none, first trimester, second trimester and third trimester. Data were available for the years 1992 to 2001. Toxaemia or hypertension data were available for the years 1992 to 2001. Data for anemia, defined in this study as hemoglobin concentration < 100 g/L, and IDDM were available for the years 1992 to 2002.

3.5 Data Analysis

All analyses were performed using SPSS 14.0 statistical software (SPSS Inc., 2005). The study population was described according to infant sex, mother's age, mother's marital status, mother's education, mother's parity, and mother's socioeconomic status. Numbers and rates of low and high birth weight were stratified by year, Census Division, and each of the demographic, lifestyle and clinical covariates. The chi-square test was used to test for associations between birth weight group and each of the covariates.

Large sample significance tests for two population proportions were used to test whether differences in mean birth weight and the proportion of low and high birth weight infants over time were large enough to be statistically significant. Birth weight rates for the period of time from 1992 to 1995 were compared with the same rates for the period of time from 2002 to 2005, thereby smoothing out any random fluctuations within one-year periods. The chi-square test was used to detect differences in maternal socio-demographic characteristics among individual socioeconomic quintiles and over two time periods, 1992 to 2005 and 2002 to 2005. Multinomial logistic regression was used to determine if birth weight outcomes were influenced by the demographic, lifestyle, and clinical covariates previously described. Multinomial logistic regression was selected for the multivariate analysis since the outcome variable had more than two categories which had no clear order. Multinomial logistic regression was preferred to binomial logistic regression since it could simultaneously predict the effect of predictor variables on low and high birth weight with respect to normal birth weight. Using normal birth weight as the reference category and dummy variables for each of the covariates, the multinomial logistic regression analysis produced odds ratios with 95% confidence intervals and corresponding P-values.

The regression analysis was conducted in five stages to account for the fact that data for some covariates were not available for all years (Table 1). The first regression included records for infants born from 1992 to 2005 and included the following covariates: infant sex, Census Division of mother's usual place of residence, maternal age, mother's legal marital status, parity, and socioeconomic status. Mother's education was then added to the regression analysis to see whether it affected the influence of socioeconomic status on birth weight. The socioeconomic scores are a composite of thirteen factors, including maternal education (Appendix A), so maternal education was added to the regression model separately. The third regression analysis included records for infants born from 1992 to 2001 and included variables from the second regression in addition to initiation of prenatal care and hypertension. The fourth regression included infants born from 1992 to 2002 and included variables from the second regression with the addition of mother's anemia, and insulin dependent diabetes mellitus. The fifth regression included records for infants born from 2002 to 2005 and included variables from regression two with the addition of whether the mothers smoked, used illicit drugs or drank alcohol during pregnancy.

Table 1: Multinomial regression model for low and high birth weight outcomes by selected individual and neighbourhood characteristics

Covariates	R1	R2	R3	R4	R5
	1992-2005	1992-2005	1992-2001	1992-2002	2002-2005
Infant sex	*	*	*	*	*
Male†					
Female					
Census Division	*	*	*	*	*
1†					
2					
3					
4					
5					
6					
7					
8					
9					
10					
Maternal age (y)	*	*	*	*	*
<20					
20-34†					
>34					
Marital status	*	*	*	*	*
Single					
Married†					
Separated/Widowed/Divorced					
Parity	*	*	*	*	*
1†					
2					
3					
4+					
Socioeconomic Status	*	*	*	*	*
Decile 1 (lowest)					
Decile 2					
Decile 3					
Decile 4					
Decile 5†					
Decile 6†					
Decile 7					
Decile 8					
Decile 9					
Decile 10 (highest)					

Table 1
(continued)

Covariates	R1 1992-2005	R2 1992-2005	R3 1992-2001	R4 1992-2002	R5 2002-2005
Maternal Education		*	*	*	*
High School Incomplete					
High School Complete†					
Beyond High School					
Initiation of Prenatal Care			*		
No Prenatal Care					
First Trimester†					
Second Trimester					
Third Trimester					
Hypertension			*		
Anemia				*	
Insulin Dependent Diabetes Mellitus				*	
Used drugs during pregnancy					*
Drank alcohol during pregnancy					*
Smoked during pregnancy					*

3.5.1 Use of Geographical Information Systems

Geographic Information Systems (GIS) analyze data with spatial components and are widely used in many disciplines. The use of GIS in public health has had increased utility in recent years as public health professionals and researchers harness the power of spatial analysis to observe patterns of health and disease. In recognition of that fact that GIS adds a powerful graphical and analytical dimension to public health, the Public Health Agency of Canada developed the Public Health Map Generator, a free web-based mapping tool allowing users to display health data on maps. The mapping tool allows users to quickly and easily display data without needing to purchase and learn to use sophisticated GIS software. This form of visual representation of health conditions allows health professionals to better understand the health of the populations they serve. The Public Health Map Generator was used in this study to illustrate the geographic distribution of adverse birth weight outcomes by Census Division, of which Newfoundland and Labrador has ten (Figure 1).

Figure 1: Census Divisions for Newfoundland and Labrador, 2001

CHAPTER 4

RESULTS

4.1 Introduction

The results are presented in three sections. The first section describes the study population and distribution of low birth weight and high birth weight by infant sex and individual and neighbourhood-level characteristics of the mothers. The second section will describe geographic and temporal trends in birth weight rates, as well as present changes in maternal characteristics over time. Low and high birth weight rates will be displayed using maps produced using the Public Health Map Generator. The last section will present findings from the multinomial logistic regression analyses which tested the influence of individual and neighbourhood level factors on birth weight outcomes in Newfoundland and Labrador from 1992 to 2005.

4.2 Description of Study Population

Table 2 describes characteristics of the study population. Just over half (51.0%) of the infants in the study were male; the majority (81.4%) were born in the normal birth weight range; and almost half (48.3%) of the births occurred to women who lived in Census Division 1. Most mothers (82.5%) were between the ages of 20 and 34 years and the majority (70.7%) were legally married.

Table 2: Characteristics of study population, Newfoundland and Labrador, 1992-2005

Characteristic	n	%
Infant Sex (N=66,638)		
Male	33,958	51.0
Female	32,680	49.0
Birth Weight Group (N=66,638)		
Low (<2500g)	1,077	1.6
Normal (2500-4000g)	54,256	81.4
High (>4000g)	11,305	17.0
Census Division (N=66,638)		
1	32,213	48.3
2	3,198	4.8
3	2,242	3.4
4	2,811	4.2
5	5,109	7.7
6	4,589	6.9
7	4,285	6.4
8	5,031	7.5
9	2,404	3.6
10	4,756	7.1
Maternal Age (N=66,638)		
<20 years	5,669	8.5
20-34 years	54,978	82.5
>34 years	5,991	9.0
Legal Marital Status of Mother (N=66,608)		
Married	47,079	70.7
Never Married	18,516	27.8
Separated/Divorced/Widowed	1,013	1.5
Mother's Education (N=64,286)		
Less than high school	12,274	19.1
Completed high school	14,455	22.5
Beyond high school	37,557	58.4
Parity of Mother (N=66,625)		
1	31,505	47.3
2	25,114	37.7
3	7,424	11.1
4+	2,582	3.9
Initiation of Prenatal Care (N=50,420)		
No Prenatal Care	507	1.0
First Trimester	45,443	90.1
Second Trimester	3,729	7.4
Third Trimester	741	1.5

Table 2
(continued)

Characteristic	n	%
Hypertension (N=50,422)		
Yes	2,678	5.3
No	47,744	94.7
Anemia (54,613)		
Yes	253	0.5
No	54,360	99.5
Insulin Dependent Diabetes Mellitus (N=54,613)		
Yes	473	0.9
No	54,140	99.1
Used drugs during pregnancy (N=15,797)		
Yes	65	0.4
No	15,732	99.6
Drank alcohol during pregnancy (N=15,789)		
Yes	150	1.0
No	15,639	99.0
Smoked during pregnancy (N=15,790)		
Yes	2,524	16.0
No	13,266	84.0

About one in five (19.1%) mothers had not completed high school while more than half (58.4%) had been educated beyond high school. Almost half (47.3%) of mothers were having their first baby, 37.7% were having their second child, 11.1% were having their third, and 3.9% of mothers were having their fourth or more child. Most mothers (90.1%) had initiated prenatal care in the first trimester of pregnancy, and most appeared to have had healthy pregnancies with small margins of women having hypertension (5.3%), anemia (0.5%), or insulin dependent diabetes mellitus (0.9%). Substance use was also low with 0.4 % of mothers using drugs, 1.0% consuming alcohol, and 16.0% smoking during pregnancy.

The total number of live births in the study population decreased from 6,114 in 1992 to 3,996 in 2005. The highest number of live births occurred in 1992 while the lowest number occurred in 2004 with 3,955 births (Figure 2).

Table 3 shows the percentage of low and high birth weight infants according to sex and selected maternal characteristics. The percentage of low birth weight infants was slightly higher among females compared to males (1.9% vs. 1.4%); infants born to mothers that resided in Census Division 2 (2.2% vs. 1.3-1.8% among other Census Divisions); infants born to mothers less than 20 or more than 34 years of age compared to mothers aged 20 to 34 years (2.0% vs. 1.5%); and mothers who were separated, widowed or divorced as opposed to married (2.8% vs. 1.5%).

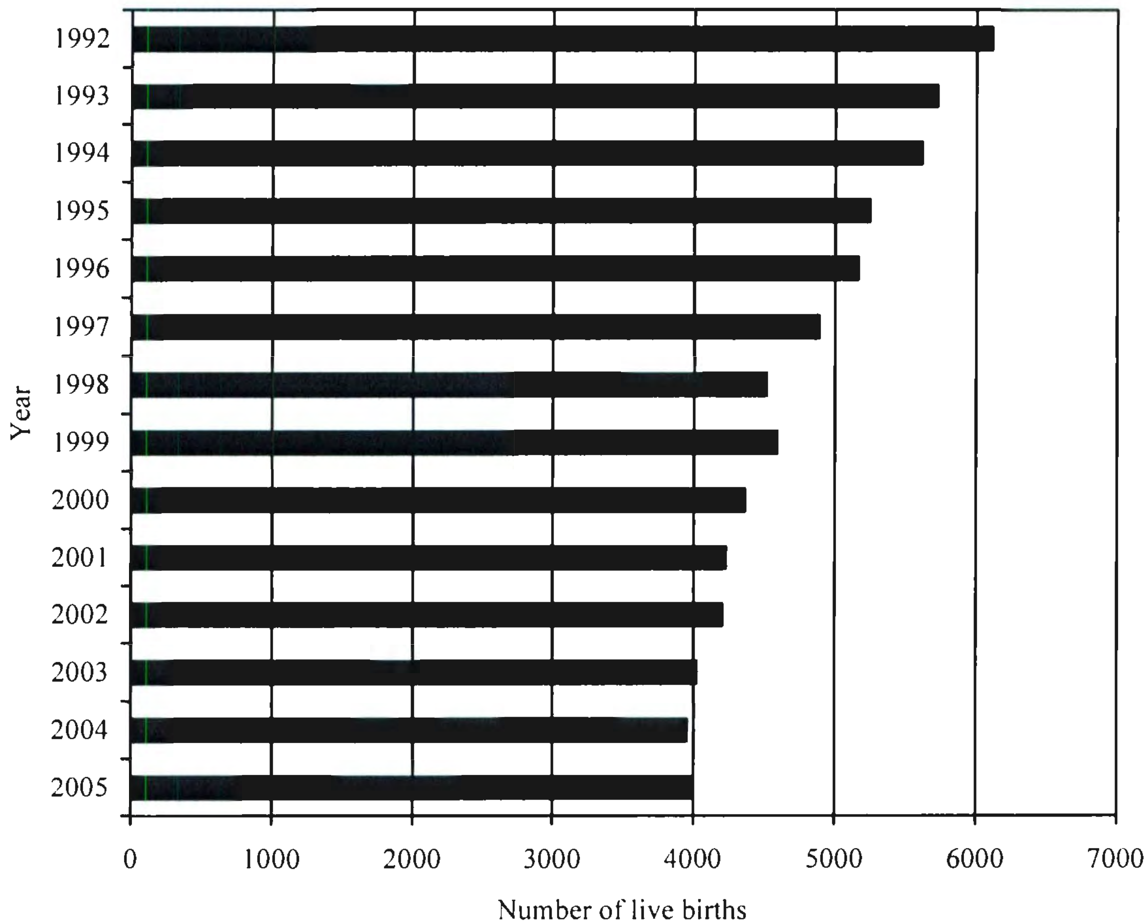


Figure 2: Number of live births by year, Newfoundland and Labrador, 1992-2005

Table 3: Percentage of low and high birth weight infants by infant sex and maternal characteristics, Newfoundland and Labrador, 1992-2005

Characteristic	Low Birth Weight n (%)	High Birth Weight n (%)	χ^2	df	P-value
Infant Sex					
Male (N=33,958)	468 (1.4)	7,064 (20.8)	735.5	2	< 0.01
Female (N=32,680)	609 (1.9)	4,241 (13.0)			
Census Division					
1 (N=32,213)	524 (1.6)	5,550 (17.2)			
2 (N=3,198)	55 (1.7)	514 (16.1)			
3 (N=2,242)	39 (1.7)	367 (16.4)			
4 (N=2,811)	62 (2.2)	383 (13.6)			
5 (N=5,109)	68 (1.3)	942 (18.4)	75.7	18	< 0.01
6 (N=4,589)	65 (1.4)	726 (15.8)			
7 (N=4,285)	78 (1.8)	726 (16.9)			
8 (N=5,031)	72 (1.4)	763 (15.2)			
9 (N=2,404)	40 (1.7)	445 (18.5)			
10 (N=4,756)	74 (1.6)	889 (18.7)			
Maternal Age					
<20 years (N=5,669)	112 (2.0)	722 (12.7)	90.6	4	< 0.01
20-34 years (N=54,978)	844 (1.5)	9,521 (17.3)			
>34 years (N=5,991)	121 (2.0)	1,062 (17.7)			
Mother's Marital Status					
Married (N=47,079)	683 (1.5)	8,561 (18.2)			
Never Married (N=18,516)	365 (2.0)	2,589 (14.0)	194.4	4	< 0.01
Separated/Widowed/Divorced (N=1,013)	28 (2.8)	149 (14.7)			
Mother's Education					
< High school (N=12,574)	312 (2.5)	1,678 (13.7)	233.8	4	< 0.01
High school (N=14,455)	241 (1.7)	2,334 (16.1)			
> High school (N=37,557)	488 (1.3)	6,913 (18.4)			
Socioeconomic Status					
Decile 1 (lowest) (N=6,467)	141 (2.2)	946 (14.6)			
Decile 2 (N=6,555)	112 (1.7)	1,005 (15.3)			
Decile 3 (N=6,446)	91 (1.4)	1,143 (17.7)			
Decile 4 (N=6,668)	116 (1.7)	1,185 (17.8)			
Decile 5 (N=6,254)	110 (1.8)	1,068 (17.1)	82.6	18	< 0.01
Decile 6 (N=6,990)	116 (1.7)	1,243 (17.8)			
Decile 7 (N=6,313)	83 (1.3)	1,053 (16.7)			
Decile 8 (N=6,637)	119 (1.8)	1,131 (17.0)			
Decile 9 (N=6,316)	83 (1.3)	1,088 (17.2)			
Decile 10 (highest) (N=6,499)	85 (1.3)	1,194 (18.4)			

Table 3
(continued)

Characteristic	Low Birth Weight n (%)	High Birth Weight n (%)	χ^2	df	P-value
Parity of Mother					
1 (N=31,505)	627 (2.0)	4,468 (14.2)			
2 (N=25,114)	309 (1.2)	4,869 (19.4)	379.0	6	< 0.01
3 (N=7,424)	88 (1.2)	1,439 (19.4)			
4+ (N=2,582)	53 (2.1)	525 (20.3)			
Initiation of Prenatal Care					
No Prenatal Care (N=507)	11 (2.2)	71 (14.0)			
First Trimester (N=45,443)	774 (1.7)	7,748 (17.0)	28.1	6	< 0.01
Second Trimester (N=3,729)	62 (1.7)	553 (14.8)			
Third Trimester (N=741)	14 (1.9)	89 (12.0)			
Hypertension					
Yes (N=2,678)	135 (5.0)	450 (16.8)	188.8	2	< 0.01
No (N=47,744)	724 (1.5)	8,015 (16.8)			
Anemia					
Yes (N=253)	5 (2.0)	69 (27.3)	19.8	2	< 0.01
No (N=54,360)	902 (1.7)	9,172 (16.9)			
Insulin Dependent Diabetes Mellitus			74.3	2	< 0.01
Yes (N=473)	6 (1.3)	150 (31.7)			
No (N=54,140)	901 (1.7)	9,091 (16.8)			
Drank alcohol during pregnancy					
Yes (N=150)	6 (4.0)	20 (13.3)	10.0	2	< 0.01
No (N=15,639)	201 (1.3)	2,763 (17.7)			
Smoked during pregnancy					
Yes (N=2,524)	71 (2.8)	245 (9.7)	173.8	2	< 0.01
No (N=13,266)	136 (1.0)	2,538 (19.1)			

Figures for reference category (normal birth weight) not shown.

Low birth weight was higher among mothers in the lowest socioeconomic status decile compared to the highest (2.2% vs. 1.3%); mothers who had no prenatal care (2.2%) or initiated prenatal care in the third trimester (1.9%) compared to mothers who initiated prenatal care in their first trimester (1.7%); mothers who had hypertension during pregnancy compared to those who did not (5.0% vs. 1.5%); and mothers with anemia compared to those without (2.0% vs. 1.7%); and those that drank alcohol (4.0% vs. 1.3%) or smoked (2.8% vs. 1.0%) during pregnancy compared to those that did not.

High birth weight was more common among male infants (20.8% vs. 13.0%); mothers who lived in Census Divisions 5 (18.4%), 9 (18.5%) and 10 (18.7%) compared to the other Census Divisions (13.6%-17.2%); mothers greater than 34 years (17.7%) compared to those less than 20 years of age (12.7%); mothers who were married (18.2) compared to those who were never married (14.0%); mothers with post-secondary education (18.4%) compared to those who had not completed high school (13.7%); mothers in the highest socioeconomic status decile (18.4%) compared to the lowest (14.6%). High birth weight was also higher among mothers with a parity of 4 or greater (20.3%) compared to women having their first baby (14.2%); mothers that initiated prenatal care in their first trimester (17.0%) compared to those that initiated prenatal care in their third trimester (12.0%); mothers that were anemic (27.3% vs. 16.9%), had insulin dependent diabetes mellitus (31.7% vs. 16.8%); and among mothers that refrained from drugs (17.7% vs. 9.2%), alcohol (17.7% vs. 13.3%) and cigarettes during pregnancy (19.1% vs. 9.7%). Chi-square tests revealed significant associations ($P < 0.01$) between birth weight and each of the infant and maternal characteristics. Drug use during pregnancy could not be included in the bivariate analysis since the minimum expected cell count was less than five and was too small (0.85) to satisfy the conditions required for the chi-square test. The distribution of maternal characteristics across socioeconomic status quintiles showed that higher socioeconomic status was associated with increasing maternal age ($P < 0.01$), higher maternal education ($P < 0.01$), and with being married ($P < 0.01$) (Table 4).

4.3 Temporal and Geographic Birth Weight Trends

Overall, rates of low birth weight per 100 live births ranged from 1.7% in 1992 to 1.5% in 2005 with a high of 2.3% in 1994 and a low of 1.1% in 2002 (Figure 3). The rate of low birth weight significantly decreased from 1992 to 1995 compared to the period 2002 to 2005 (1.9% to 1.3%: $P < 0.01$). Rates of high birth weight per 100 live births ranged from 16.1% in 1992 to 17.1% in 2005 with a high of 18.9% in 2000 and a low of 15.5% in 1995 (Figure 3). The rate of high birth weight significantly increased from 1992 to 1995 compared to the period 2002 to 2005 (16.2% to 17.5%: $P < 0.01$).

Overall, mean birth weight increased from 3,529 grams for the period 1992 to 1995 to 3,566 grams for the period 2002 to 2005 ($P < 0.01$). Mean birth weight was 96 grams higher for multiparous women compared to primiparous women (3,593 grams and 3,497 grams, respectively: $P < 0.01$). Differences in mean birth weight by time period of birth and parity of mother are presented in Table 5.

Table 4: Maternal characteristics by socioeconomic status quintiles, Newfoundland and Labrador, 1992-2005

Characteristic	Q1 (lowest SES) N=13,022	Q2 N=13,114	Q3 N=13,244	Q4 N=12,950	Q5 (highest SES) N=12,815
Maternal Age					
<20 years	13.0	11.3	8.7	6.1	3.4
20-34 years	80.4	82.3	83.3	83.8	82.8
>34 years	6.6	6.5	8.0	10.1	13.8
Mother's Education					
Less than high school	30.7	26.9	19.5	11.7	5.9
Completed high school	31.2	26.8	22.6	19.2	12.2
Beyond high school	38.1	46.4	57.9	69.1	81.9
Legal Marital Status of Mother					
Never Married	37.6	32.3	30.1	22.4	16.0
Married	60.8	65.9	68.2	75.9	82.9
Separated/Divorced/ Widowed	1.6	1.8	1.6	1.5	1.1
Parity of Mother					
Primiparous	45.2	45.6	47.6	49.4	48.7
Multiparous	54.8	54.4	52.4	50.6	51.3

Q = quintile.

χ^2 tests for differences in maternal characteristics among the five socioeconomic status quintiles were all significant at $P < 0.01$ with the exception of education and parity for quintile 3.

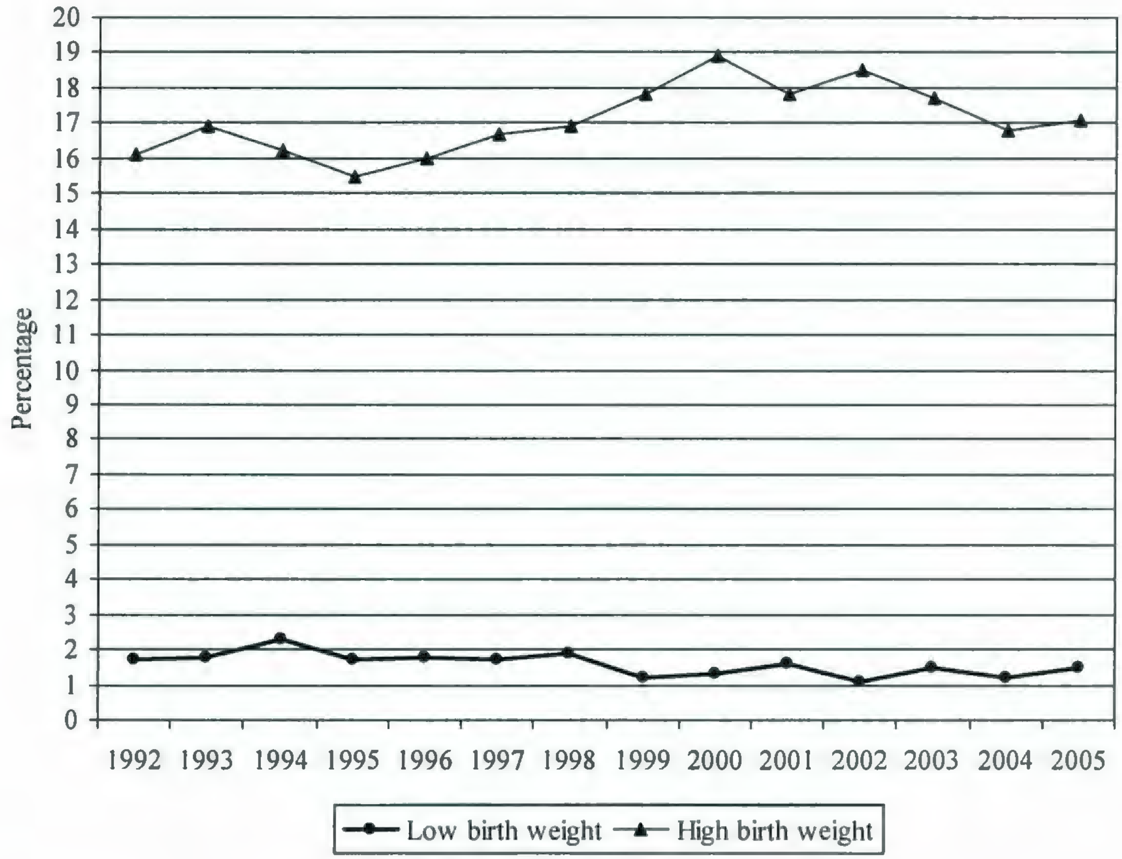


Figure 3: Percentage of low birth weight and high birth weight infants by year, Newfoundland and Labrador, 1992-2005

Table 5: Differences in mean birth weight by time period of birth and parity of mother, Newfoundland and Labrador, 1992-2005

	Mean Birth Weight	Standard Deviation	t	P-value
Period of Birth				
1992-1995	3,529	503	-7.269	< 0.01
2002-2005	3,566	488		
Parity				
Primiparous	3,497	489	-25.000	< 0.01
Multiparous	3,593	500		

t-tests were used to test for statistically significant differences in mean birth weight between groups

Geographically, the lowest rate of low birth weight was found in Census Division 5 (1.3%), while the highest rate of low birth weight was found in Census Division 4 (2.2%) (Figure 4). Figure 5 illustrates the distribution of low birth weight by Census Division using the Public Health Map Generator. There were no significant differences over time in any of the Census Divisions when rates of low birth weight from 1992 to 2005 were compared to the rates from 2002 to 2005.

Census Division 4 had the lowest percentage of high birth weight infants at 13.6%, while Census Division 10 had the highest rate at 18.7% (Figure 4). Figure 6 maps the distribution of high birth weight by Census Division. The map shows that the rate of high birth rate was also high in Census Divisions 5 and 9. The rate of high birth weight significantly increased in two of the province's ten Census Divisions from 1992 to 1995 compared to 2002 to 2005; from 16.0% to 17.2% in Census Division 1 ($P < 0.05$), and from 13.7% to 18.0% in Census Division 6 ($P < 0.01$).

Using large sample tests for two population proportions, changes in maternal characteristics were compared for the two periods: 1992 to 1995 and 2002 to 2005. Tests revealed that, compared to women who had babies from 1992 to 1995, women who gave birth from 2002 to 2005 were more likely to be older, having their first baby, have higher levels of education, and never been married.

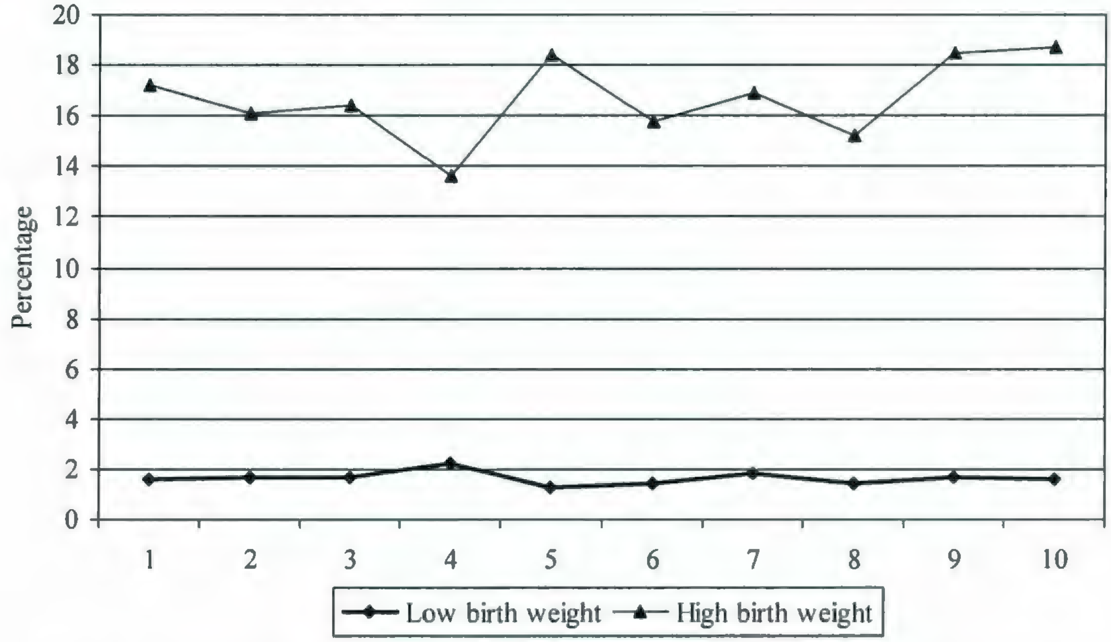
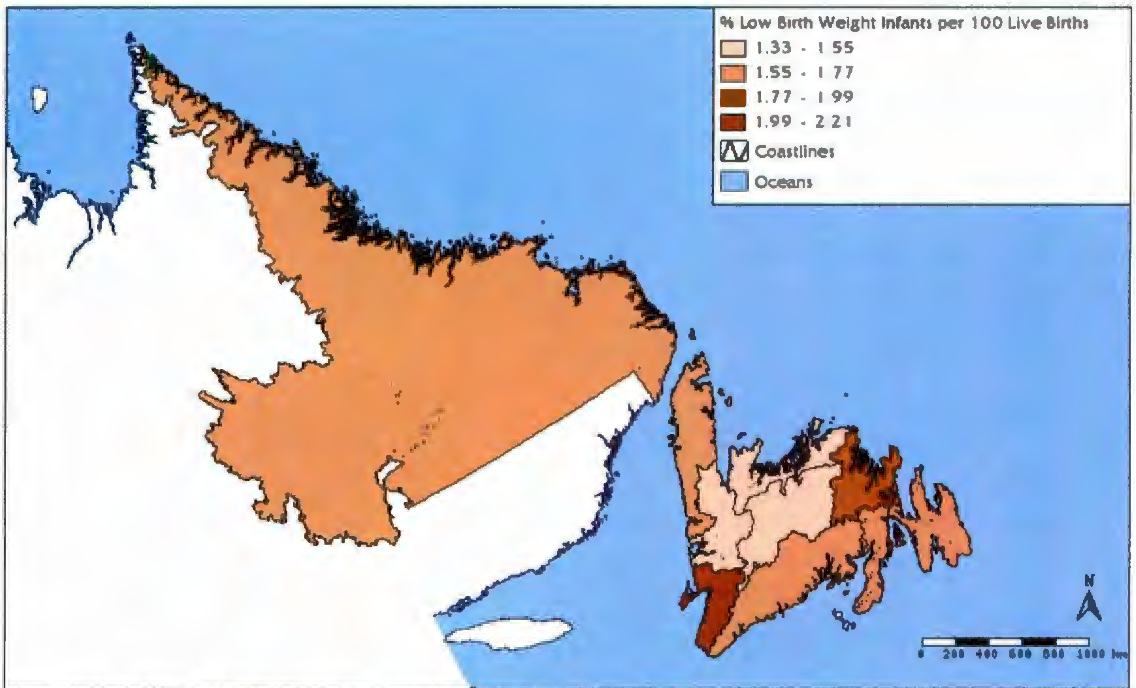
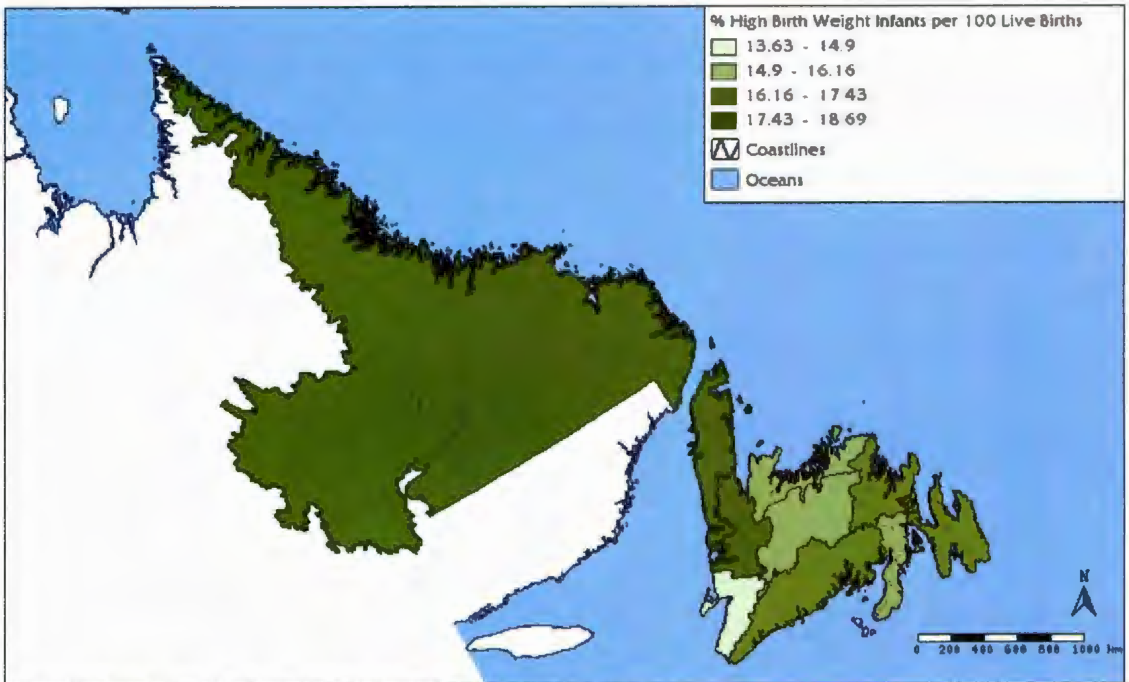


Figure 4: Percentage of low birth weight and high birth weight infants by Census Division, Newfoundland and Labrador, 1992-2005



Source: Live Birth System, Newfoundland and Labrador Centre for Health Information

Figure 5: Percentage of live births of low birth weight, by 2001 Census Divisions, Newfoundland and Labrador, 1992-2005



Source: Live Birth System, Newfoundland and Labrador Centre for Health Information

Figure 6: Percentage of live births of high birth weight, by 2001 Census Divisions, Newfoundland and Labrador, 1992-2005

The percentage of mothers greater than 34 years of age more than doubled from 6.2% to 12.6% ($P < 0.01$); the percentage of mothers who were never married significantly increased from 25.0% to 40.8% ($P < 0.01$); the percentage of mothers who had not completed high school dropped from 25.3% to 13.6% ($P < 0.01$); and the percentage of mothers who had enrolled in educational training beyond high school significantly increased from 48.8% to 69.0% ($P < 0.01$). The proportion of first-time mothers significantly increased from 45.8% to 48.2% ($P < 0.01$).

4.4 Predictors of Abnormal Birth Weight

Results of the multinomial regression analysis are presented in four tables. The first two tables show the influence of those variables for which data were available for the entire study period, 1992 to 2005: infant sex, Census Division for mother's place of residence, mother's age, mother's marital status, parity and socioeconomic status on low and high birth weight outcomes. The second set of tables illustrate the changes in the odds ratios of giving birth to low or high birth weight infants as additional variables were added to the regression analysis.

4.4.1 Demographic Factors

Compared to women who delivered a normal birth weight infant, women in Newfoundland and Labrador were significantly more likely to have a low birth weight infant if they had a female infant (OR 1.25, 95% CI 1.10-1.41); were 35 years of age or older (OR 1.45, 95% CI 1.18-1.77); were single (OR 1.19, 95% CI 1.03-1.37); were separated, widowed or divorced (OR 1.83, 95% CI 1.24-2.71); or were in the lowest socioeconomic status decile (OR 1.28, 95% CI 1.02-1.60) (Table 6). Women were less likely to have a low birth weight infant if they lived in Census Division 8 (OR 0.76, 95% CI 0.58-0.99); or were in the seventh SES decile (OR 0.77, 95% CI 0.59-0.99), ninth SES decile (OR 0.75, 95% CI 0.58-0.98), or highest SES decile of socioeconomic status (OR 0.75, 95% CI 0.57-0.97).

Giving birth to a high birth weight infant was significantly associated with living in Census Division 5 (OR 1.09, 95% CI 1.01-1.18), 9 (OR 1.15, 95% CI 1.03-1.29), or 10 (OR 1.13, 95% CI 1.04-1.23) (Table 7). Women were less likely to have a high birth weight infant if they had a female infant (OR 0.57, 95% CI 0.55-0.59); lived in Census Division 4 (OR 0.81, 95% CI 0.72-0.91), 6 (OR 0.91, 95% CI 0.83-0.99), or 8 (OR 0.88, 95% CI 0.81-0.97); were less than 20 years of age (OR 0.91, 95% CI 0.83-0.99); were single (0.82, 95% CI 0.78-0.86), separated, widowed or divorced (OR 0.72, 95% CI 0.60-0.86); or fell in the lowest SES decile (OR 0.85, 95% CI 0.78-0.92), second SES decile (OR 0.89, 95% CI 0.81-0.96), or seventh SES decile (OR 0.91, 95% CI 0.83-0.99).

Column $OR_{(2)}$ in Table 8 presents results of the regression analysis when maternal education is added to the analysis. Compared to women who completed high school, women who did not complete high school were more likely to have a low birth weight infant (OR 1.63, $P < 0.01$) while women who had education beyond high school were more likely to have a high birth weight infant (OR 1.16, $P < 0.01$).

Table 6: Rates and odds ratios of giving birth to a low birth weight infant, Newfoundland and Labrador, 1992-2005

Characteristic	N	n	%	OR	95% CI	P-value
Infant sex						
Male†	33,958	468	1.4	Ref.		
Female	32,680	609	1.9	1.25	1.10, 1.41	< 0.001
Census Division						
1†	32,213	524	1.6	Ref.		
2	3,198	55	1.7	0.93	0.69, 1.25	0.637
3	2,242	39	1.7	0.90	0.64, 1.28	0.568
4	2,811	62	2.2	1.10	0.81, 1.43	0.618
5	5,109	68	1.3	0.82	0.63, 1.07	0.139
6	4,589	65	1.4	0.82	0.62, 1.06	0.132
7	4,285	78	1.8	0.98	0.76, 1.27	0.893
8	5,031	72	1.4	0.76	0.58, 0.99	0.044
9	2,404	40	1.7	0.86	0.61, 1.22	0.399
10	4,756	74	1.6	0.91	0.71, 1.18	0.494
Maternal age (y)						
<20	5,669	112	2.0	0.92	0.74, 1.15	0.461
20-34†	54,978	844	1.5	Ref.		
>34	5,991	121	2.0	1.45	1.18, 1.77	< 0.001
Marital status						
Single	18,516	365	2.0	1.19	1.03, 1.37	0.021
Married†	47,079	683	1.5	Ref.		
Separated/Widowed/Divorced	1,013	28	2.8	1.83	1.24, 2.71	0.002
Parity						
1†	31,505	627	2.0	Ref.		
2	25,114	309	1.2	0.66	0.57, 0.76	< 0.001
3	7,424	88	1.2	0.60	0.47, 0.76	< 0.001
4+	2,582	53	2.1	0.98	0.72, 1.32	0.868
Socioeconomic Status						
Decile 1 (lowest)	66,638	6,467	9.9	1.28	1.02, 1.60	0.035
Decile 2	66,638	6,555	10.1	1.01	0.80, 1.28	0.916
Decile 3	66,638	6,446	9.9	0.88	0.68, 1.13	0.302
Decile 4	66,638	6,668	10.2	1.01	0.83, 0.31	0.739
Decile 5†	66,638	6,254	9.6	Ref.		
Decile 6†	66,638	6,990	10.7	Ref.		
Decile 7	66,638	6,313	9.7	0.77	0.59, 0.99	0.044
Decile 8	66,638	6,637	10.2	1.01	0.79, 1.27	0.961
Decile 9	66,638	6,316	9.7	0.75	0.58, 0.98	0.032
Decile 10 (highest)	66,638	6,499	10.0	0.75	0.57, 0.97	0.028

† Reference group

Odds ratios and 95% confidence intervals calculated using multinomial logistic regression

Table 7: Rates and odds ratios of giving birth to a high birth weight infant, Newfoundland and Labrador, 1992-2005

Characteristic	N	n	%	OR	95% CI	P-value
Infant sex						
Male†	33,958	7,064	20.8	Ref.		
Female	32,680	4,241	13.0	0.57	0.55, 0.59	< 0.001
Census Division						
1†	32,213	5,550	17.2	Ref.		
2	3,198	514	16.1	0.92	0.83, 1.02	0.129
3	2,242	367	16.4	1.00	0.88, 1.13	0.990
4	2,811	383	13.6	0.81	0.72, 0.91	0.001
5	5,109	942	18.4	1.09	1.01, 1.18	0.033
6	4,589	726	15.8	0.91	0.83, 0.99	0.024
7	4,285	726	16.9	1.00	0.92, 1.10	0.926
8	5,031	763	15.2	0.88	0.81, 0.97	0.007
9	2,404	445	18.5	1.15	1.03, 1.29	0.017
10	4,756	889	18.7	1.13	1.04, 1.23	0.003
Maternal age (y)						
<20	5,669	722	12.7	0.91	0.83, 0.99	0.045
20-34†	54,978	9,521	17.3	Ref.		
>34	5,991	1,062	17.7	0.95	0.88, 1.02	0.132
Marital status						
Single	18,516	2,589	14.0	0.82	0.78, 0.86	< 0.001
Married†	47,079	8,561	18.2	Ref.		
Separated/Widowed/Divorced	1,013	149	14.7	0.72	0.60, 0.86	< 0.001
Parity						
1†	31,505	4,468	14.2	Ref.		
2	25,114	4,869	19.4	1.39	1.33, 1.46	< 0.001
3	7,424	1,439	19.4	1.39	1.30, 1.49	< 0.001
4+	2,582	525	20.3	1.50	1.34, 1.66	< 0.001
Socioeconomic Status						
Decile 1 (lowest)	66,638	6,467	9.9	0.85	0.78, 0.92	< 0.001
Decile 2	66,638	6,555	10.1	0.89	0.81, 0.96	0.005
Decile 3	66,638	6,446	9.9	1.02	0.94, 1.10	0.705
Decile 4	66,638	6,668	10.2	1.01	0.94, 1.10	0.737
Decile 5†	66,638	6,254	9.6	Ref.		
Decile 6†	66,638	6,990	10.7	Ref.		
Decile 7	66,638	6,313	9.7	0.91	0.83, 0.99	0.022
Decile 8	66,638	6,637	10.2	0.94	0.87, 1.02	0.152
Decile 9	66,638	6,316	9.7	0.95	0.87, 1.03	0.225
Decile 10 (highest)	66,638	6,499	10.0	1.02	0.94, 1.11	0.612

† Reference group

Odds ratios and 95% confidence intervals calculated using multinomial logistic regression

Table 8: Odds ratios of giving birth to a low birth weight infant by infant sex and maternal characteristics, Newfoundland and Labrador, 1992-2005

Characteristic	$OR_{(1)}$	$OR_{(2)}$	$OR_{(3)}$	$OR_{(4)}$	$OR_{(5)}$
	'92 – '05	'92 – '05	'92 – '01	'92 – '02	'02 – '05
Infant sex					
Male†	Ref.	Ref.	Ref.	Ref.	Ref.
Female	1.25**	1.24**	1.23**	1.21**	1.38*
Census Division					
1†	Ref.	Ref.	Ref.	Ref.	Ref.
2	0.93	0.89	0.94	0.98	0.50
3	0.90	0.84	0.93	0.91	0.36
4	1.10	1.04	1.10	1.13	0.75
5	0.82	0.78	0.72*	0.78	0.98
6	0.82	0.75*	0.80	0.82	0.58
7	0.98	0.95	0.87	0.95	1.06
8	0.76*	0.70**	0.69*	0.71*	0.56
9	0.86	0.82	0.84	0.85	0.70
10	0.91	0.80	0.84	0.81	0.58
Maternal age (y)					
<20	0.92	0.70**	0.71**	0.67**	0.70
20-34†	Ref.	Ref.	Ref.	Ref.	Ref.
>34	1.45**	1.57**	1.69**	1.71**	1.34
Marital status					
Single	1.19*	1.04	1.06	1.03	1.29
Married†	Ref.	Ref.	Ref.	Ref.	Ref.
Separated/Widowed/Divorced	1.83*	1.70*	1.75*	1.52	1.51
Parity					
1†	Ref.	Ref.	Ref.	Ref.	Ref.
2	0.66**	0.63**	0.67**	0.63**	0.65*
3	0.60**	0.48**	0.50**	0.44**	0.65
4+	0.98	0.74	0.82	0.73	0.74
Socioeconomic Status					
Decile 1 (lowest)	1.28*	1.18	1.10	1.13	1.76
Decile 2	1.01	0.95	0.90	0.91	1.28
Decile 3	0.88	0.85	0.84	0.85	1.03
Decile 4	1.01	0.99	0.97	0.96	1.07
Decile 5†	Ref.	Ref.	Ref.	Ref.	Ref.
Decile 6†	Ref.	Ref.	Ref.	Ref.	Ref.
Decile 7	0.77*	0.81	0.82	0.84	0.81
Decile 8	1.01	1.06	1.02	1.05	1.43
Decile 9	0.75*	0.78	0.77	0.79	0.92
Decile 10 (highest	0.75*	0.81	0.81	0.79	1.12

Table 8
(continued)

Characteristic	OR (1)	OR (2)	OR (3)	OR (4)	OR (5)
	’92 – ’05	’92 – ’05	’92 – ’01	’92 – ’02	’02 – ’05
Maternal Education					
High School Incomplete		1.63**	1.65**	1.71**	1.13
High School Complete†		Ref.	Ref.	Ref.	Ref.
Beyond High School		0.75**	0.75**	0.75**	0.89
Initiation of Prenatal Care					
No Prenatal Care			1.19		
First Trimester†			Ref.		
Second Trimester			0.77		
Third Trimester			0.87		
Hypertension			3.31**		
Anemia				1.31	
Insulin Dependent Diabetes Mellitus				0.88	
Used drugs during pregnancy					1.18
Drank alcohol during pregnancy					2.38
Smoked during pregnancy					2.05**

† Reference group
**P≤0.01, *P≤0.05
Odds ratios and 95% confidence intervals calculated using multinomial logistic regression

Adding maternal education to the regression analysis eliminated the effect of socioeconomic status and single marital status on the odds or having a low birth weight infant. However, the odds of having a low birth weight infant became significant for women less than 20 years of age (OR 0.70, $P < 0.01$) and women living in Census Division 6 (OR 0.75, $P < 0.05$). The addition of maternal education eliminated the effect of maternal age less than 20 years on the odds of having a high birth weight infant (Table 9). Infant sex remained statistically significant throughout all cycles of the regression analysis.

4.4.2 Maternal Morbidity during Pregnancy

Compared to women who delivered an infant weighing 2,500 to 4,000 grams, women were more likely to have a low birth weight infant if they had hypertension (OR 3.31, $P < 0.01$) (Table 8). Women were more likely to have a high birth weight infant if they were anemic (OR 1.83, $P < 0.01$) or had insulin dependent diabetes mellitus (OR 2.40, $P < 0.01$) (Table 9).

4.4.3 Obstetric Factors

Women were less likely to have a low birth weight infant if they were having their second child (OR 0.66, 95% CI 0.57-0.76) or third child (OR 0.60, 95% CI 0.47-0.76) (Table 8). Likewise, compared to woman who were having their first child, women who were having their second or more child were also more likely to have a high birth weight

Table 9: Odds ratios of giving birth to a high birth weight infant by infant sex and maternal characteristics, Newfoundland and Labrador, 1992-2005

Characteristic	OR (1)	OR (2)	OR (3)	OR (4)	OR (5)
	'92 – '05	'92 – '05	'92 – '01	'92 – '02	'02 – '05
Infant sex					
Male†	Ref.	Ref.	Ref.	Ref.	Ref.
Female	0.57**	0.57**	0.57**	0.57**	0.56**
Census Division					
1†	Ref.	Ref.	Ref.	Ref.	Ref.
2	0.92	0.94	0.97	0.95	0.84
3	1.00	1.04	0.97	1.03	1.31*
4	0.81**	0.83**	0.81**	0.82**	0.90
5	1.09*	1.10*	1.10*	1.10*	1.12
6	0.91*	0.92	0.87*	0.89*	1.03
7	1.00	1.01	1.02	1.01	0.94
8	0.88**	0.91*	0.89*	0.90*	0.90
9	1.15*	1.16*	1.19*	1.16*	1.17
10	1.13**	1.18**	1.21**	1.19**	1.13
Maternal age (y)					
<20	0.91*	1.05	1.03	1.03	1.20
20-34†	Ref.	Ref.	Ref.	Ref.	Ref.
>34	0.95	0.91*	0.95	0.92	0.80**
Marital status					
Single	0.82**	0.87**	0.87**	0.87**	0.92
Married†	Ref.	Ref.	Ref.	Ref.	Ref.
Separated/Widowed/Divorced	0.72**	0.75**	0.71**	0.74**	0.88
Parity					
1†	Ref.	Ref.	Ref.	Ref.	Ref.
2	1.39**	1.43**	1.43**	1.44**	1.49**
3	1.39**	1.49**	1.48**	1.46**	1.71**
4+	1.50**	1.67**	1.73**	1.67**	1.76**
Socioeconomic Status					
Decile 1 (lowest)	0.85**	0.89*	0.89*	0.90*	0.92
Decile 2	0.89**	0.91*	0.97	0.94	0.77**
Decile 3	1.02	1.04	1.07	1.07	0.93
Decile 4	1.01	1.03	1.05	1.06	1.00
Decile 5†	Ref.	Ref.	Ref.	Ref.	Ref.
Decile 6†	Ref.	Ref.	Ref.	Ref.	Ref.
Decile 7	0.91*	0.89**	0.90*	0.91	0.88
Decile 8	0.94	0.92	0.95	0.95	0.83*
Decile 9	0.95	0.91*	0.93	0.93	0.85
Decile 10 (highest)	1.02	0.99	1.01	1.01	0.91

Table 9
(continued)

Characteristic	OR (1)	OR (2)	OR (3)	OR (4)	OR (5)
	'92 – '05	'92 – '05	'92 – '01	'92 – '02	'02 – '05
Maternal Education					
High School Incomplete		0.81**	0.81**	0.80**	0.96
High School Complete		Ref.	Ref.	Ref.	Ref.
Beyond High School		1.16**	1.15**	1.15**	1.11
Initiation of Prenatal Care					
No Prenatal Care			0.79		
First Trimester†			Ref.		
Second Trimester			0.88*		
Third Trimester			0.72*		
Hypertension			1.11		
Anemia				1.83**	
Insulin Dependent Diabetes Mellitus				2.40**	
Used drugs during pregnancy					0.56
Drank alcohol during pregnancy					1.11
Smoked during pregnancy					0.47**

† Reference group

**P≤0.01, *P≤0.05

Odds ratios and 95% confidence intervals calculated using multinomial logistic regression

infant (OR 1.39, 95% CI 1.33-1.46 for parity of two; OR 1.39, 95% CI 1.30-1.49 for parity of three, and OR 1.50, 95% CI 1.34-1.66 for parity of four or greater) (Table 9). Parity remained statistically significant throughout all cycles of the regression analysis.

4.4.4 Prenatal Care

Compared to women who initiated prenatal care in the first trimester of their pregnancy, women who initiated care in the second or third trimesters were less likely to have a high birth weight infant (OR 0.88 and 0.72, respectively, $P < 0.01$). There was no effect of initiation of prenatal care on risk of delivering a low birth weight infant.

4.4.5 Toxic Exposures due to Maternal Lifestyle and Behaviours

Compared to women who had a normal birth weight infant, women who smoked during pregnancy were more likely to have a low birth weight infant (OR 2.05, $P < 0.01$) (Table 8) and less likely to have a high birth weight infant (OR 0.47, $P < 0.01$) (Table 9). Drug use and alcohol consumption during pregnancy were not significantly associated with birth weight outcomes.

CHAPTER 5

DISCUSSION

5.1 Introduction

The aim of this study was to describe the birth weight distribution of infants born in Newfoundland and Labrador from 1992 to 2005 and identify factors associated with adverse birth weight outcomes. The use of vital statistics data provided a practical data source, but changes to the Live Birth Notification form, coding differences and changes in data entry practices over the 14-year period made aggregation of the data a challenge. The final analysis file contained nearly 90% of all birth records. The results are therefore considered representative of the general population.

5.2 Study Population

The majority of infants born full term in Newfoundland and Labrador from 1992 to 2005 were within the normal birth weight range, with 81.4% of infants (N=54,256) weighing between 2,500 and 4,000 grams at birth. High birth weight accounted for the vast majority of infants with birth weights outside the normal range with 17.0% of infants (N=11,305) weighing above 4,000 grams; low birth weight accounted for the remaining 1.6% (N=1,077). In general, the distribution of low and high birth weight according to maternal characteristics was consistent with previous research, as described in more detail in further sections. Low birth weight was more prevalent among younger and older mothers, mothers who were single, separated, widowed or divorced, mothers with low levels of education, and women living in neighbourhoods with the lowest socioeconomic status. Smaller babies were also more common among mothers who had hypertension, anemia, drank alcohol or smoked during pregnancy. The proportions of high birth weight infants were higher among mothers who were older, married, had higher levels of education, lived in the wealthiest neighbourhoods, had other children, or were diabetic.

Intrauterine growth restriction (IUGR) is a term that is used to describe poor growth of a fetus while *in utero*. As a medical risk factor associated with pregnancy, it is diagnosed using ultrasound technology. IUGR was included as a field on the Live Birth Notification form from 1992 to 2002. Of the 907 full term gestation infants weighing less than 2,500 grams at birth during this time, IUGR was only noted on the birth registration form for 215 of them, or 23.7%. There are a few possible explanations. First, IUGR may not have been identified during pregnancy. This is especially likely for women that only had an 18 week ultrasound, which constitutes the majority of pregnancies, since IUGR cannot be identified at this early stage of pregnancy. It is also possible that the attending physician completing the birth registration form did not fill out the form correctly or completely, although information on fetal growth is expected to be documented on the prenatal record. Finally, the attending physician may not have been aware of the IUGR if he or she was not the physician that provided prenatal care to the mother. Although these reasons are speculative, they all likely contribute to the poor data quality of this field on the birth registration form.

5.3 Birth Weight Trends

Results from the study indicate that mean birth weight and rates of high birth weight have significantly increased in Newfoundland and Labrador from 1992 to 2005, while rates of low birth weight have significantly decreased. The provincial high birth weight rate of 17.5% for the period from 2002 to 2005 is higher than the Canadian rate of 12.5% (Statistics Canada, 2004; Statistics Canada, 2005; Statistics Canada, 2006a; Statistics Canada, 2007). The finding of increasing birth weight is consistent with that found in previous studies investigating birth weight trends in developed countries (Orskou, Kesmodel, Henriksen and Secher, 2001; Ananth and Wen, 2002; Kramer et al., 2002; Wen et al., 2003; Health Canada, 2003; Surkan, Hsieh, Johansson, Dickman and Cnattingius, 2004; Amigo, Vargas and Rona, 2005; Bell, 2008). Since the investigation included only those infants born at term (37 to 41 completed weeks of gestation) it can be inferred that increases in birth weight reflect increases in fetal growth during pregnancy. Increases in the provincial rate of high birth weight may be due in part to significant increases in the rate of high birth weight in Census Division 1, which accounts for almost half of the province's total number of births.

Although Census Division 1 had significant increases in high birth weight rates from 1992 and 2005, the highest rates of macrosomia were concentrated in Census Divisions 5, 9 and 10. Low birth weight was highest in Census Division 4. Further investigation, including a comparison of the determinants of birth weight between Census Divisions, is required to explain the geographic variation in birth weight rates.

Overall, upward shifts in birth weight in Newfoundland and Labrador may be explained, at least in part, by changes in maternal demographics. The significant increase in the proportions of older and more educated mothers may be responsible for increases in birth weight. The increase in the proportion of mothers aged 35 years of older from 6.2% to 12.6% from 1992 to 2005 mirrors the increases documented in Alberta and Nova Scotia (Tough et al., 2002; Fell et al., 2005). Although, the proportion of unmarried mothers increased significantly from 25.0% to 40.8%, it is believed that this is not an indication of increases in the proportion of unpartnered mothers, but instead a reflection of increased numbers of women who are co-habitating or living common-law. This notion is supported by a study conducted in Finland by Raatikainen, Heiskanen and Heinonen (2005) who found that 74.6% of women who were unmarried during pregnancy were cohabitating with their partners. Data on the Live Birth Notification forms for 2002 to 2005 indicate that 63.9% of mothers who were never married were living together with their baby's father as a couple. Furthermore, the majority of mothers who were legally separated, divorced, or widowed were also co-habiting with their baby's father, 52.2%, 76.6% and 62.5%, respectively.

5.4 Predictors of Abnormal Birth Weight

The results demonstrate that there are several factors significantly associated with birth weight outcomes in Newfoundland and Labrador.

5.4.1 Infant Sex

Throughout each cycle of the regression analysis, female infants were more likely to be low birth weight and male infants were more likely to be high birth weight. This suggests that infant sex is a strong and statistically significant predictor of birth weight, with female infants having a 25% greater chance of being low birth weight and 43% less likelihood of being high birth weight. This is consistent with previous research findings from England, Australia, and Canada that report male infants generally weigh more than female infants at birth (Dougherty and Jones, 1982; Guaran, Wein, Sheedy, Walstab and Beischer, 1994; Nault, 1997; Kramer et al., 2001).

5.4.2 Maternal Demographic Factors

Although a slightly higher proportion of mothers less than 20 years of age had a low birth weight infant compared to mothers aged 20 to 34 years (2.0% vs. 1.5%), younger mothers were less likely to have a low birth weight infant when odds ratios were calculated in the multivariate analysis. This finding, along with the finding that older mothers are more likely to have a low birth weight infant, are contrary to the findings of some previous studies which suggested that low birth weight was associated with younger maternal age (Ng and Wilkins, 1994; Nault, 1997; Crosse, Alder, Ostbye, and Campbell, 1997). These studies based their findings on comparisons of low birth weight rates by mother's age but did not calculate odds ratios for low birth weight by mother's age. One of the studies that did find an association between low birth weight and older maternal age (Tough, Svenson, Johnston and Schopflocher, 2001) used mothers aged 12 to 19 years as the reference group so the findings cannot be directly compared to the findings of this study. However, the findings can be partially compared to those of Joseph et al. (2005) who found that mothers aged 30 years or greater were more likely to have small-for-gestational-age babies. In the current study, the associations between mother's age and risk of having a low birth weight infant were eliminated when smoking, drug use, and alcohol consumption were added to the regression model, suggesting that there may be associations between mother's age and substance use during pregnancy.

The association between mother's age and high birth weight is unclear since the odds ratios and significance values of younger and older mothers delivering a large baby varied depending on the variables included in the regression model. Older maternal age was associated with decreased risk of high birth weight when maternal education and substance use were included in the model. There was no association when initiation of prenatal care and clinical covariates were added to the model.

Findings from this study indicate that marriage does seem to have a protective effect when it comes to low birth weight, however, married women are more likely to have a high birth weight infant. The elevated risk of low birth weight (OR 1.19, $P < 0.05$) among unmarried women found in this study was very similar to that found by Tough, Svenson, Johnston and Schopflocher (2001) (OR 1.18, 95% CI 1.08-1.29). The odds ratio was also similar to that found by Raatikainen, Heiskanen and Heinonen in 2005 (OR 1.17, 95% CI 1.03-1.32) who postulated that unmarried status may reflect other risk factors rather than being an independent risk factor. The findings of this study support this theory given that single marital status was only significant during the first round of regression analysis which included infant sex, Census Division, maternal age, parity and socioeconomic status. When mother's education, initiation of prenatal care, clinical and lifestyle factors were added to the analysis, single marital status was no longer significant for low birth weight. Raatikainen, Heiskanen and Heinonen found that unmarried women are more often primiparous, more often unemployed, and smoke more than married women. They further noted that unmarried women are also more likely to experience emotional stress compared to married women in stable marital situations. It is likely that the effects of single marital status in future research may be less significant as marital practices continue to change in the direction of more cohabiting unions, instead of traditional marriages.

Odds ratios for low birth weight among women that were separated, widowed or divorced were higher and remained significant through most of the regression analysis compared to those found for single women, with OR values ranging from 1.42 to 1.83. This further supports the theory proposed by Raatikainen, Heiskanen and Heinonen (2005) that the results for single marital status are affected by women living in common-law unions and may not be an accurate reflection of unpartnered status.

Examining the associations between maternal education and socioeconomic status with birth weight outcomes posed a number of challenges. As previously stated, education data had been collected in two ways over the course of the study period. While a logical approach was taken to categorize the number of years of education into one of three groups (less than high school, completed high school or education beyond high school), there were likely instances whereby mother's educational attainment was misclassified. In addition, data on maternal education was missing for 3% of mothers. However, this data were missing at random and were unlikely to have biased the results. Individual-level data were not available for socioeconomic status. A proxy measure of socioeconomic status was obtained by linking the mothers' postal codes on the birth registration forms to a set of socioeconomic status scores that had been previously developed for another research study (Audas, Cirtwill and O'Keefe, 2007). Mothers were grouped into quintiles and deciles based on their socioeconomic status using cut-points derived from the study population. Mothers were subsequently grouped according to how they ranked in comparison to each other, rather than how they ranked in the general population. However, since this was a population-based study this probably did not have a large impact on the findings.

The distribution of maternal characteristics across socioeconomic status quintiles in this study was similar to that found by Luo, Wilkins and Kramer (2006) who analyzed the effect of neighbourhood income and maternal education on birth outcomes in Quebec using birth registration data on infants born from 1991 to 2000. Both studies found that compared to mothers living in the richest neighbourhoods, mothers living in the poorest neighbourhoods were more likely to be less than 20 years of age, unmarried, and not have completed high school. Both studies also found that mothers who lived in the poorest neighbourhoods were more likely to have a low birth weight baby. In the current study, the power of socioeconomic status in predicting low birth weight was eliminated when mother's education, initiation of prenatal care, medical risk factors and substance use factors were added to the model. This is not surprising given that factors such as cigarette smoking, poor nutrition, and maternal morbidity, each themselves direct causes of low birth weight, are also strongly associated with socioeconomic status (Kramer, 1987b; Bonellie, 2001). In addition, Luo, Wilkins and Kramer concluded that the effects of maternal education were larger than, and independent of, the effects of neighbourhood income. The Quebec study did not investigate the effects of neighbourhood income or maternal education on high birth weight, however, this study found that women living in the poorest neighbourhoods were less likely to have a high birth weight infant, even after maternal education and other covariates were added to the model. The association, however, did disappear when substance use variables, including smoking, were added to the model. Maternal education was also significantly associated with high birth weight, with women of less education having a decreased risk of giving birth to a macrosomic infant, whereas those with the highest levels of education were more likely to have a larger baby. Again, these associations did not remain when substance use factors were added to the analysis.

5.4.3 Maternal Morbidity during Pregnancy

The study revealed that maternal morbidity during pregnancy was associated with both low birth weight and high birth weight outcomes. Hypertension was predictive of low birth weight while diabetes and anemia were associated with high birth weight.

Although equal percentages (16.8%) of high birth weight infants were born to women who had hypertension during pregnancy and those that did not, a higher percentage of low birth weight infants were born to mothers that had hypertension during pregnancy (5.0%) compared to those that did not (1.5%). The regression analysis revealed that hypertension during pregnancy had no association with high birth weight outcomes. However, women that were hypertensive during pregnancy were 3.3 times more likely to have a low birth weight infant ($P < 0.01$). Similar odds ratios have been identified in other studies (Fang, Madhavan and Alderman, 1999; Samadi et al., 1996; Xiao, Sorensen, Williams and Luthy, 2003; Gilbert, Young and Danielsen, 2007). This may be explained by the fact that hypertensive women delivered earlier than non-hypertensive women; 31.6% of hypertensive women had delivered by 38 weeks compared to 17.6% of non-hypertensive women.

Anemic mothers were almost twice as likely to have a high birth weight baby compared to non-anemic mothers. This finding is contrary to earlier studies which found anemia to be associated with low birth weight outcomes (Lone, Qureshi, and Emanuel, 2004; Mahajan, Singh, Shah, Gupta and Kochupillai, 2004; Scholl, 2005). The reliability of this finding is uncertain due to the small percentage of anemic mothers in the study population (0.5%). Furthermore, since the cause of the anemia could not be ascertained from the birth registration record, the association between anemia and birth weight could not be adequately explored.

Results for diabetes and birth weight were as expected based on previous research (Boulet, Alexander, Salihu and Pass, 2003). Diabetic mothers were more than twice as likely to deliver a high birth weight infant compared to non-diabetic mothers (OR 2.4, $P < 0.01$). Almost one-third (31.7%) of mothers who had insulin dependent diabetes gave birth to a high birth weight baby.

5.4.4 Obstetric Factors

The percentage of mothers giving birth to high birth infants increased with the number of children born. High birth weight ranged from 14.2% among first-time mothers to 20.3% among mothers having their fourth child or greater. Parity greater than one was associated with decreased risk of low birth weight and increased risk of high birth weight. These findings are consistent with previous research that found a linear relationship between parity and birth weight (Tough et al., 2001; Orskou et al., 2003). Although women are having fewer children compared to previous generations, second or third-born children are still more likely to be heavier than their older siblings.

5.4.5 Prenatal Care

Previous investigations into the association between prenatal care and birth weight have reported mixed findings. Although the relationship between prenatal care and restricted fetal growth was not significant in the regression analysis, initiation of prenatal care in the second or third trimester was associated with decreased risk of delivering a high birth weight infant. Reichman and Teitler (2005) stated that the effectiveness of prenatal care in improving birth outcomes is difficult to prove given that randomized experiments would deprive women of care and thus would be unethical to carry out. The authors further stated that mothers least at risk of adverse birth outcomes were the most likely to get early prenatal care, therefore estimates of the effects of prenatal care were likely to be overstated.

There are claims that there is little that prenatal care can do to improve aggregate birth outcomes because most pregnancy complications are the result of behaviours and life circumstances that precede pregnancy (Reichman and Teitler, 2005). There is little doubt however that medical care during pregnancy is extremely important for mothers and their babies. Establishing the characteristics of women who do not seek prenatal care or seek care late in their pregnancies requires investigation among the Newfoundland and Labrador population. Lack of health insurance, found to be associated with absent prenatal care in other studies (Maupin et al, 2004), cannot explain the lack of or delayed prenatal care in Newfoundland and Labrador given that the population benefits from universal health care. Other factors, including decreased access to care, particularly for women living in rural areas of the province, may be at least partly responsible.

5.4.6 Toxic Exposures due to Maternal Lifestyle and Behaviours

The proportion of mothers under investigation who used substances during pregnancy was much less than the degree of substance use reported among pregnant women in other studies (Tough, Svenson, Johnston and Schopflocher, 2001; Visscher, Feder, Burns, Brady and Bray, 2003; Jaddoe et al., 2007). This may be partly due to the fact that the study was restricted to infants born term, and previous research has found that those born to mothers who used substances during pregnancy are more likely to be born premature (Okah, Cai and Hoff, 2005). The proportion of mothers reported as having used substances during pregnancy may also have been low due to data quality issues. Data on substance use during the periconceptional and pregnancy period have been collected on birth registrations in Newfoundland and Labrador since 2002. The data are recorded by health care staff and are based on information found on the prenatal record and/or information provided by the mother after delivery. There are several factors that may affect the validity and reliability of this data.

The Newfoundland and Labrador Prenatal Record is initiated by the mother's family physician upon confirmation of pregnancy. The record collects several types of data including demographics, obstetrical history, medical history, history of present pregnancy, and lifestyle history which includes the collection of data related to substance use including smoking, alcohol consumption and illicit drug use. The first factor that potentially impacts on the quality of the data collected on the prenatal record relates to physician practice of asking pregnant patients questions pertaining to substance use. Physicians' reluctance to screen pregnant women for substance use stems from a host of factors including concerns and misconceptions about the risks associated with treating pregnant substance users, a lack of knowledge about addiction and referral options, and a lack of confidence in treatment programs (Chasnoff, Neuman, Thornton, and Callaghan, 2001). Physician hesitation may also be based on the assumption that substance use is not prevalent among their patients. This misconception is evident by estimates from the 2005 Canadian Community Health Survey in which 23.8% of Canadian mothers reported that they smoked during their last pregnancy and 11.7% reported consuming alcohol (Statistics Canada, 2006b). Questions on drug use during pregnancy were not included in the survey. In addition to physician discomfort in questioning women about their substance use history, the quality of the data recorded on the prenatal record is also influenced by reluctance among women to admit unfavourable behaviours. This response bias may underestimate the true number of women that use substances during pregnancy (Jacobson, Chiodo, Sokol and Jacobson, 2002; Kennare, Heard and Chan, 2005).

Another factor affecting the quality of substance use data reported on the Live Birth Notification form relates to the collection of these data in the hospital setting. At approximately 20 weeks gestation, a copy of the prenatal record is provided to the mother by her physician which she is to bring to future prenatal care visits so it can be updated.

When she goes for delivery she is to bring it to the hospital so it can be added to her medical chart. If the mother fails to bring the prenatal record to the hospital, or if the record is missing information on substance use during pregnancy, the hospital staff must seek this information after delivery in order to record it on the birth registration form. As with the prenatal care setting, there exists hesitation on the part of the hospital staff to ask mothers questions pertaining to these issues, and reluctance on the part of mothers to respond truthfully. This is particularly true just after delivery, given women's fear of having their children taken into care, fear of legal consequences, shame and guilt (Koren, Chan, Klein and Karaskov, 2002). For these reasons, data pertaining to substance use during pregnancy on the birth registration forms may be underreported.

There are other limitations to data reported on the birth registration form; type of substances used is not captured, nor is the frequency or quantity of substance use. This information would be particularly useful for examining how the degree of substance use impacts weight outcomes of infants at birth. In previous research, low birth weight rates have been shown to increase as the number of health-compromising behaviours increases (Okah, Cai, and Hoff, 2005). The effects of multiple compromising behaviours and specific combinations of behaviours should be included in future research.

The small proportions of women using substances during pregnancy, particularly alcohol and drugs, may not have provided sufficient numbers to adequately test the association between substance use and birth weight outcomes. Alcohol use was significant in the bivariate analysis, and appeared to have a tendency toward low birth weight (OR 2.38), although the association was not significant. However, consistent with numerous prior investigations, smoking significantly increased women's risk of delivering a low birth weight infant (OR 2.05, $P < 0.01$) and decreased risk for having a high birth weight baby (OR 0.47, $P < 0.01$). With additional years of data, and inclusion of infants born at all gestational ages, the impact of drugs and alcohol on infant weight may be more fully studied.

5.5 Strengths and Limitations

This is the first known study that examined birth weight outcomes, associated trends and determinants, specific to the Newfoundland and Labrador population. Since the study was population-based the results can be generalized to the entire population. The study covered a time period expanding 14 years, therefore, there was a large sample available for analysis. This was particularly useful for investigating low birth weight given such births usually account for only 1-2% of term births each year in Newfoundland and Labrador. The large data set was sufficient to analyze trends over time as well as include a large number of predictor variables in the regression model. Overall, the quality of the data was very good and missing data was minimal. However, the representativeness of some findings, in particular those related to substance use, is uncertain. The use of data elements captured on the Live Birth Notification form meant there were a select number of variables available for inclusion in the study. Therefore, the study included only a partial list of factors that could increase risk for adverse birth weight outcomes. Notably absent from the analysis were mother's pre-pregnancy BMI and gestational weight gain. Both of these factors have been found to impact birth weight, with increased weight gain and BMI associated with higher birth weight (Shapiro, Sutija and Bush, 2000; Kramer et al., 2002; Surkan, Hsieh, Johansson, Dickman and Cnattingius, 2004). The influence of maternal BMI is particularly important given rates of overweight and obesity in Newfoundland and Labrador is at an all time high, with almost two-thirds (64.5%) of the population aged 12 years and older overweight or obese, compared to 50.3% of all Canadians (Newfoundland and Labrador Centre for Health Information, 2007).

Of the data fields that were available in the Live Birth System, not all were available for all years. For instance, smoking, alcohol consumption, and drug use were only available for years 2002 to 2005. This may have had a particular effect on the power of the model to detect associations between substance use and birth weight. Furthermore, vital statistics data are noted for their lack of precision in reported diagnosis of medical conditions and morbidities (Boulet, Alexander, Salihu and Pass, 2003). These problems would not be expected to vary by birth weight and therefore should not have biased the results. As previously stated, lifestyle factors such as smoking and alcohol use during pregnancy may have been underreported, which would have biased the results toward the null value of no difference.

It can be argued that weight for gestational age may have been a better outcome measure given that it would have taken into account infant weight at any gestational age thus allowing for the inclusion of all infants born in the Province. For example, a baby can be born term with a weight greater than 2,500 grams but still have had fetal growth restriction if its weight is low compared to most other infants born at that gestational age. A population-based Canadian reference for birth weight for gestational age was developed by Kramer et al. (2001) for the Canadian Perinatal Surveillance System. The growth chart defines a small-for-gestational-age (SGA) infant as one whose weight falls below the 10^{th} percentile for its gestational age (in completed weeks). A large-for-gestational-age (LGA) infant is one whose weight is above the 90^{th} percentile for gestational age. However, the use of weight-for-age charts for assessing fetal growth does have limitations. Data used to create the size-for-gestational-age charts are based on the weight distributions of infants who are born at a given gestational age, but do not include weights of fetuses that remain *in utero* at each gestational age (Hutcheon and Platt, 2008). This is especially problematic for infants born preterm. Hutcheon and Platt state that preterm births are not normal pregnancies and should not be used to characterize the growth patterns of the full conception cohort. The charts are therefore based on the weights of an extremely small fraction of the total birth population and introduce a bias into studies of fetal growth. The limitations of prenatal growth standards have deterred some neonatologists from using them to replace birth weight standards (Ehrenkranz, 2007). Finally, the lack of a standard definition for high birth weight meant that direct comparisons could not be made with some other studies. This is a common problem in perinatal epidemiology (Boulet, Alexander, Salihu and Pass, 2003).

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

Birth weight outcomes in Newfoundland and Labrador are associated with infant sex and a combination of individual and community-level maternal characteristics including age, marital status, education, socioeconomic status, parity, timing of prenatal care, smoking, and medical conditions including hypertension, anemia and diabetes.

Infant birth weight has increased significantly in Newfoundland and Labrador from 1992 to 2005, with the heaviest infants concentrated on the Northern Peninsula and in Labrador. Rises in high birth weight rates and mean birth weight have been accompanied by significant declines in the proportion of infants born in the low birth weight range. Increases in infant weight at birth are at least partly tied to changes in maternal demographics including increasing maternal age and education. Further research is required to explain the geographic variability in birth weight across the province.

As women continue to delay child-bearing and attain higher levels of education, and as conditions such as overweight, obesity and diabetes continue to rise, it is expected that the proportion of bigger babies will grow. The monitoring of birth weight rates and the relative contribution of the determinants of fetal growth will be a vital part of informing policy and programs related to the provision of prenatal care to pregnant women. It is recommended that intervention efforts, which often target mothers at risk for delivering low birth weight infants, such as those having low socioeconomic status and those that smoke during pregnancy, be modified to accommodate the growing group of mothers at risk for delivering high birth weight infants. With the promotion of better health among women of child-bearing age, and increased awareness of the importance of healthy birth weight, it may be possible to curb the big baby boom.

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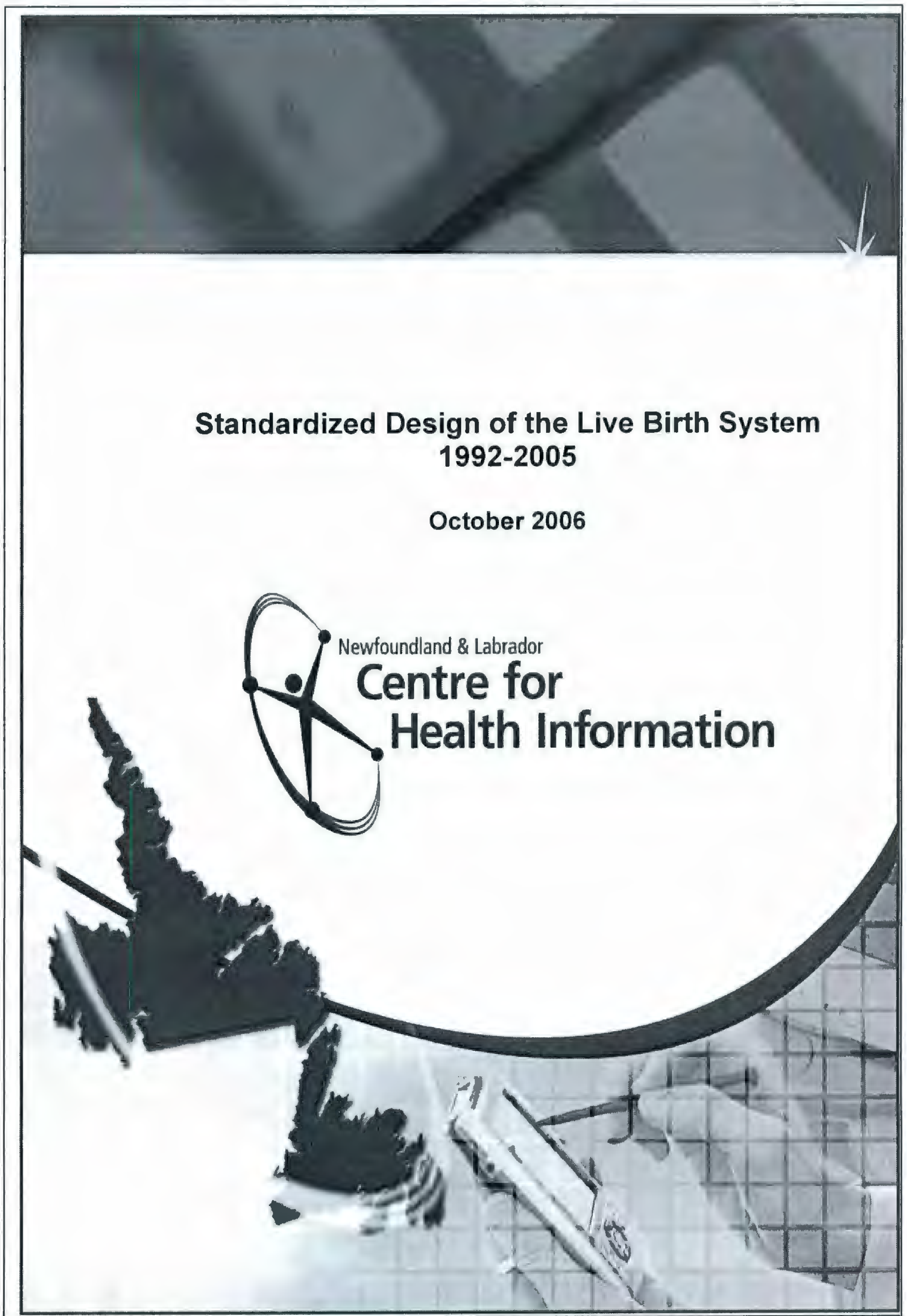
APPENDIX A



Standardized Design of the Live Birth System
1992-2005

October 2006

Newfoundland & Labrador
Centre for
Health Information

Variable Name	Description	Comments	Variable Specifications	
			Type	Width
REGISTRATION				
year	Year of Birth	Data available for 1992-2005	Numeric	4
reg_num	Infant's Registration Number	Data available for 1992-2005	Numeric	11
INFANT				
c_name	Infant's Name	Last name available for 1997-2001 Full name available for 2002 Not available for 2003-2005	String	45
c_sex	Child's Sex	Data available for 1992-2005	Numeric	1
		Years 1992-2001 sex of baby was coded as M or F. All years changed to numeric format and recoded as follows: M → 1 F → 2		
c_dob	Child's DOB (MM/DD/YYYY)	Data available for 1992-2005	Date	10
		Syntax used to change all years to date format with width 10.		
c_locbir	Locality of birth (hospital, home, other, unknown)	Data available for 2002-2005	String	1
c_locoth	Other (specified)	Data available for 2002-2005	String	20
hospital	Hospital (Based on hospital code)	Data available for 1999-2000 and 2002-2005. Edit program can insert data for 1992-1997 and 2001.	String	45
hospcode	Hospital Code	Data available for 1992-2005	String	3
c_locat	Place of Occurrence – City / Town (Based on hospital code)	Data available for 1997-2000 and 2002-2005. Edit program can insert data for 1992-1996 and 2001.	String	20
c_plccde	SGC code for place of occurrence. (Based on hospital code)	Data available for 1992-2000 and 2002-2005. Edit program can insert data for 2001.	String	7

		Some years had SGC codes that were 10 digits (i.e. 1001519Z83). All years changed to 7 digits.		
c_admnum	Infant's Hospital Admission Number	Data available for 1992-2005	String	12
c_chanum	Infant's Hospital Chart Number	Data available for 2002-2005	String	12
MOTHER				
m_name	Mother's Surname, Full Given Name(s)	Data available for 1997-2002	String	45
m_maiden	Mother's Maiden Name	Data available for 1997-2002	String	20
m_mcp	Mother's MCP Number	Data available for 1997-2005	Numeric	12
m_admnum	Mother's Hospital Admission Number	Data available for 1992-2005	String	12
m_chanum	Mother's Hospital Chart Number	Data available for 1994-1995 and 1997-2005	String	12
m_dob	Mother's Date of Birth (MM/DD/YYYY)	Data available for 1992-2005 Syntax used to change all years to date format with width 8.	Date	10
m_age	Mother's Age	Data available for 1992-2005	Numeric	2
m_bplace	Mother's Birth Place (Province / Territory / Outside Canada)	No data available	String	25
m_brcode	Mother's Birth Place Residence Code	Data available for 1992-2002	String	3
maddres1	Mother's Address_1 (street)	Data available for 1992-1995 and 1997-2001.	String	25
maddres2	Mother's Address_2 (street / city / town)		String	25
maddres3	Mother's Address_3 (city / town)		String	50
maddres4	Mother's Address_4 (province)		String	25
m_pcode	Mother's Postal Code	Data available for 1992-2005	String	6

m_addcod	Mother's Home Residence Code	Data available for 1992-2005 Some years had SGC codes that were 10 digits (i.e. 1001519Z83). All years changed to 7 digits.	String	7
m_marsta	Legal Marital Status of Birth Mother	Data available for 1992-2005 1992 – 2001 recoded as follows: 1 → 1 2 → 2 3 → 5 4 → 4 5 → 2 6 → 3 Blank/Missing → O	String	1
laparent	Living Arrangements of Birth Parents	Data available for 2002	String	1
mrparent	Marital Relationship of Birth Parents	Data available for 2002	String	1
m_educ	Mother's Education	Data available for 2002-2005 This categorical way of classifying mother's education appeared on the LBN form in 2002. Data for 1992-2001 found in the variable *meduc*.	String	1
FATHER				
f_name	Father's Name	Data available for 1997-2002	String	45
f_dob	Father's Date of Birth (MM/DD/YYYY)	Data available for 1992-2002 Syntax used to change all years to date format with width 8.	Date	10
f_age	Father's Age	Data available for 1992-2002	Numeric	2
f_brcode	Father's Birth Residence Code	Data available for 1992-2002	String	3
HEALTH HISTORY AND MEDICAL CERTIFICATION OF BIRTH				
meduc	Mother's education (actual number of years)	Data available for 1992-2001	Numeric	2
feduc	Father's education (actual number of years)	Data available for 1992-2001	Numeric	2

crelcode	Baby's Religious Denomination	Data available for 1992-2001	Numeric	2
live	Number of Livebirth Children Ever Born to This Mother	Data available for 1992-2005	Numeric	2
still	Number of Stillbirth Children Ever Born to This Mother	Data available for 1992-2005	Numeric	2
lastdate	Date of Last Delivery (MM/DD/YYYY)	Data available for 1992-2005 Syntax used to change all years to date format with width 10.	Date	10
livestil	Last Delivery Live or Still Birth	Data available for 1992-2001	Numeric	2
prevcsec	Previous C-Section (any birth)	Data available for 2002-2005	Numeric	2
lstyle1	Lifestyle Issues / Substance Use - NONE	Data available for 2002-2005	Numeric	1
lstyle2	Lifestyle Issues / Substance Use - DRUGS	Data available for 2002-2005	Numeric	1
lstyle3	Lifestyle Issues / Substance Use - UNKNOWN	Data available for 2002-2005	Numeric	1
lstyle4	Lifestyle Issues / Substance Use - ALCOHOL	Data available for 2002-2005	Numeric	1
lstyle5	Lifestyle Issues / Substance Use - SMOKING	Data available for 2002-2005	Numeric	1
lstyle6	Number of Cigarettes / Day	Data available for 2002-2005	Numeric	2
support1	Support Available - Husband / Partner	Data available for 2002-2005	Numeric	1
support2	Support Available - Living With Parents / Other Support	Data available for 2002-2005	Numeric	1
support3	Support Available - Lives Alone	Data available for 2002-2005	Numeric	1

pncspec	Specialist for Prenatal Care	Data available for 2002	Numeric	1
other1	Specialist for Prenatal Care - Other	Data available for 2002	String	20
other2	Specialist for Prenatal Care - Other	Data available for 2002	String	20
other3	Specialist for Prenatal Care - Other	Data available for 2002	String	20
speccare	Specialist for Prenatal Care	Data available for 1992-2001 Responses for women who had a specialist prenatal care are indicated by 'Y' (Yes) and 'N' (No).	String	1
trimest1	First Trimester	Data available for 1992-2001 All applicable trimesters are indicated by an 'X'.	String	1
trimest2	Second Trimester		String	1
trimest3	Third Trimester		String	1
pncbegan	Prenatal Care Began At (No. of Weeks)	Data available for 2002	Numeric	2
pnctrime	Prenatal Care Began At (Trimester)	Data available for 1992-2001	Numeric	2
famphys	Family Physician (Provider Number)	Data available for 1992-2001	String	6
famdis1	Familial Diseases - No	Data available for 1992-2001	String	1
famdis2	Familial Diseases - Deafness	Data available for 1992-2001	String	1
famdis3	Familial Diseases - Other	Data available for 1992-2001	String	1
famicd1	Family Disease (1)	Data available for 1992-2001	String	4
famicd2	Family Disease (2)		String	4
famicd3	Family Disease (3)		String	4
famicd4	Family Disease (4)		String	4
famicd5	Family Disease (5)		String	4
famicd6	Family Disease (6)		String	4
numdeliv	Total Number of Infants in THIS Delivery	Data available for 1992-2002 From 1992-2001 this variable was	String	1

		called *kindbrth*. Single births were coded as '1' and twin births were coded as '2'. Other multiple births were coded as '3'. The variable *kindoth* specified the number of births in the other multiple births. The current variable has been recoded for 1992-2001 as follows: *kindbrth:* *numdeliv:* 1 → 1 2 → 2 *kindoth:* 3 → 3 4 → 4 5 → 5		
numstill	Number of Stillborn in THIS Delivery	Data available for 1992-2002	Numeric	1
comprg01	Medical Risk Factors: None	Data available for 1992-2002	String	1
comprg02	Anemia < 100 G/L	Data available for 1992-2002 1992-2001 variable renamed *comprg7 → comprg02*	String	1
comprg03	Hypertension (Chronic)	Data available for 2002	String	1
comprg04	Hypertension (Associated with Pregnancy)	Data available for 2002	String	1
comprg05	UTI (Urinary Tract Infection)	Data available for 2002	String	1
comprg06	IUGR (Intrauterine Growth Restriction)	Data available for 1992-2002	String	1
comprg07	Insulin Dependent Diabetes	Data available for 1992-2002 1992-2001 variable renamed *comprg5 → comprg07*	String	1
comprg08	Violence During Pregnancy	Data available for 2002	String	1
comprg09	Infectious Disease	Data available for 2002	String	1
comprg10	Isoimmunization	Data available for 1992-2002 1992-2001 variable renamed *comprg3 → comprg10*	String	1
comprg11	Antepartum Hemorrhage	Data available for 1992-2002	String	1

		1992-2001 variable renamed *comprg4* → *comprg11*		
comprg12	Depression	Data available for 2002	String	1
comprg13	Other Complications of Pregnancy	Data available for 1992-2002	String	1
		1992-2001 variable renamed *comprg8* → *comprg13*		
toxorhyp	Toxaemia or Hypertension	Data available for 1992-2001	String	1
		1992-2001 variable was named *comprg2*		
mrficd1	Medical Risk Factors (Other): ICD-10	Data available for 1992-2002	String	6
mrficd2	Medical Risk Factors (Other): ICD-10	1992-2001 variables renamed *c8icd1* → *mrficd1* *c8icd2* → *mrficd2* *c8icd3* → *mrficd3* *c8icd4* → *mrficd4*	String	6
mrficd3	Medical Risk Factors (Other): ICD-10		String	6
mrficd4	Medical Risk Factors (Other): ICD-10		String	6
labdel	Labour - YES / NO	Data available for 1995-1997 and 1999-2005	Numeric	1
		1995-1997 and 1999-2005 *labdel0* recoded as follows: 'X' → 2 'Else' → 1		
labcode1	Type of Labour - Spontaneous	Data available for 1994-2005	String	1
		1994-2001 variable *labdel1* renamed *labcode1*		
labcode2	Type of Labour - Induction	Data available for 2002-2005	String	1
labcode4	Type of Labour - Augmented After Onset	Data available for 2003-2004	String	1
labdel2	Labour - Induced	Data available for 1992-2001	String	1
		1992-1993 variable *labdel1* renamed *labdel2*		
vbac	Labour – VBAC (Vaginal	Data available for 1994-2001	String	1

	Birth After Cesarean)			
labcomp	Complications of Labour - Yes	Data available for 1992-2001	String	1
lbicd1	Complications of Labour ICD-9 (1)	Data available for 1992-2001	String	5
lbicd2	Complications of Labour ICD-9 (2)	Data available for 1992-2001	String	5
lbicd3	Complications of Labour ICD-9 (3)	Data available for 1992-2001	String	5
lbicd4	Complications of Labour ICD-9 (4)	Data available for 1992-2001	String	5
delpres	Delivery Presentation	Data available for 1994-2005	Numeric	1
		1994-2001 recoded as follows: *delpres1:* *delpres:* 'X' → 1 *delpres2:* *delpres:* 'X' → 2 *delpres3:* *delpres:* 'X' → 3		
dpresicd	Delivery Presentation (Other): ICD-10	Data available for 2002-2005	String	6
dmethod	Method of Delivery	Data available for 1992-2005	Numeric	1
		1992-1993 recoded as follows: *deliver1* *dmethod* *deliver5* *deliver8* 'X' → 1 *deliver2* *dmethod* *deliver3* 'X' → 3 *deliver4* *dmethod* *deliver6* *deliver7* 'X' → 2 1994-2001 recoded as follows: *delmode1* *dmethod* 'X' → 1 *delmode2* *dmethod* 'X' → 3 *delmode3* *dmethod*		

		'X' → 2 *delmode4* *dmethod* 'X' → 2		
csecicd1	C / S Indications: ICD (1)	Data available for 1994-2005	String	6
csecicd2	C / S Indications: ICD (2)	1994-2001 uses ICD-9 codes 2002-2005 uses ICD-10 codes	String	6
csecicd3	C / S Indications: ICD (3)		String	6
csecicd4	C / S Indications: ICD (4)		String	6
intenone	Interventions - None	Data available for 2002-2003	String	1
lowforcp	Interventions - Low Forceps	Data available for 2002-2003	String	1
midforcp	Interventions - Mid Forceps	Data available for 2002-2003	String	1
vacuum	Interventions - Vacuum Extraction	Data available for 2002-2003	String	1
episitmy	Interventions - Episiotomy	Data available for 2002-2003	String	1
medicat	Interventions - Medications	Data available for 2002-2003	String	1
tear	Interventions - Tear	Data available for 2002-2003	String	1
tearicd	Tear (Specify degree): ICD-10	Data available for 2002-2003	String	6
multiple	Multiple Birth - Order	Data available for 1992-2002 1992-2002 variable *brthseq* renamed *multiple*	String	1
gestagew	Gestational Age Completed - Weeks	Data available for 1992-2005	Numeric	2
gestaged	Gestational Age Completed - Days	Data available for 2002	Numeric	1
gaconfrm	G/A confirmed by antenatal ultrasound	Data available for 2002	String	1
gagew_us	Gestation Age – Weeks (Based on Ultrasound)	Data available for 2003-2005	Numeric	2
gaged_us	Gestation Age – Days (Based on Ultrasound)	Data available for 2003-2005	Numeric	1

gagew_lp	Gestation Age – Weeks (Based on Last Menstrual Period)	Data available for 2003-2005	Numeric	2
gaged_lp	Gestation Age – Days (Based on Last Menstrual Period)	Data available for 2003-2005	Numeric	1
birthwgt	Birth Weight (grams)	Data available for 1992-2005	Numeric	5
apgar1	Apgar Score at 1 Min	Data available for 1992-2005	Numeric	2
apgar5	Apgar Score at 5 Mins	Data available for 1992-2005	Numeric	2
apgar10	Apgar Score at 10 Mins	Data available for 1992-2001	Numeric	2
apgar15	Apgar Score at 15 Mins	Data available for 1992-2001	Numeric	2
neocond	Neonatal Conditions / Birth Injuries noted at Birth	Data available for 1992-2001	String	1
neoicd1	Neonatal Conditions: ICD-9 (1)	Data available for 1992-2001	String	4
neoicd2	Neonatal Conditions: ICD-9 (2)	Data available for 1992-2001	String	4
congen	No Congenital Anomalies	Data available for 1992-2002	String	1
congen1	NTD (Neural Tube Defect)	Data available for 2002	String	1
conicd1	NTD - ICD-10	Data available for 2002	String	6
congen2	Congenital Heart Defect	Data available for 2002	String	1
conicd2	Congenital Heart Defect - ICD-10	Data available for 2002	String	6
congen3	Craniofacial	Data available for 2002	String	1
conicd3	Craniofacial - ICD-10	Data available for 2002	String	6
congen4	GI (Gastrointestinal)	Data available for 2002	String	1
conicd4	GI - ICD-10	Data available for 2002	String	6
congen5	MS (Musculoskeletal)	Data available for 2002	String	1
conicd5	MS - ICD-10	Data available for 2002	String	6
congen6	GU (Genitourinary)	Data available for 2002	String	1

conicd6	GU - ICD-10	Data available for 2002	String	6
congen7	Chromosomal Anomalies	Data available for 2002	String	1
conicd7	Chromosomal Anomalies ICD-10	Data available for 2002	String	6
congen8	Other Congenital Anomalies	Data available for 2002	String	1
conicd8a	Other Congenital Anomalies ICD-10	Data available for 2002	String	6
conicd8b	Other Congenital Anomalies ICD-10	Data available for 2002	String	6
conicd8c	Other Congenital Anomalies ICD-10	Data available for 2002	String	6
conicd8d	Other Congenital Anomalies ICD-10	Data available for 2002	String	6
anom2	Anencephalus	Data available for 1992-2001	String	1
anom3	Spina Bifida	Data available for 1992-2001	String	1
anom4	Hydrocephalus	Data available for 1992-2001	String	1
anom5	Craniofacial	Data available for 1992-2001	String	1
anom6	Fetal Alcohol Syndrome	Data available for 1992-2001	String	1
anom7	T E Fistula	Data available for 1992-2001	String	1
anom8	Hypospadis / Epispadias	Data available for 1992-2001	String	1
anom9	Reduction Deformity	Data available for 1992-2001	String	1
anom10	Rectal/Anal Atresia/Stenosi	Data available for 1992-2001	String	1
anom11	Omphalocele / Gastroschisis	Data available for 1992-2001	String	1
anom12	Chromosomal Anomalies	Data available for 1992-2001	String	1
an12icd1	Chromosomal Anomalies ICD-9 (1)	Data available for 1992-2001	String	6
an12icd2	Chromosomal Anomalies ICD-9 (2)	Data available for 1992-2001	String	6
an12icd3	Chromosomal Anomalies	Data available for 1992-2001	String	6

	ICD-9 (3)			
anom13	Other Congenial Anomalies	Data available for 1992-2001	String	1
an13icd1	Other Congenial Anomalies ICD-9 (1)	Data available for 1992-2001	String	6
an13icd2	Other Congenial Anomalies ICD-9 (2)	Data available for 1992-2001	String	6
an13icd3	Other Congenial Anomalies ICD-9 (3)	Data available for 1992-2001	String	6
deliver	Delivered By (Provider Code)	Data available for 1992-2002	String	6
deldesig	Designation of attendant	Data available for 2003-2005	Numeric	1
deldesot	Designation of attendant Other (Specify)	Data available for 2003-2005	String	20
comments	Comments	Data available for 1994 and 1997-2000	String	40

APPENDIX B

Taken from Audas, R., Cirtwill, C., & O'Keefe, B. (2007).

The process for converting postal code data to the SES indicator is as follows:

- Postal codes were linked to a Dissemination Area (DA) through Statistics Canada Post Code Conversion File
- Each DA is assigned an SES 'score' based on its characteristics from the 2001 Census. 13 accepted indicators are used to compute a measure of SES for each school's enumeration areas:

    - the proportion of the labour force in high-status occupations;
    - the proportion of the population holding a university degree;
    - the proportion of the population having less than a high school diploma;
    - average income;
    - the proportion of 15-to-24-year-olds not participating in education;
    - average home value;
    - average rent;
    - the proportion of one-parent families;
    - the employment rate for adults;
    - the unemployment rate for adults;
    - the employment rate for youths aged 15 to 24;
    - the unemployment rate for youths aged 15 to –24
    - the proportion of households classified as 'low income'.

- Each of these indicators was standardized using the provincial average and, in the case of items 3, 5, 8, 10, 12, and 13 multiplied by –1[1]. The 13 items were then summed to give a single indicator of SES for each enumeration area.

[1] In the other seven items, a larger number tends to suggest a higher level of social affluence. For items 3,5,8,10 and 12, a higher number suggests a lower level of social affluence; by multiplying them by -1, all 12 items move in the same direction.

APPENDIX C

Memorial
University of Newfoundland

Office of Research and Graduate Studies (Medicine)
Faculty of Medicine
The Health Sciences Centre

May 18, 2006

Reference #06.81

Ms. N. Edwards
C/o Dr. R. Audas
Community Health
2nd Floor, Faculty of Medicine

Dear Ms. Edwards:

This will acknowledge your correspondence dated May 16, 2006, wherein you clarify issues regarding your research study entitled "**Mapping birth weight and health service utilization of infants and young children using linked administrative databases**".

At the meeting held on April 27, 2006, the initial review date of this study, the Human Investigation Committee (HIC) agreed that the response could be reviewed by the Co-Chairs and, if found acceptable, full approval of the study be granted.

The Co-Chairs of the HIC reviewed your correspondence, approved the response and, under the direction of the Committee, granted ***full approval*** of your research study. This will be reported to the full Human Investigation Committee, for their information at the meeting scheduled for May 25, 2006.

Full approval has been granted for one year. You will be contacted to complete the annual form update approximately 8 weeks before the approval will lapse on **April 27, 2007**. It is your responsibility to ensure that the renewal form is forwarded to the HIC office not less than 30 days prior to the renewal date for review and approval to continue the study. The annual renewal form can be downloaded from the HIC website http://www.med.mun.ca/hic/downloads/Annual%20Update%20Form.doc.

Modifications of the protocol/consent are not permitted without prior approval from the Human Investigation Committee. Implementing changes in the protocol/consent without HIC approval may result in the approval of your research study being revoked, necessitating cessation of all related research activity. Request for modification to the protocol/consent must be outlined on an amendment form (available on the HIC website) and submitted to the HIC for review.

St. John's, NL, Canada A1B 3V6 • Tel.: (709) 777-6762 • Fax: (709) 777-7501 • email: rgs@mun.ca

For a hospital-based study, it is **your responsibility to seek the necessary approval from the Health Care Corporation of St. John's and/or other hospital boards as appropriate**.

This Research Ethics Board (the HIC) has reviewed and approved the application for the study which is to be conducted by you as the qualified investigator named above at the specified study site. This approval and the views of this Research Ethics Board have been documented in writing. In addition, please be advised that the Human Investigation Committee currently operates according to the Tri-Council Policy Statement and applicable laws and regulations.

Notwithstanding the approval of the HIC, the primary responsibility for the ethical conduct of the investigation remains with you.

We wish you every success with your study.

Sincerely,

John D. Harnett, MD, FRCPC
Co-Chair
Human Investigation Committee

Richard S. Neuman, PhD
Co-Chair
Human Investigation Committee

JDH;RSN\jjm

C Dr. C. Loomis, Vice-President (Research), MUN
Mr. W. Miller, Director of Planning & Research, HCCSJ

APPENDIX D

LIVE BIRTH NOTIFICATION

Government of Newfoundland and Labrador
Department of Health

Registration number

SECTION A – Mandatory for Registration of Birth (required within 48 hours of delivery)

CHILD

1. Surname, Given Name(s)
2. Sex ☐ M ☐ F ☐ Unknown
3. Date of Birth (Y/M/D)
4. Hospital
Birth location (City, municipality/place)
SBCode
5. Hosp. Adm. No.

MOTHER

6. Surname, Given Name(s)
Birth Surname
7. MCP#
8. Hosp. Adm. No.
Hosp. chart No
9. Date of Birth (Y/M/D)
10. Age
11. Birthplace (Province/Country outside Canada)
SBCode
12. Mother's Home Address
SBCode
Postal Code
13. Marital Status
1 ☐ Never Married
2 ☐ Married
3 ☐ Widowed
4 ☐ Divorced
5 ☐ Common Law
6 ☐ Separated

FATHER

14. Surname, Given Name(s)
15. Date of Birth (Y/M/D)
16. Age
17. Birthplace (Province/Country outside Canada)
SBCode

I certify that the information given is true and accurate to the best of my knowledge and belief.
Signature of Mother and/or Father
DATE YEAR MO DY

SECTION B – Health History and Medical Certification of Birth

PART 1 – HEALTH HISTORY

18. Education Attained (Parents)
a. Mother
b. Father
19. Baby's Religious Denomination
20. Number of Children Ever Born to this Mother (including this livebirth)
LiveBirth
StillBirth
21. Date of Last Delivery (if applicable)
YEAR MO DY
1 ☐ Live
2 ☐ Stillborn
22. Kind of Present Delivery
a. 1 ☐ Single 2 ☐ Twin 3 ☐ Other
b. Number of Stillborn
23. Multiple Birth Sequence
1 ☐ 1st 2 ☐ 2nd
3 ☐ Other – *Specify*
24. Birthweight (in grams)
g
25. Trimester Prenatal Care Began
1 ☐ None 3 ☐ 2nd
2 ☐ 1st 4 ☐ 3rd
26. Apgar score
1' 5' 10' 15'
27. Family Physician
28. Specialist for Prenatal Care
☐ No
☐ Yes ▶ Trimester ☐ 1st ☐ 2nd ☐ 3rd

PART 2 – PHYSICIAN SECTION

30. Delivery
Presentation
1 ☐ Cephalic 2 ☐ Breech 3 ☐ Other
Mode
1 ☐ Spont. 3 ☐ Forceps 4 ☐ Vacuum
2 ☐ C/S
Indications for C/S:
ICD9 > ICD9 >
ICD9 > ICD9 >
31. Labour
1 ☐ None 2 ☐ Spont. 3 ☐ Induced 4 ☐ VBAC offered 5 ☐ Complications: list
ICD9 > ICD9 >
ICD9 > ICD9 >
32. Complications of Pregnancy
1 ☐ None
2 ☐ Toxaemia or hypertension
3 ☐ Rhesus isoimmunization
4 ☐ Antepartum haemorrhage
5 ☐ Diabetes (Ins. Dep.)
6 ☐ IUGR
7 ☐ Anemia < 100 G/L
8 ☐ Other (Complications of Pregnancy) (List below)
ICD9 > ICD9 >
ICD9 > ICD9 >
33. Neonatal Conditions/Birth Injuries noted at Birth 1 ☐ None 2 ☐ Yes – *Specify*
ICD9 > ICD9 >
34. Gestation Period completed weeks
35. Congenital Anomalies
1 ☐ None
2 ☐ Anencephalus
3 ☐ Spina bifida
4 ☐ Hydrocephalus
5 ☐ Craniofacial
6 ☐ Fetal alcohol syndrome
7 ☐ T-E fistula
8 ☐ Hypospadias/epispadias
9 ☐ Reduction deformity of limbs
10 ☐ Rectal / anal atresia / stenosis
11 ☐ Omphalocele / gastroschisis
12 ☐ Chromosomal anomalies ICD9 >
13 ☐ Other congenital anomalies ICD9 >

29. Familial Diseases (Up to and including second cousins of parents) 1 ☐ No 2 ☐ Deafness 3 ☐ Other *(Please Specify Below)*
ICD9 > ICD9 > ICD9 >
36. Delivered By (Surname, Given Names)
Position/Title
Signature
DATE: YEAR MO DY

SECTION C – Hospital Nursing Discharge Summary

Date of discharge Y M D
Telephone numbers PRIMARY Alternate
Directions to home
Infant discharge weight gms
Discharge head circumference cms
Length at birth cms
Feeding ☐ Breast ☐ Formula
Neonatal screening ☐ Yes ☐ No
Status of child ▶ ☐ Foster/Adoption ☐ Still in hospital ☐ Transferred to ▶
☐ Discharged to home
☐ Died

Neonatal conditions: *If checked, give details below*
☐ Meningitis / Septicemia ☐ Congenital Infections
☐ Ototoxic Drugs > 5 days ☐ Bilirubin > exchange level

Mother
☐ Incision / Epis/Tear ☐ Attended prenatal ed. ☐ Sutures / Clips
☐ Rhogam ☐ Tubal ligation ☐ PPSP Questionnaire given
Blood Gr. ______ HgB ______ BP ______

Follow-up recommendations to Community Health Nurse

Post-Delivery Length of Stay______
☐ CHN contact in hospital
☐ Routine follow-up
☐ Referral Faxed
☐ Referral phoned
Signature R.N.
Date

8-2370-73.1 1994-07-04

Government of Newfoundland and Labrador

LIVE BIRTH NOTIFICATION

1. Registration number 10

PART A of A & B - Mandatory for Registration of Birth (Required within 48 hours of delivery)

INFANT

2. Surname, Full Given Name(s)
3. Sex ☐ M ☐ F ☐ U
4. UPI
5. Date of Birth (M/D/Y)
6. Locality of Birth ☐ Hospital ☐ Private Home ☐ Other Health Care Facility ☐ Unknown ☐ Other *(Specify)* ➔
7. Hospital — Hospital Code
8. Place of Occurrence City / Town — Code
9. Admit. #
10. Hospital Chart #

MOTHER

11. Surname, Full Given Name(s)
12. Maiden Name and Initials
13. MCP
14. UPI
15. Admit. #
16. Hospital Chart #
17. Date of Birth (M/D/Y)
18. Age
19. Birth Place *(Province / Territory / Outside Canada)* — Code
20. Usual Home Address — SGC Code — Postal Code — Telephone Number
21. Complete Mailing Address — Postal Code
22. Legal Marital Status of Birth Mother ☐ Never Married ☐ Legally Married and Not Separated ☐ Legally Married but Separated ☐ Divorced ☐ Widowed ☐ Unknown
23. Living Arrangements of Birth Parents ☐ Living Together as a Couple ☐ Not Living Together as a Couple ☐ Unknown
24. Marital Relationship of Birth Parents *(Legally Married to Each Other)* ☐ Yes ☐ No ☐ Unknown
25. Education ☐ Has not Graduated High School ☐ Graduated High School ☐ Beyond High School ☐ College or University Degree (including trade) ☐ Unknown

FATHER

26. Surname, Full Given Name(s)
27. Date of Birth (M/D/Y)
28. Age
29. Birth Place *(Province / Territory / Outside Canada)* — Code

CERTIFICATION (For office use only) — Date of Certification ⟶ Month/Day/Year

HEALTH HISTORY AND MEDICAL CERTIFICATION OF BIRTH

31. No. of children born to this Mother (Including this livebirth) Liveborn ____ Stillborn ____
32. Date of last delivery Month / Day / Year
33. Previous C/Section *(any birth)* ☐ Yes ☐ No
34. Lifestyle Issues Substance Use ☐ None ☐ Drugs ☐ Unknown ☐ Alcohol ☐ Smoking ➔ ____ Cigarettes per day
35. Support Available ☐ Husband / Partner ☐ Living with Parents / Other supports ☐ Lives Alone
36. Medical Specialist for Prenatal Care ☐ None ☐ OBS / GYN ☐ Other *(Specify)* ➔
37. Prenatal care began at No. of Weeks ➔
38. Total number of infants in this delivery *(including live & stillborn)* ☐ Single birth ☐ Twin ☐ Triplet ☐ Quadruplet ☐ Quintuplet
39. No. of stillborn in *this* event ☐ None No.:____
40. **Medical Risk Factors** ☐ None ☐ Anemia (<100G/L) ☐ Hypertension *(Chronic)* ☐ Hypertension (Assoc. Pregnancy) ☐ UTI ☐ IUGR ☐ Insulin Dependent Diabetes ☐ Violence during pregnancy ☐ Depression ☐ Isoimmunization ☐ Gestational Diabetes ☐ Antepartum Hemorrhage ☐ Other *(Specify)* ____ Code
41. **Labour** ☐ Yes ☐ No If yes ➔ ☐ Spontaneous ☐ Induction ☐ Spontaneous with augmentation
42. **Delivery Presentation** ☐ Vertex ☐ Breech ☐ Other *(Specify)* ➔ Code
43. **Method of Delivery** ☐ Vaginal Spontaneous ☐ Vaginal Assisted ☐ C / Section — C/S Indications ➔ Code
44. **Interventions / Complications of Delivery** *(check more than one if appropriate)* ☐ None ☐ Low Forceps ☐ Mid Forceps ☐ Vacuum Extraction ☐ Episiotomy ☐ Medications ☐ Tear *(Specify degree)* ➔ Code
45. Multiple birth-birth order ☐ 1st ☐ 2nd ☐ Other *(Specify)* ➔
46. **Gestation Age (Based on U/S if possible)** U/S ____ weeks ____ days LMP ____ weeks ____ days
47. Birth weight ____ grams
48. Apgar Score ____ At 1 ____ At 5
49. **Congenital Anomalies:** ☐ Yes ☐ No

	Diagnosed Prenatally	Suspected at Birth	Specify
NTD	☐	☐	
Cong. Heart Def.	☐	☐	
Craniofacial	☐	☐	
GI	☐	☐	
MSK	☐	☐	
GU	☐	☐	
Chromosomal	☐	☐	

If anomaly confirmed *(Specify)* ____ Code

50. Delivered by (Surname, Given Name) - One Name Only — Code
51. Designation of attendant ☐ Medical Doctor ☐ Nurse ☐ Midwife ☐ Unknown ☐ Other *(Specify)* ➔
52. **Signature for Certification of Birth**
53. Date (M/D/Y)

8-2300-73.1: 2004-11-03

DISTRIBUTION: White and Canary - Vital Statistics Goldenrod - Hospital Pink - Health and Community Services