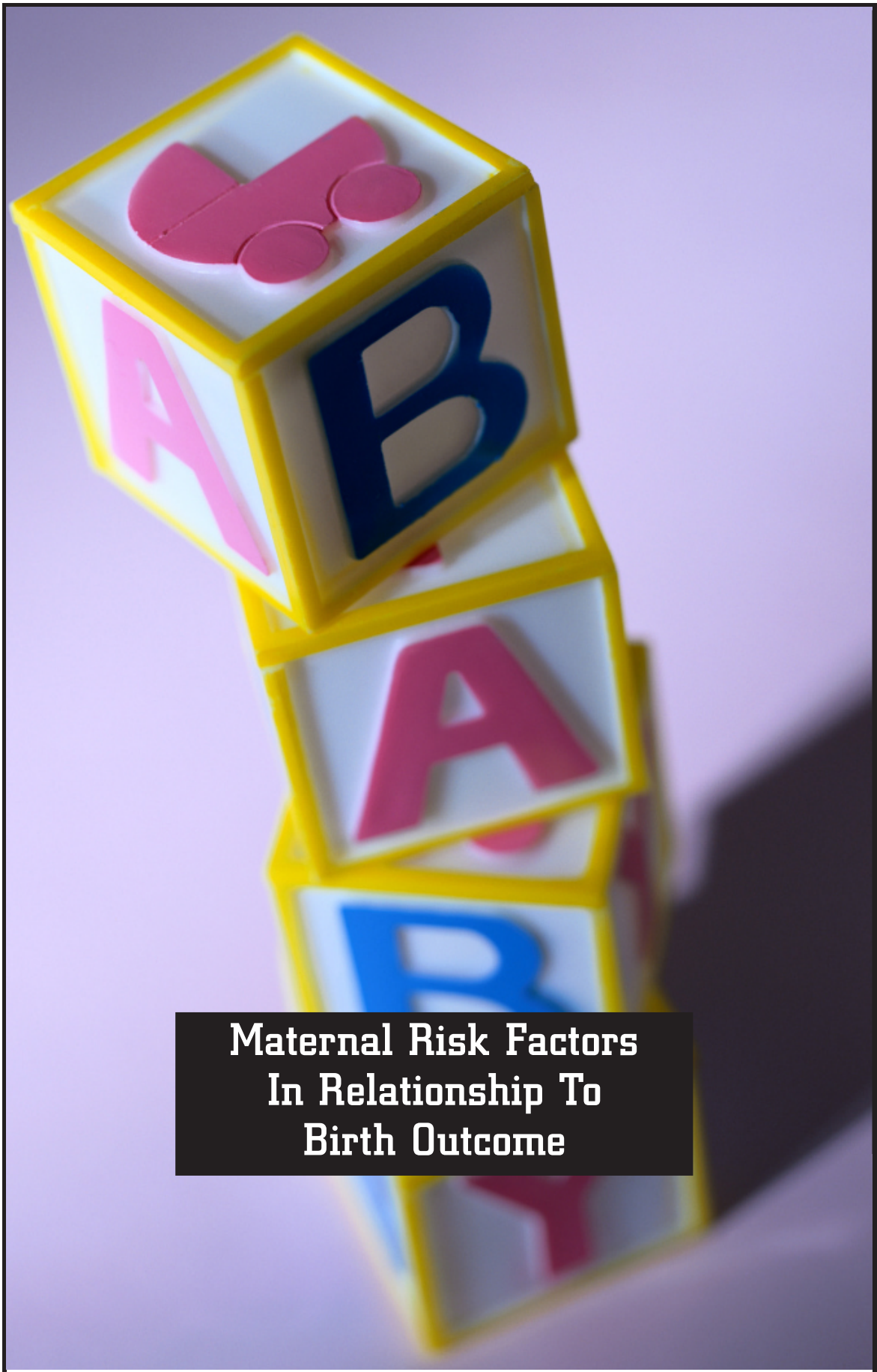

Maternal Risk Factors In Relationship To Birth Outcome

REPORT

Health Surveillance

Alberta
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Maternal Risk Factors in Relationship to Birth Outcome

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EXECUTIVE SUMMARY

There is substantial literature that addresses the impact of maternal behaviours on infant health. Potential risk factors for sub-optimal prenatal and newborn outcome include smoking, alcohol consumption and use of illicit drugs.[1] [2] [3] This report describes how maternal behaviours such as the use of tobacco, alcohol and illicit drugs among Alberta's women impacts the risk of pre-term birth (<37 weeks gestation) and low birth weight (<2500 grams). As well, the report highlights regional variations in maternal and infant characteristics, the understanding of which may be useful in the design and implementation of targeted intervention programs.

Smoking among Alberta women was found to be associated with a significant increased risk of low birth weight. In Alberta, the prevalence of smoking among pregnant women was 28.8%, which suggests that public health measures to reduce smoking during pregnancy may be warranted. Significant regional variations in smoking were observed with Keeweetinok (55.1%), Lakeland (39.9%), Northern Lights (39%), and Northwestern (39%) rates at least 10% higher than the provincial average (28.8%). Provincial smoking rates decreased from 29.6% in 1994 to 28.1% in 1996.

The excessive consumption of alcohol during pregnancy has been associated with a constellation of outcomes including decreased body weight, fetal malformations, CNS dysfunction and behavioral impairments, and, infants expressing these characteristics are described as having Fetal Alcohol Syndrome[4] . In Alberta, 7.5% of mothers consumed alcohol during their pregnancy though in the vast majority of cases consumption was described as occasional, light or moderate. None the less, these women were more likely to deliver infants who were pre-term. Use of alcohol varied significantly by region and was more frequent in the regions of David Thompson (14.3%), Northwestern (11.1%), and Keeweetinok (10.5%). Provincially, the use of alcohol decreased significantly among pregnant women from 8.5% in 1994 to 6.4% in 1996.

Although only 1.4% of pregnant women in Alberta admitted to using illicit drugs during pregnancy, 1,479 infants were exposed to the effects of drugs in utero. This exposure may influence newborn and pediatric outcome. Unfortunately, the data do not allow us to look specifically at different outcomes according to type of drug used. The effects of prenatal exposure to marijuana may include decreased birth weight,[5] neurobehavioral abnormalities, and poor abstract/visual reasoning,[6] however, other research suggests that the long term consequences are uncertain.[9] [7] [8] [9] The use of cocaine during pregnancy has been associated with spontaneous abortion, prematurity, low birth weight and neurobehavioral deficits although these findings have not been reported consistently.[10] [11] [12] [13] Use of street drugs during pregnancy ranged from 0.4% in Northwestern to 2.9% in Northern Lights. The use of street drugs was constant between 1994 and 1996 in Alberta.

The information in this report allows for the identification of high-risk behaviours related to birth weight and gestation. Such information provides an understanding of who is at risk and is important for the design and implementation of prevention programs.

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1.0 INTRODUCTION

The proportion of newborns born weighing less than 2500 grams is an internationally accepted measure of population health status. Low birth weight (LBW) has been acknowledged as the single most important determinant of neonatal mortality.[14 15 16 17 18] Low birth weight infants contribute to about 75% of the deaths that occur in the first week of life.

Within Alberta, the incidence of low birth weight is used as a system-wide measure of population health status. A provincial target of 5.5% has been set for the year 2002.[19] However, the proportion in 1995 was 6.0% (and it rose slightly in 1997 to 6.2%).

To facilitate progress towards the target of 5.5%, it is critical to identify those determinants of low birth weight that may be modifiable, and thereby offer the potential to reduce the incidence of low birth weight and pre-term birth.

The importance of optimal growth and development in the first year of life can not be under stated. Early childhood experiences can have life-long effects on health status.[20] Cigarette smoking by pregnant women is a common and avoidable factor associated with adverse infant outcomes including low birth weight and pre-term delivery.[21 22] As well, the use of alcohol and drugs during pregnancy can have adverse effects on the developing fetus.[7 15] Furthermore, maternal age, low socio-economic status, domestic violence and stress all increase the likelihood of adverse fetal outcomes.[23]

1.1 LOW BIRTH WEIGHT

Low birth weight infants are at a greater risk of having a disability and for diseases such as cerebral palsy, visual problems, learning disabilities and respiratory problems.[19 24] These morbidities are often chronic and have long term sequelae impacting the child, family, schools and communities. The factors that elevate the risk of low birth weight are multiple and complex. They include smoking, alcohol and drug use as well as broad determinants of health such as maternal age, in vitro fertilization and assisted reproduction, multiple births, social support and socioeconomic status. Multiple births are at an increased risk of low birth weight and the rate of triplets and higher order births has increased from 8 to 22 per 100,000 births between 1974-1990 in Canada.[19]

The prevalence of low birth weight among live born infants in Alberta in 1995 was 6%, higher than the Canadian rate of 5.7%.[19] Furthermore, Norway, Finland, France, Sweden and Switzerland report low birth weight rates which are lower than the Canadian rate.

1.2 PRE-TERM DELIVERY

The incidence of pre-term delivery (<37 weeks completed gestation) varies from population to population with reported estimates ranging between 6.0% and 10.0%.[25] These births are reported to contribute to 85% of all neonatal deaths and are of substantial social, emotional and economic impact.[26]

The majority of pre-term infants are low birth weight and this combination increases the risk of growth and development problems, visual and hearing difficulties, delayed speech, and other health conditions.[2 27] The risk of pre-term delivery is elevated by the same risk factors as for low birth weight (e.g. smoking, low socio-economic status) as well as by maternal medical conditions such as high blood pressure or diabetes. It has been suggested that known risk factors may explain only a small fraction of spontaneous pre-term delivery in low risk pregnancies[28] and it is recognized as a complex issue. The relationship between pre-term birth and smoking, alcohol and drug use is described below.

1.3 SMOKING

The prevalence of smoking among pregnant mothers ranges from 33.0% in New Zealand,[29] 32.4% in Nova Scotia,[30] to 18.7% in Ottawa, Ontario.[31] The overall prevalence of smoking in Alberta was 28.8%. Some studies have noted that approximately 30.0% of women report that they quit smoking during pregnancy, [32] a rate that was substantially greater than the 8.4% reported by Alberta women.

Cigarette smoking accounts for approximately 34% of all known preventable low birth weights in the United States.[18] Infants born to mothers who smoke both weigh less and are more likely to be delivered pre-term.[32 33] Furthermore, the more a mother smokes, the greater the decrease in birth weight.[34] Smoking may be responsible for as many as one-quarter of all NICU (Neonatal Intensive Care Unit) costs associated with low birth weight babies.[35] Although smoking is more common among young women, the risk of low birth weight is elevated among both older and younger mothers.[31 36]

There is an increased risk of pre-term birth associated with maternal smoking.[29 37] Furthermore, the combination of smoking and alcohol restricts fetal growth to a greater extent then either do independently.[53] It may be hypothesized that the combination of smoking and alcohol consumption exacerbates the risk of pre-term delivery by a physiologic mechanism, and/or women who both smoke and consume alcohol have distinct psychological, social or economic needs that need to be addressed to reduce the risk of pre-term delivery.

When women smoke during pregnancy, the risk of perinatal death increases by 33% (intrauterine fetal death after 20 weeks gestation) as does the risk of neonatal death (death in the first 28 days).[38] This increased risk is primarily a result of the increase in low birth weight and premature delivery. An estimated 5.3% of perinatal deaths in the United States could be prevented if cessation of smoking occurred during pregnancy.[39]

Substantial literature exists on the relationship between smoking and sudden infant death syndrome.[40] [41] Golding notes that the positive dose response relationship between smoking and sudden infant death remains consistent across numerous studies. In fact, the odds ratios associated with smoking during pregnancy and the increased likelihood of SIDS ranged from 1.4 to 4.4.[42]

Smoking during pregnancy has been linked to delayed motor development at 1 year of age and to poor dental health.[4] Children of smokers continue to be shorter than peers for up to 14 years.[5] [6] The relationship between maternal smoking and childhood mortality has also been reported at 3.9 per 1000 among non-smokers compared to 13.0 per 1000 for heavy smokers and 11.1 per 1000 for light smokers.[42]

1.4 ALCOHOL

The excessive consumption of alcohol during pregnancy has been associated with a constellation of adverse outcomes including: decreased body weight, fetal malformations, CNS dysfunction and behavioral impairments. Infants expressing these characteristics are described as having Fetal Alcohol Expression/Fetal Alcohol Syndrome (FAE/FAS).[7] The estimated global incidence of FAS is 1.9 per 100 live births.[43] FAS rates in the United States vary from about 2.5% to 4.0% and have not been reported among women with moderate to mild alcohol intake.[44]

Current evidence suggests that 10 to 20 times as many fetuses are exposed to moderate (1-3 drinks per day) levels of alcohol as to heavy doses.[45] The prevalence of moderate alcohol consumption among pregnant women may range from 5.0% to 20.0% and this exposure may cause subtle cognitive and behavioral abnormalities that may not be apparent until school age.[46] Moderate use of alcohol is generally not associated with decreases in birth weight. However, the combination of smoking and alcohol has been reported to restrict fetal growth to a greater extent then either do independently.[47]

1.5 ILLICIT DRUG USE

In general, the use of illicit drugs has been found to increase the risk of low birth weight and pre-term delivery.[48] More specifically, the use of cocaine during pregnancy has been associated with spontaneous abortion and neurobehavioral deficits,[15] [49] [50] although these findings are not consistent. The prevalence of cocaine use among pregnant women has been reported to be 0.6% in Missouri and 31.0% in urban Detroit.[57] It has been described as a dominant factor in predicting pre-term and LBW deliveries.[51] In fact, in a multivariate analysis of pre-term delivery and low birth weight, cocaine use was more predictive of LBW or pre-term delivery than prenatal care, marijuana and tobacco, race and previous pre-term birth.[57] Studies since the 1980's have revealed cocaine abuse in pregnancy to be associated with spontaneous abortion, still birth, pre-term labour and delivery and low birth weight.[52] [53] [54]

Some of the effects of prenatal exposure to marijuana have included decreased birth weight, neurobehavioral abnormalities, and poor abstract/visual reasoning.[8] [9] The use of marijuana in the third trimester has been associated with delayed motor development.[11] However, other research suggests that the long term consequences of marijuana use are unknown, if any exist. [9] [10] [11]

Mortality rates among women who used cannabis were no higher than among unexposed infants, nor did the rate of SIDS differ.[55]

The use of tobacco, alcohol and illicit street drugs have all been implicated in adverse pregnancy outcomes. The present report will examine and describe the impact of these factors as they relate to birth weight and gestation. In addition, positive behaviours such as prenatal care will also be incorporated. The relationship between these factors will be highlighted as well as the geographic distribution of these factors across Alberta's 17 Regional Health Authorities.

2.0 DATA

This report uses information from the Alberta *Notice of a Live Birth or a Still Birth and Newborn Record* (PNOB), which is completed when an infant is born in the province. Specifically all women who delivered an infant, either live or stillborn, in Alberta between January 1, 1994 and December 31, 1996 are included in this report. Information on infant factors included:

- gestational age,
- type of birth (singleton, twin, triplet)
- sex,
- birth weight, and
- visible birth defects.

Information on the mother included:

- age at time of delivery,
- parity,
- gravida,
- frequency of prenatal visits,
- marital status,
- smoking status during pregnancy,
- alcohol consumption during pregnancy, and
- use of street drugs during pregnancy.

Since the health determinant data is not routinely entered into the Vital Statistics electronic data systems, all data were double entered and verified as part of the current project.

Complete data was available for most of the variables noted above, and, with the exception of number of prenatal visits where the response rate was 77.0%, the response rates exceeded 88.0%.

The characteristics of mothers who delivered between 1994 and 1996 are described in Appendix 1. The mean maternal age was 28.4 years (range 12-52 years). Approximately three quarters (74.0%) of women were married at the time of delivery. The median number of prenatal visits was 9, however 22.7% of women had 5 or fewer prenatal visits.

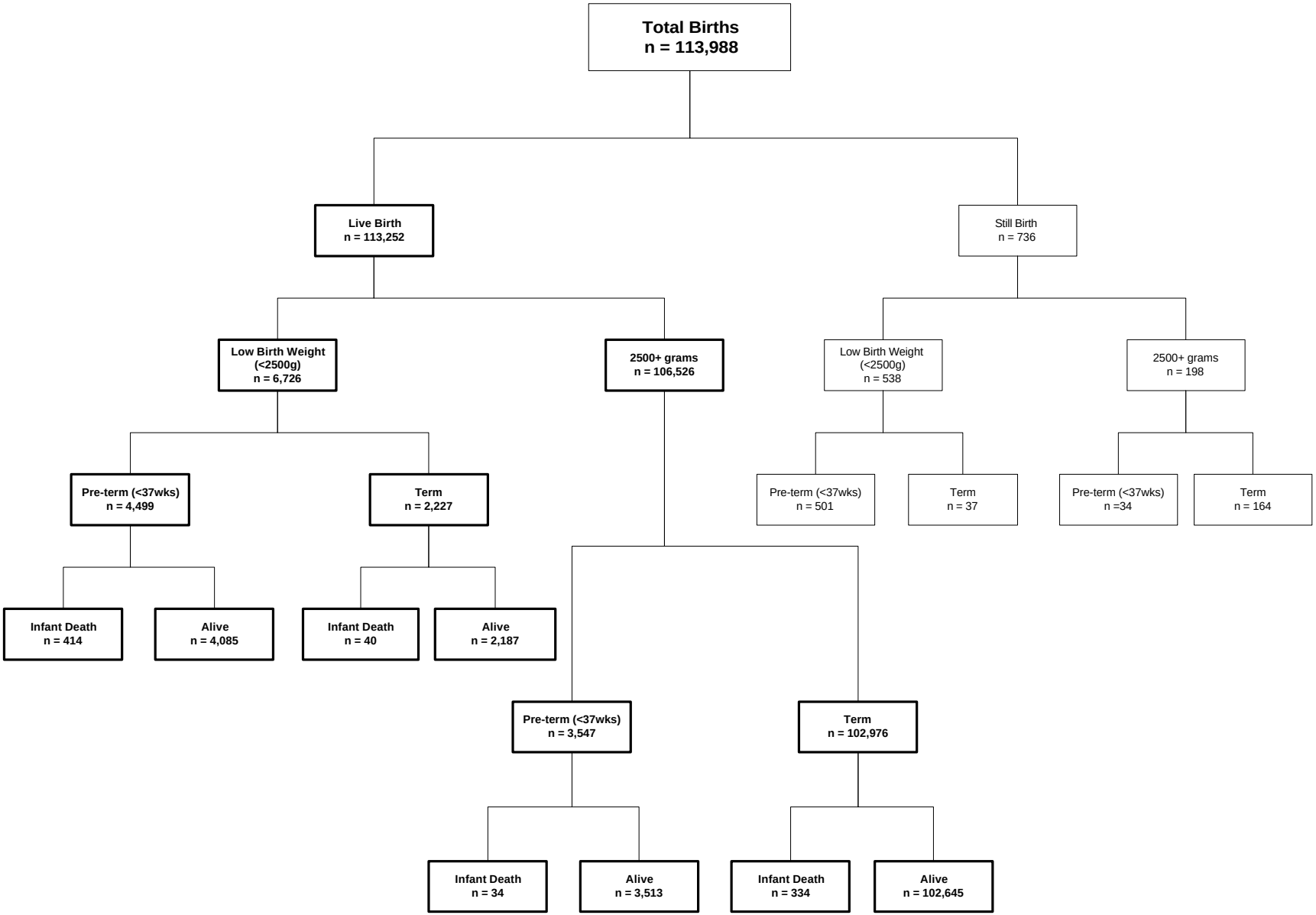
Smoking was reported by 28.8% (n = 31,390) of the mothers. More specifically, 26.4% of mothers were current smokers and 8.2% had quit smoking sometime during this pregnancy. Alcohol consumption during pregnancy was reported by 7.5% of the group (n = 7,970). Use of street drugs during pregnancy was reported by 1.4% of mothers (n =1,479).

Including this birth, over 98% of mothers had not experienced an infant death and 97.9% had never had a stillbirth. Slightly over 71% had not experienced fetal loss (spontaneous or therapeutic) in the past. In the present report, fetal loss refers to the termination of a pregnancy, either spontaneous (i.e. miscarriage) or induced. The data collected as part of this study did not allow for the distinction to be made, nor does it provide reasons for the loss.

Over the 3 year period there were 113,994 infants born in Alberta; 51.5% (n = 58,741) were male (see Appendix 2). The mean gestation was 39.0 weeks with a range of 15-47, and 92.4% of the infants were born at 37 weeks gestation or later. Over 99.0% of infants were live born and singleton births accounted for 97.6% of all births. Visible birth defects were noted in 3.1% of births (n = 3,635). Labor was spontaneous in 74.8% of births.

Figure 2.1 displays the distribution of births included in the study. From this flow chart it is possible to determine the proportion of low birth weight and pre-term births as well as an indication of infant mortality (death prior to the first birthday). For example, among low birth weight live births, 66.9% were pre-term (4,499/6,726 = 66.9%) compared to only 3.3% among those newborns weighing 2500 grams or more (3547/106,526 = 3.3%).

Figure 2.1 Classification of Births in Alberta, 1994-1996.

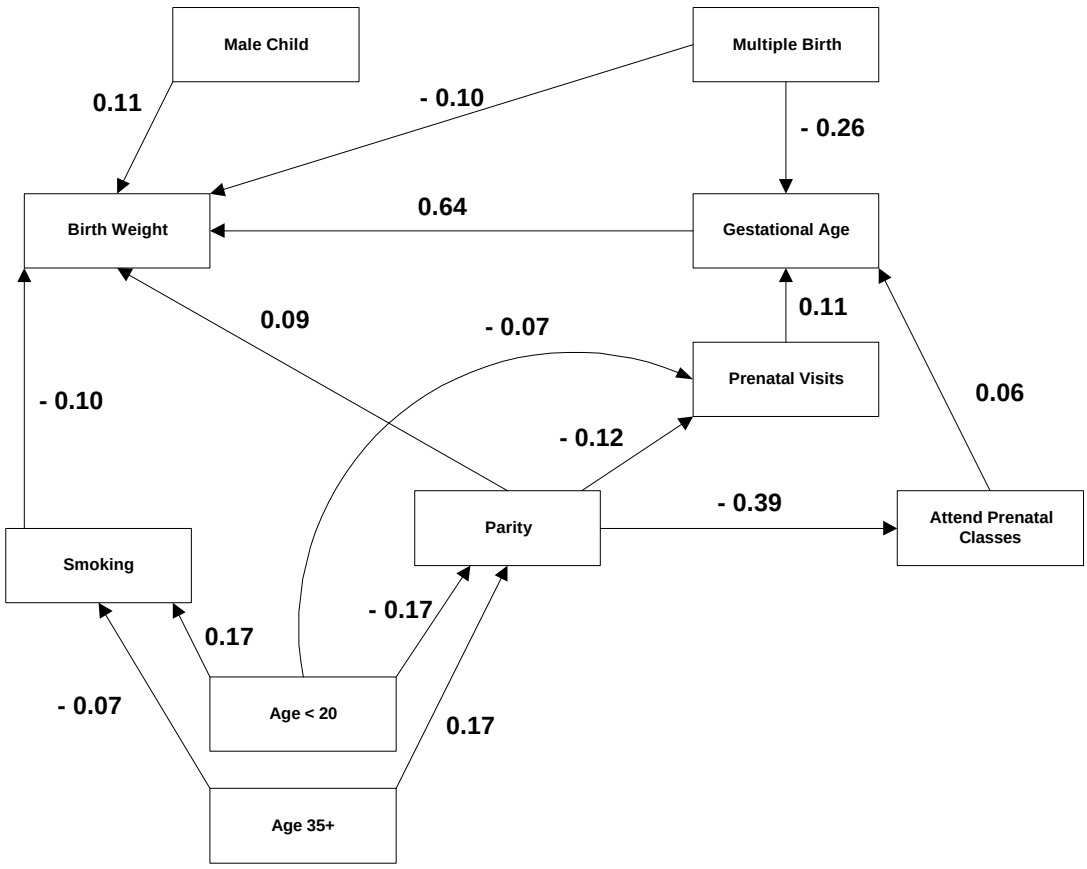


3.0 RESULTS

The current analysis focused first upon the entire Alberta population of new mothers, and highlighted two variables: birth weight, and gestational age. In what follows, three complementary analyses are presented. The exposition will focus upon interpreting the results of these analyses, while technical details will be made available on request.

Figure 3.1 presents the results of a structural equation modeling analysis [56] of birth weight, gestational age, and a variety of risk factors in the form of a causal network diagram. Each variable is represented in a box, and the arrows between the boxes represent hypothesized causal influences between these variables, and their direction. Where no arrow connects two boxes, no causal influence is postulated. The arrows are labeled with numbers that can range in size from –1.0 to 1.0 and represent the strength of the relationship. (These weights can interpreted in a fashion similar to the standardized beta weights in a multiple regression analysis). Positive coefficients mean that increases in the variable at the arrowless end of the relationship cause increases in the variable at the arrowed end of the relationship. Similarly, negative coefficients mean that increases in the variable at the arrowless end of the relationship cause decreases in the variable at the arrowed end of the relationship.

Figure 3.1 Causal Network of Risk Factors and Birth Outcomes



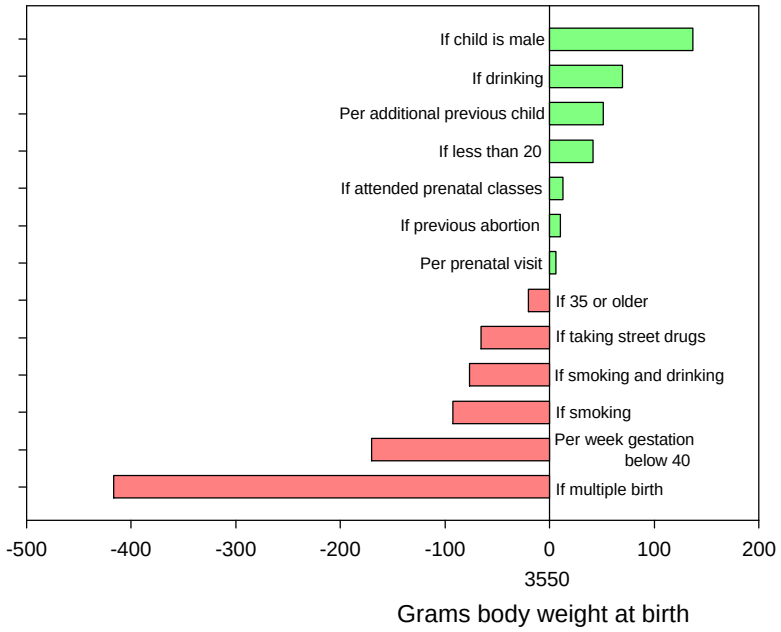
The model does a good job of capturing the associations between the variables. All of the coefficients included in the diagram are statistically significant (in part because of the very large sample of births analyzed), but some of these coefficients (particularly those below 0.15 in absolute value) represent very small relationships. While these very likely represent real causal features, they will not have predictive significance in clinical settings in which one or a small number of individual births are being examined.

The major features of the causal network are as follows:

- The major determinant of birth weight is gestational age; this relationship is substantially stronger than all others in the model.
- A multiple birth has an effect on both birth weight and gestational age. The larger part of the effect of a multiple birth on birth weight is mediated by the tendency for multiple deliveries to have shorter gestational ages.
- Male children tend to be heavier.
- Smoking has a negative effect on birth weight, but does not have an effect on the gestational age at delivery.
- Prenatal care in the form both of prenatal visits and attendance at prenatal classes tends to lengthen gestational age at delivery.
- Mothers who have given birth previously are considerably less likely to attend prenatal classes, and also tend to have fewer prenatal visits. There is also a small tendency for mothers who have given birth previously to have heavier babies.
- Mothers below the age of 20 are more likely to be delivering a first child. Of greater concern is that these mothers are more likely to be smokers and there is also a small tendency for them to have fewer prenatal visits.
- Older mothers are more likely to have had previous children, but slightly less likely to be smokers.

While this causal analysis gives insight into the relationships between risk factors and birth outcome variables, it does not easily yield an understanding of the magnitude of these effects. For these purposes, separate multiple linear regression analyses on birth weight and gestational age are more informative. **Figures 3.2** and **3.3** represent the beta weights of these regressions in a fashion that allows them to be directly interpreted.

Figure 3.2 Effects of Risk Factors on Average Birth Weight

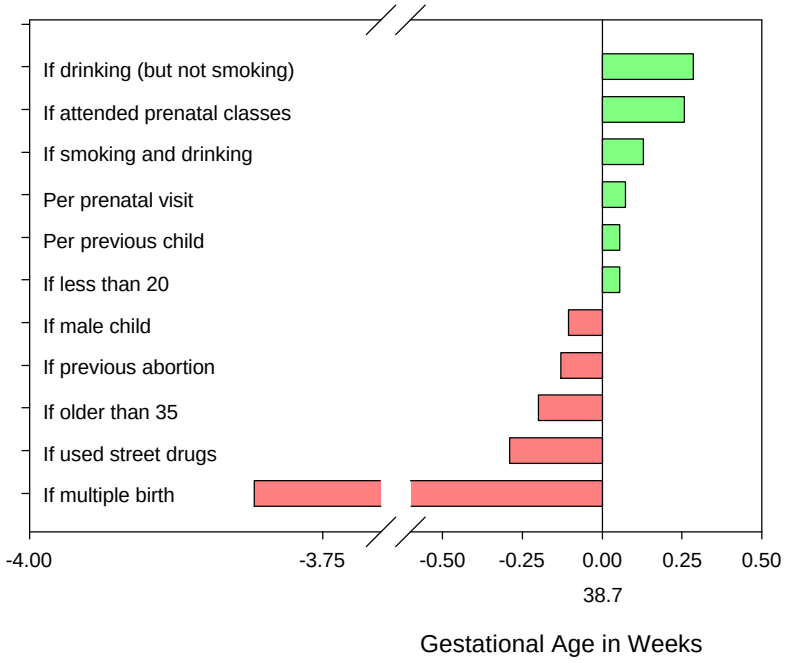


Taking 3550 grams as a baseline, **Figure 3.2** shows the average change in birth weight expected when various conditions are met. For example, a male child is on average 137 grams heavier (than 3550 grams), while the child of a smoker is on average 93 grams lighter. These effects can be combined additively to arrive at a predicted birth weight for a child born under various conditions. Thus for example,

		3550 grams
a male child		+137 grams
born at a gestational age of 40 weeks		+ 0 grams
to a mother under the age of 20		+ 41 grams
who drank but did not smoke during pregnancy		+69 grams
who attended prenatal classes		+13 grams
had 8 prenatal visits	+ (8 × 6 grams) =	48 grams
would be expected to weigh on average		= **3858 grams**

Similarly, **Figure 3.3** shows the effects on gestational age at delivery of various factors.

Figure 3.3 Effects of Risk Factors on Average Gestational Age



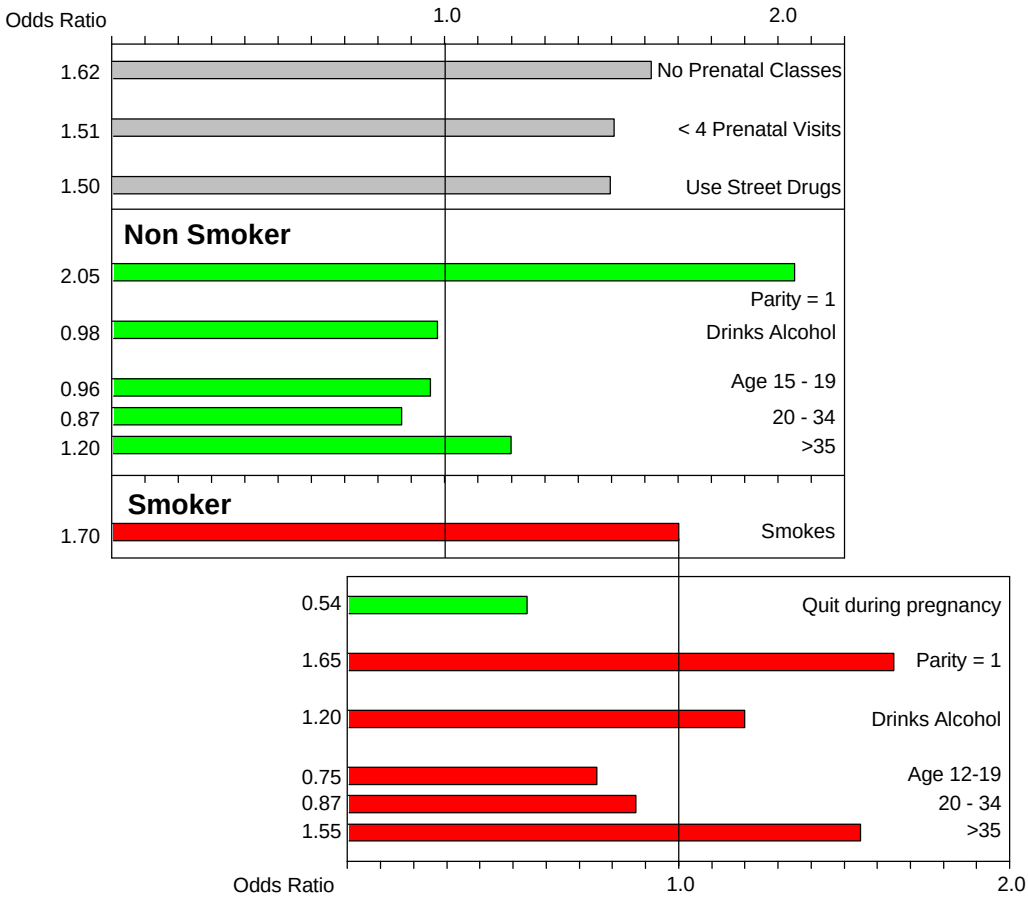
These factors can also be combined additively. For example, a child born to a mother

		38.70 weeks
who smoked and drank during pregnancy		+0.13 weeks
who also used street drugs		-0.29 weeks
who had had a previous abortive outcome		-0.13 weeks
and three previous children	+ (3 × 0.06) =	0.18 weeks
but who had no prenatal visits		+0 weeks
nor prenatal classes		+0 weeks
if the child were female		
would be expected on average to deliver at	= **38.59 weeks**	
if the child were male		-.11 weeks
would be expected on average to deliver at	= **38.48 weeks**	

It should be noted that the effects for birth weight and for gestational age at delivery are very small as revealed by these analyses. There is however another way of examining the data that

gives a more alarming picture of the effects of various factors on birth weight and gestational age at delivery. This method focuses upon the less likely but more extreme values of birth weight and gestational age, specifically upon children who weight less than 2500 grams at birth, and children who were born prematurely at less than 37 weeks gestation. Logistic regression analysis can give estimates of the increase in the odds that a child will be of low birth weight or born prematurely according to different factors. **Figures 3.4** and **3.5** present the results of separate analyses of risk factors in mother's characteristics and behaviors on the odds that she will give birth to a low birth weight infant or give birth prematurely. These figures present the odds ratios associated with different factors as derived from the beta weights of the regression analysis in a fashion that can be directly interpreted.

Figure 3.4 Risk factors for low birth weight infant.



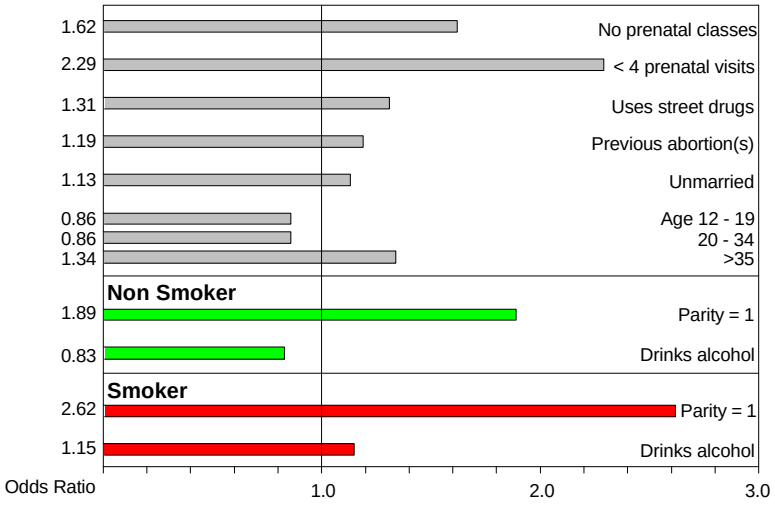
Thus a mother who had fewer than 4 prenatal visits was 1.51 times as likely to bear a child less than 2500 grams in weight. As with the linear regression, the odds of a low birth weight baby can be derived for a combination of factors. However, to estimate the odds due to multiple factors,

the separate odds are *multiplied* (rather than added). A complicating feature in the current case is that some factors interact which means that their effects depend specifically upon the level of some other factor. In particular, smoking status appears to alter the effect of other factors. As an example of calculation using this graph, consider

	Odds Ratio
a mother who does not attend prenatal classes	1.62
has fewer than 4 prenatal visits	$\times$ 1.51
smokes	$\times$ 1.70
is having a first child (from the section for smokers)	$\times$ 1.65
is over 35 years of age	$\times$ 1.55
has odds of having a low birth weight baby of	= 10.6 times

when compared to a woman in the reference category (non smoker, age 20-34, with previous children, more than 4 prenatal visits, and prenatal class attendance). This method clearly demonstrates the increased risk of having a LBW newborn as the number of risk factors increases. Using the same factors and procedure for gestational age, the risk of delivering prematurely would be increased 13-fold ($1.62 \times 2.29 \times 2.62 \times 1.34 = 13.02$).

Figure 3.5 Risk factors and associated odds ratios for pre-term delivery.



4.0 DISTRIBUTION OF RISK FACTORS

The previous section described the relationships between factors related to birth weight and gestation within the Alberta population of newborn infants. The impact of multiple risk factors clearly highlights the potential benefit that may be achieved through effective interventions. In addition to describing the dynamics between the factors under study, it is also important to describe the distribution of these factors within Alberta. A focus on the regional distribution of risk factors allows for the identification of potential problem areas and provides an opportunity to target public health initiatives to ensure efficient and relevant program delivery. The current section will discuss the geographic, as well as age distribution, of each factor under study.

4.1 BIRTH WEIGHT AND PRE-TERM BIRTH

Overall, 5.9% of the live births in Alberta between 1994 and 1996 were under 2500 grams. The distribution of low birth weight (<2500 grams) and pre-term (<37 completed weeks gestation) birth by Regional Health Authority are presented in **Figures 4.1** and **4.2** respectively. The proportion of low birth weight live births ranged from a high of 6.3% for the Calgary Regional Health Authority to a low of 4.2% in the Northwestern Health Authority.

Despite the strong relationship between pre-term delivery and low birth weight, the geographic distribution of pre-term birth showed a different pattern (**Figure 4.2**). The pre-term delivery rate was 7.5% between 1994 and 1996. Palliser (6.2%) and Mistahia (6.8%) had pre-term delivery rates which were statistically significantly lower than the provincial rate. Both the Capital (8%) and Keeweetinok Lakes (9.5%) Health Authorities had rates that were significantly higher than the provincial average.

Figure 4.1 Distribution of Low Birth Weight by Health Region in Alberta, 1994-96.

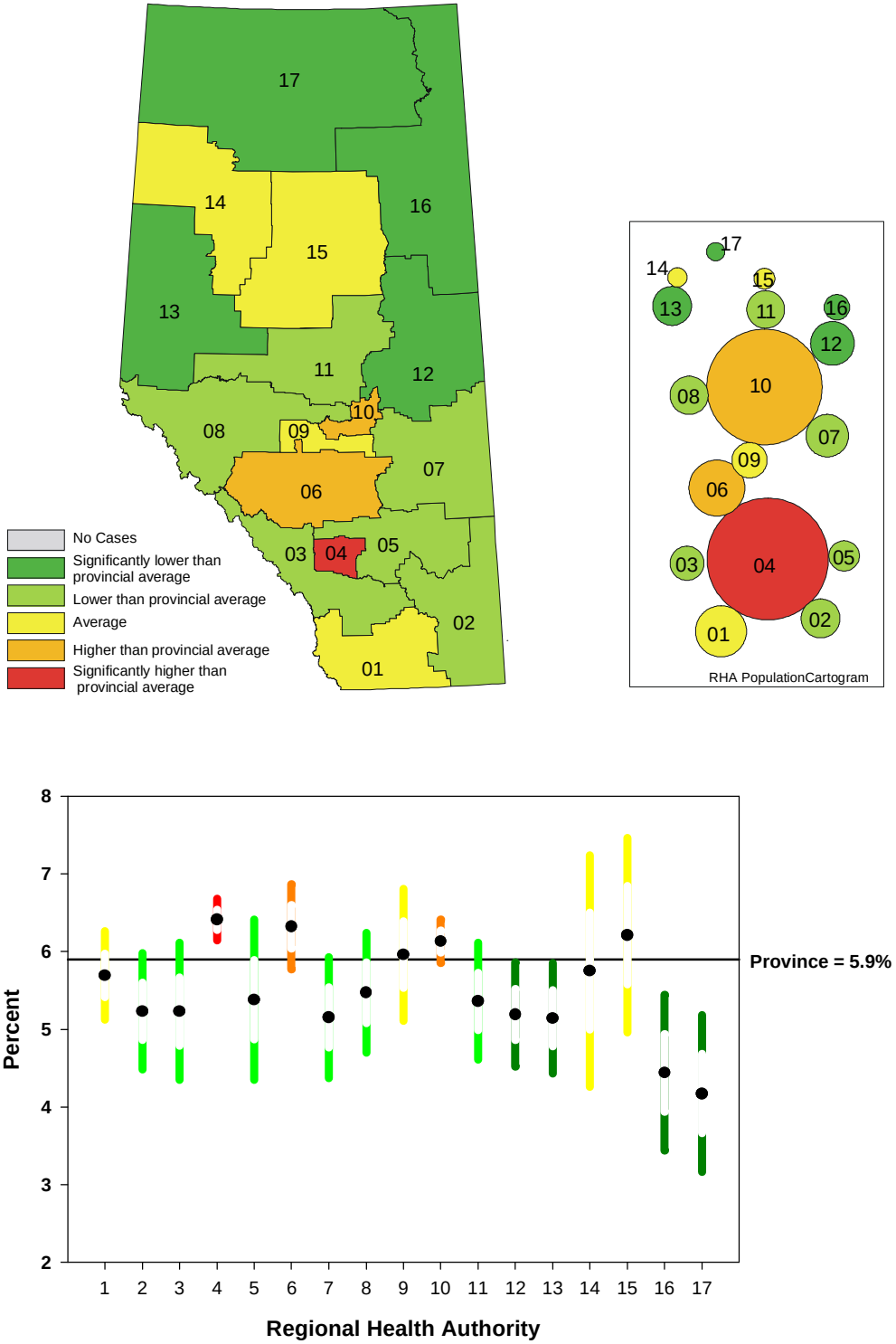
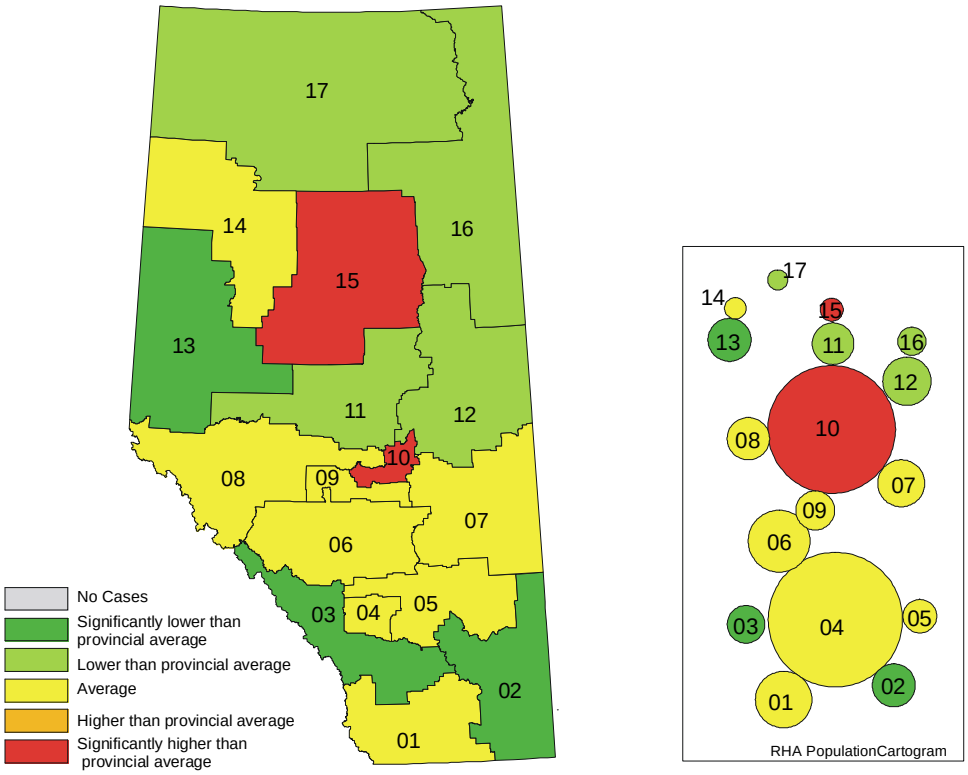
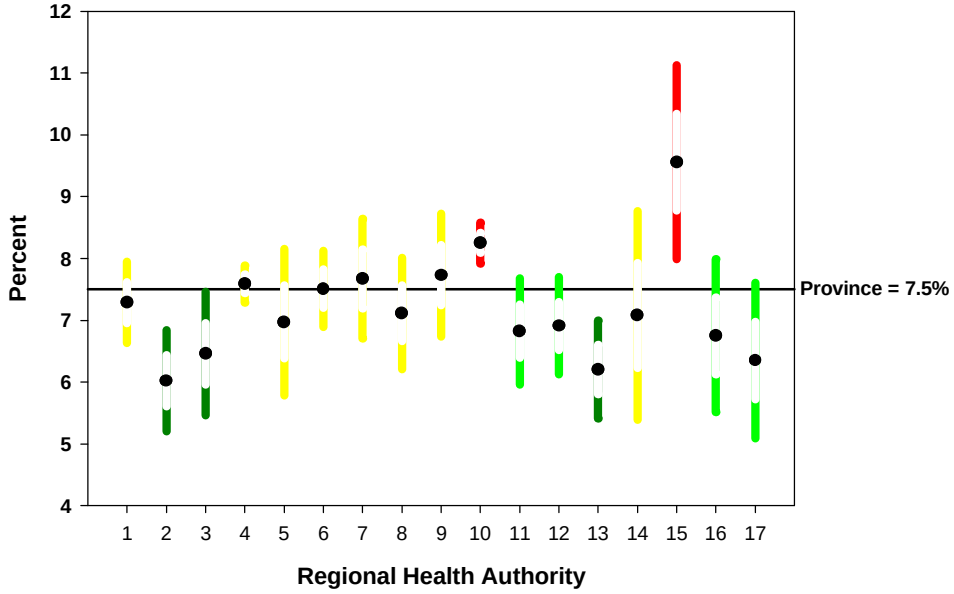


Figure 4.2 Regional Distribution of Pre-term (<37 weeks gestation) Births in Alberta, 1994-96.





4.2 MATERNAL AGE

The average maternal age at time of delivery between 1994 and 1996 was 28.4 years (26 years for first delivery), with the youngest mother being 12 and the oldest 51. The average age ranged from a low of 25.6 years in Northwestern to a high of 29.4 years in Calgary. The greatest proportion of births was to women aged 20-34 (81%), followed by women over age 34 (12%) and those aged 12-19 (8%).

Figure 4.3 displays the proportion of live born low birth weight newborns by the age of the mother. A bimodal distribution is evident from this figure, with the highest proportion of low birth weight newborns occurring among teens and women over age 35. A similar pattern is evident for pre-term delivery (<37 weeks) with younger (<18 years) and older (≥35 years) mothers having the highest rates (**Figure 4.4**). These findings are consistent with the research literature indicating an increased risk for both low birth weight and pre-term delivery among younger and older mothers.

Figure 4.3 Percentage of Low Birth Weight Newborns by the Age of Mother, 1994-1996.

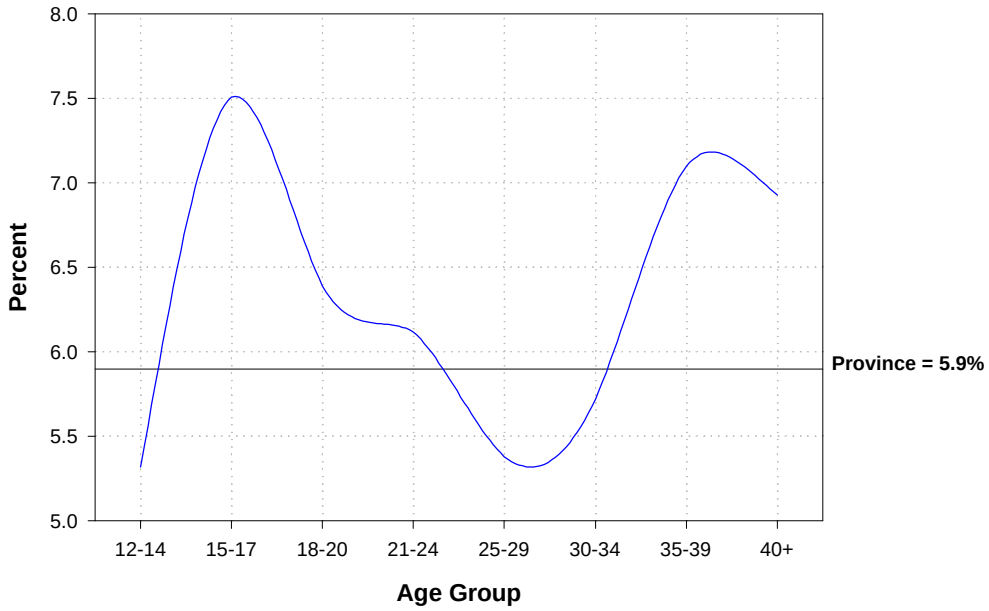
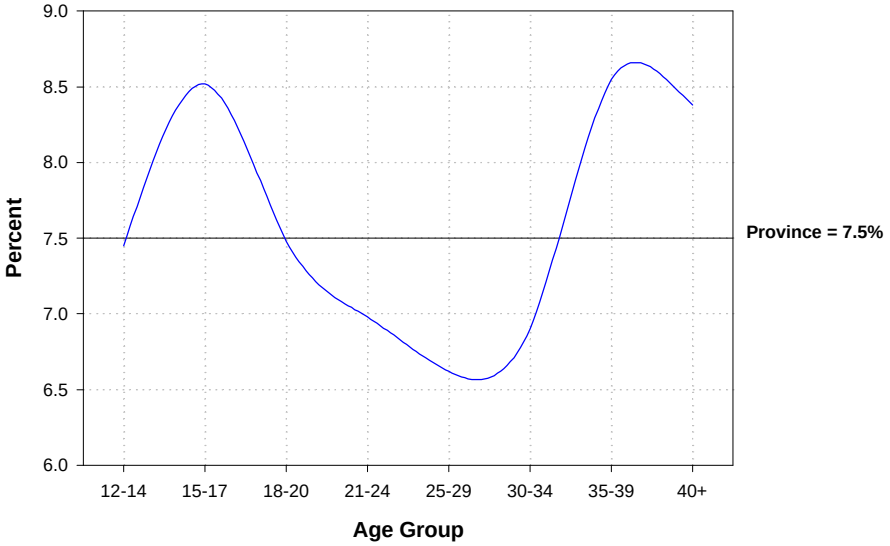
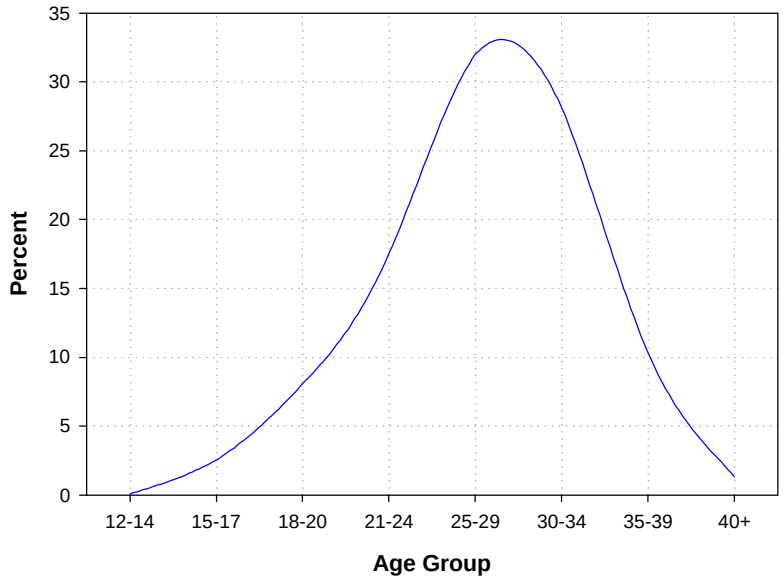


Figure 4.4 Percentage of Pre-Term (<37 weeks) Births by the Age of the Mother, 1994-96.



While the risk for both LBW and pre-term birth are clearly elevated for both the younger (<18 years) and older (≥ 35) mothers it should be noted that the vast majority of births (81%) occur to women between the ages of 18 and 35 (**Figure 4.5**).

Figure 4.5 Percentage Distribution of Live Births by Age of the Mother, 1994-1996.



Significant geographic differences exist in both the percentage of women age 35 and older and under age 18 delivering across Alberta's 17 Regional Health Authorities. Live births to women

age 35 and older were significantly higher than the provincial rate (11.7%) in the Calgary (15.3%), Capital (12.9%) and Headwaters (14.1%) health regions. The converse was true for the percentage of women under age 18 delivering in Alberta. A strong increasing percentage was observed among the northern most areas of the province. Both Keeweetinok (5.5%) and Northwestern (5.8%) were approximately twice the provincial rate (2.6%) for births to teens.

Figure 4.6 Regional Distribution of Births to women under age 18 in Alberta, 1994-96.

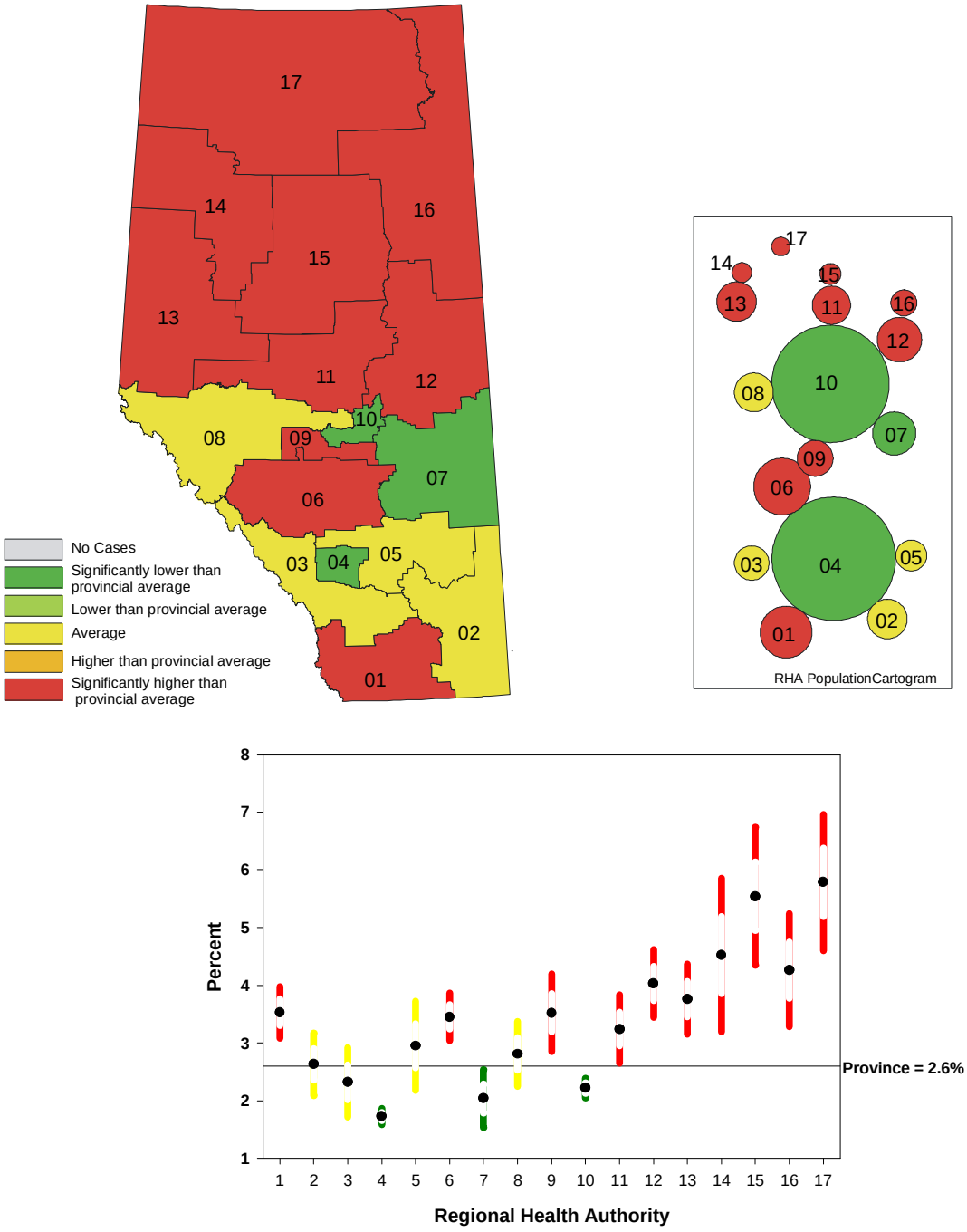
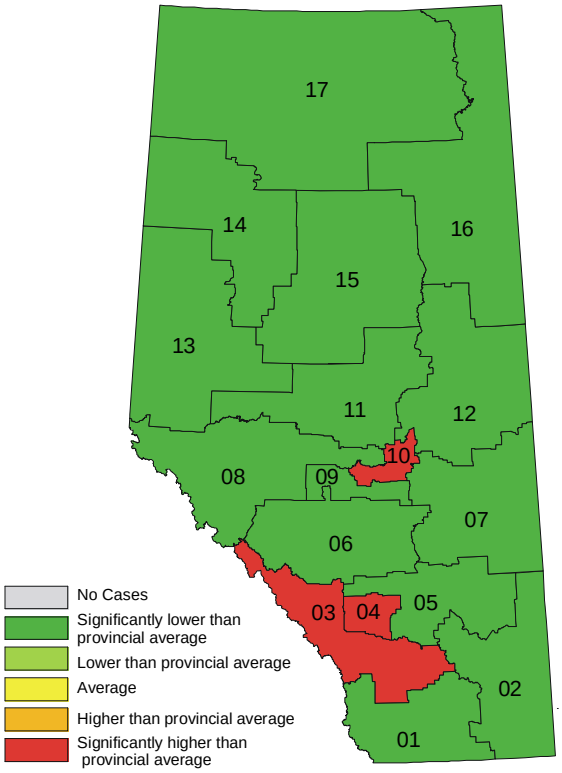
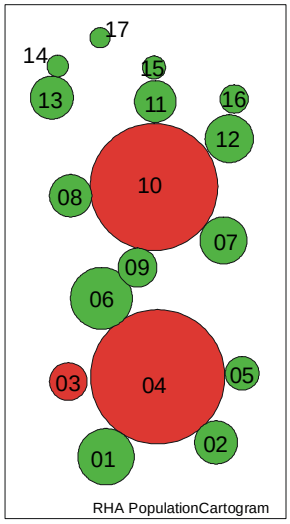
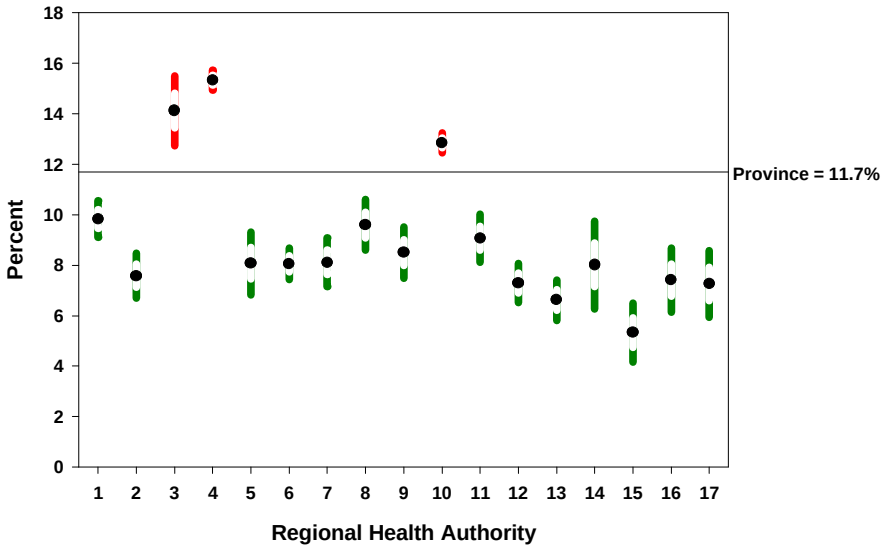


Figure 4.7 Regional Distribution of Births to women aged 35+ years in Alberta, 1994-96.







4.3 PRENATAL CARE

The extent to which prenatal care contributes to positive birth outcomes is not fully known. However, it is generally excepted that some form of prenatal care is more beneficial than none.[57] Unfortunately, information about the form and type of prenatal care is often lacking or refers only to the care provided by a health professional; usually a physician. The present study distinguishes between prenatal visits to a physician (or midwife) and prenatal classes, often provided by instructors of varying backgrounds. While the quality of these interventions cannot be directly assessed here, attendance can be measured. Limitations with the data are present and include: no measure of the adequacy of the prenatal care; and an inability to assess knowledge uptake and the adoption of positive behaviours. These limitations would mask positive effects resulting in conservative estimates of the impact of prenatal classes and visits on birth weight and gestation.

4.3.1 PRENATAL CLASS ATTENDANCE

Within Alberta, participation in prenatal classes was associated with both age and parity. As presented above (**Figure 3.1**), multiparous women were less likely to attend prenatal classes; possibly a result of having attended during a previous pregnancy. There also appears to be an age effect independent of parity with older (age ≥ 35) primiparous women less likely to attend prenatal classes compared to primiparous women between the ages of 20 and 35 years.

Considering the inverse relationship between parity and prenatal class attendance, it becomes important to control for parity when making comparisons. Thus both **Figures 4.8** and **4.9** only present data for primiparous women. Overall, 65% of women attended some form of prenatal class, ranging from a low of 45% among women under age 18 to a high of 75% among women between the ages 30 and 34 years (**Figure 4.8**).

Figure 4.8 Proportion of women attending prenatal classes (parity=1), 1994-96.

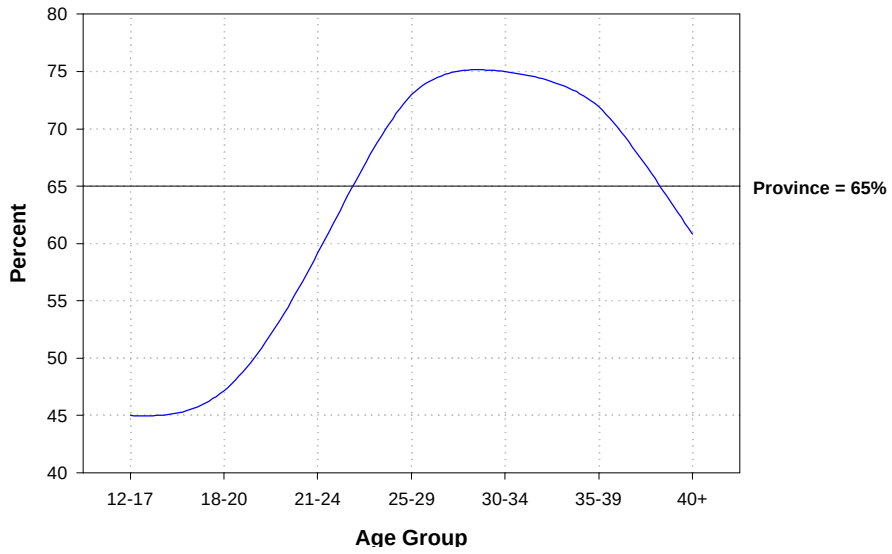
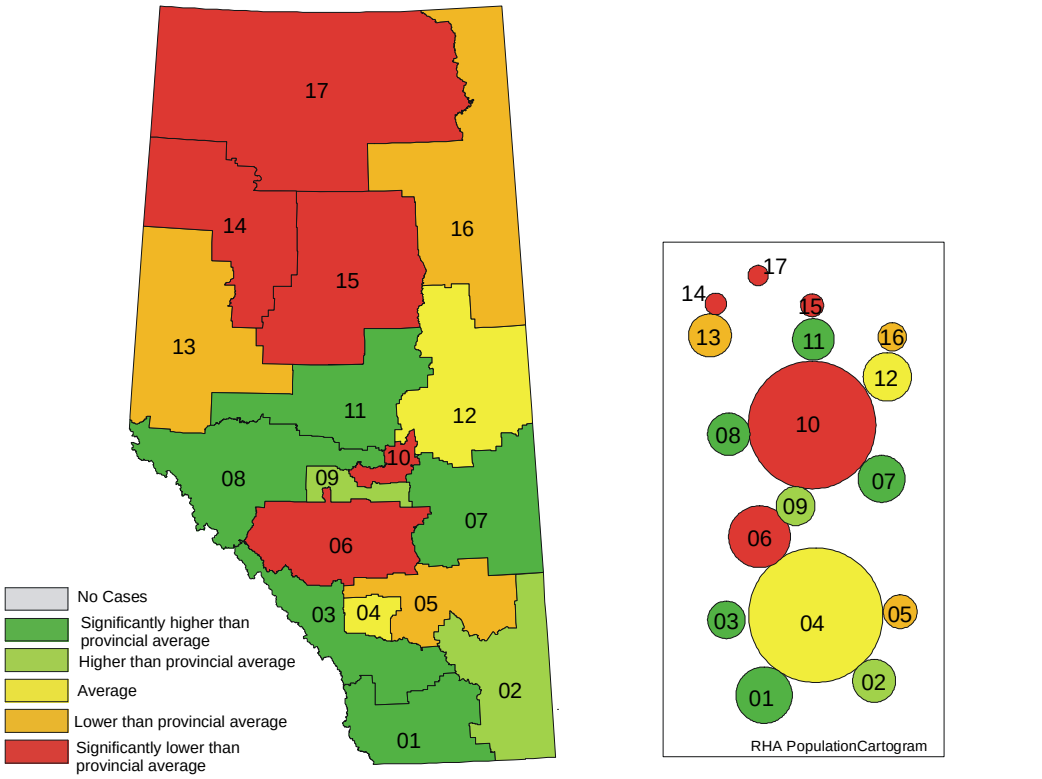
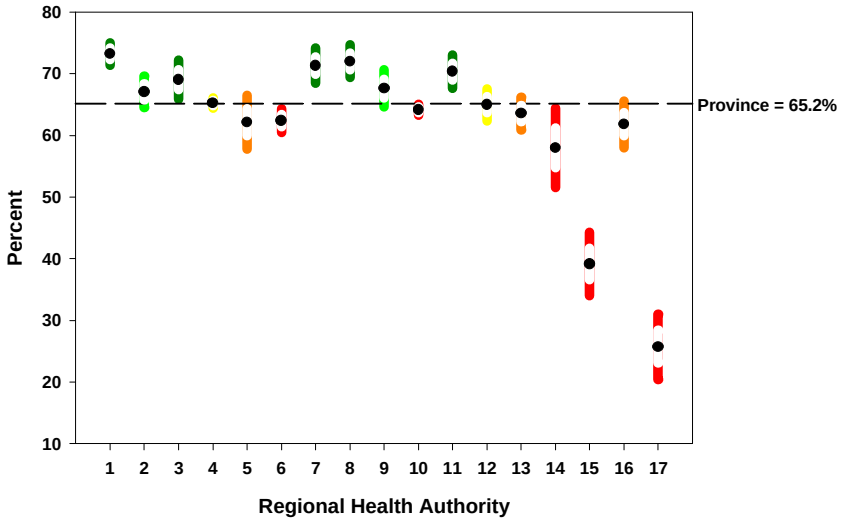


Figure 4.9 Percentage of Women Attending Prenatal Classes by Regional Health Authority, 1994-96





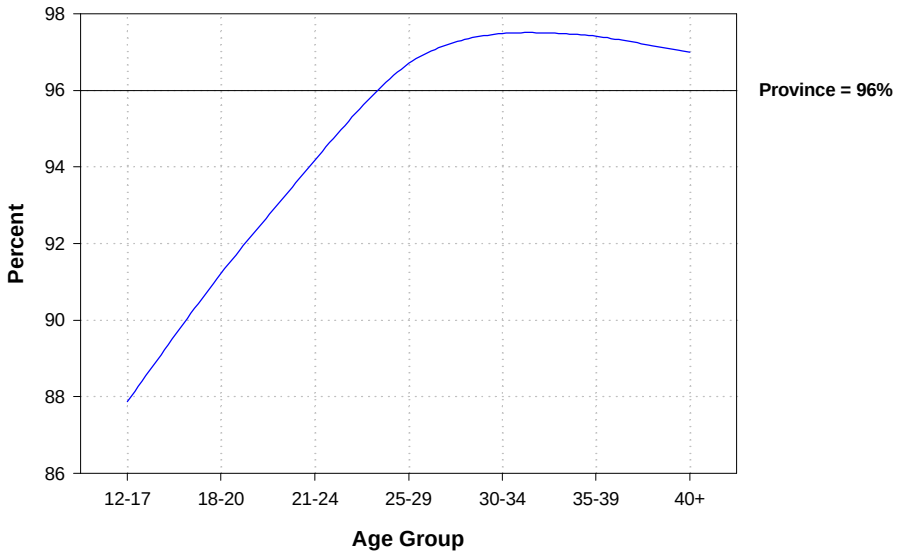
Statistically significant differences in the distribution of prenatal class across Alberta's seventeen Regional Health Authorities was observed (**Figure 4.9**). Five health regions (David Thompson, Capital, Peace, Keeweetinok, Northwestern) were significantly lower than the provincial average of 65%. Prenatal class attendance was particularly low in the two northern regions of Keeweetinok (39.2%) and Northwestern (25.7%). Reasons for these disparities are not evident from the present data, but require further attention to develop strategies for addressing the low rates of attendance, particularly in light of the positive impact attendance appears to have on birth outcomes, such as birth weight and gestation.

4.3.2 PRENATAL VISITS

Prenatal visits are intended to monitor progress and ensure interventions needed are delivered in a timely manner and they typically involve some form of contact with a physician or other health care provider (i.e. midwife). It differs from prenatal classes in that prenatal visits typically involve contact with a physician, and are focused mainly on the clinical aspects related to the pregnancy.

Overall, the median number of prenatal visits was nine. To ensure optimal follow-up and care during pregnancy, a cut-off of four or more prenatal visits was used for the present report as a proxy for having a minimally acceptable number of prenatal visits. Even if a child was delivered pre-term, it is reasonable to suggest that at least four prenatal visits could have been attended.

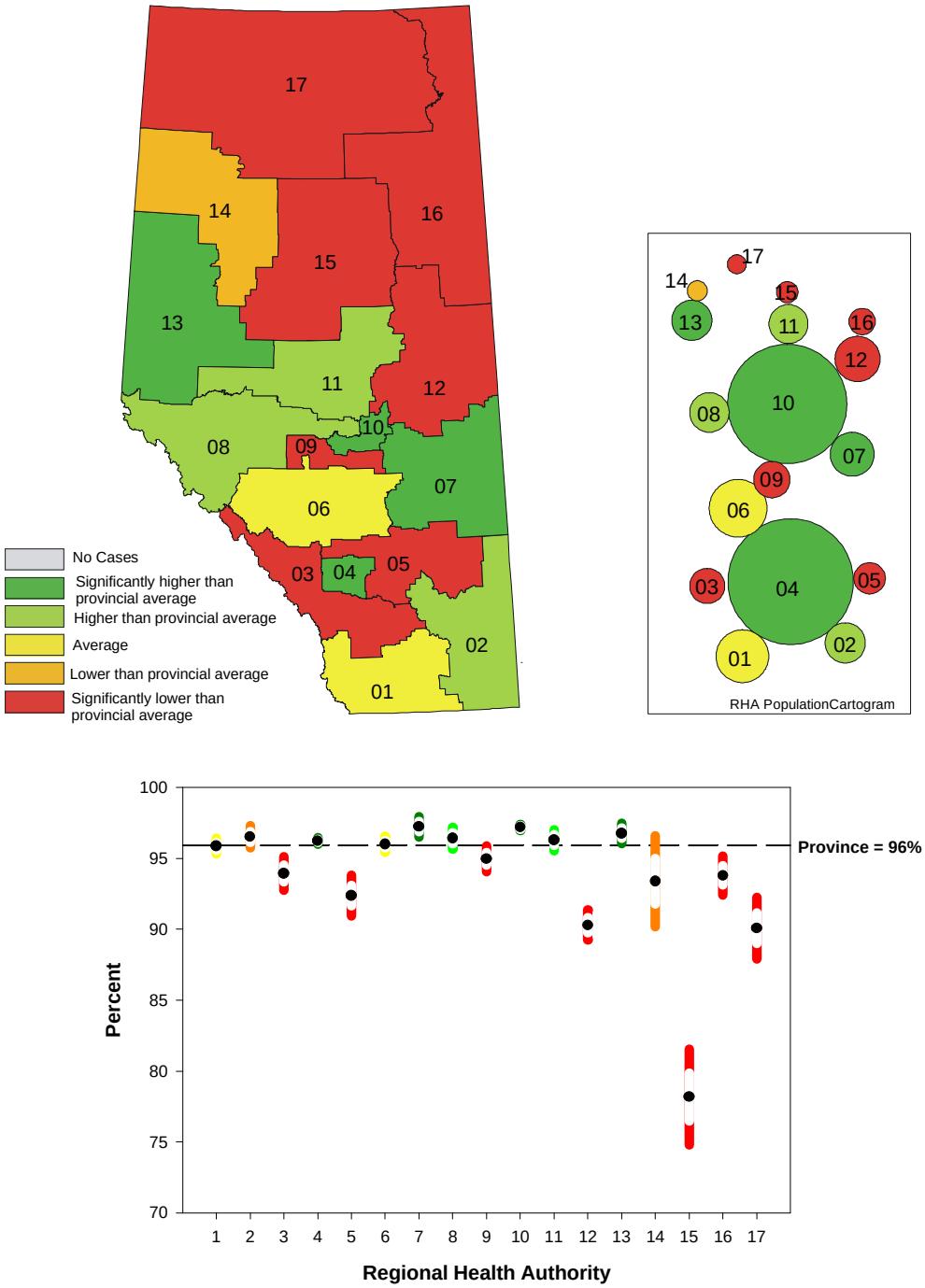
Figure 4.10 Proportion of women having four or more prenatal visits, 1994-1996.



Among women over the age of 25, virtually all (>97%) had received four or more prenatal visits (**Figure 4.10**). The number of visits was lowest among women under the age of 20 years.

As seen in **Figure 4.11**, seven health regions were significantly lower than the provincial average on this measure. In particular, the Keeweetinok health region had the lowest proportion of women having four or more prenatal visits. The low rate of prenatal visits would appear to warrant attention given the poor outcomes related to birth weight and pre-term birth.

Figure 4.11 Percent of Women having Four or More Prenatal Visits.



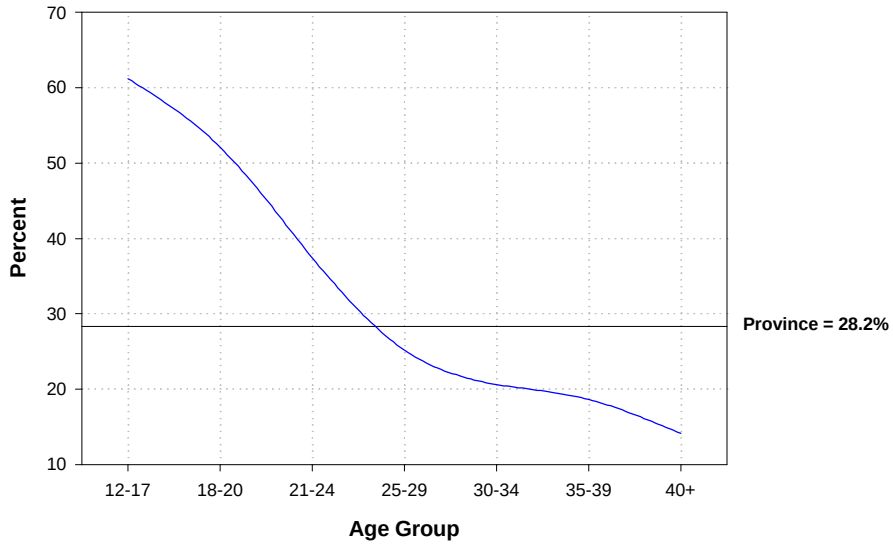
In summary, many factors have an influence on the number of prenatal visits and it is noted that a woman who delivers a pre-term newborn has less opportunity to be exposed to prenatal visits. Also, it is not possible, from this data, to assess the adequacy of the care provided. Nor is it possible to assess knowledge uptake and adoption in the form of healthier behaviours during pregnancy. However, prenatal visits appear to play a positive role influencing birth weight, whether directly or indirectly.

4.4 TOBACCO USE

Smoking has been well established as a risk factor related to low birth weight.[58] While there is some evidence that smoking reduces gestation,[59] it is believed that smoking primarily affects intrauterine growth. The results of the structural equation modeling analysis presented earlier in this report would appear to support the theory that smoking during pregnancy affects intrauterine growth rather than gestational age at delivery. Unfortunately, the data on quantity smoked was not sufficient to determine any potential dose-response relationship. Despite this, smoking still remains as a significant, potentially modifiable, risk behaviour. The cessation of smoking during pregnancy leads to increases in birth weight, though these newborns still lag behind those from mothers who did not smoke at all during the pregnancy.

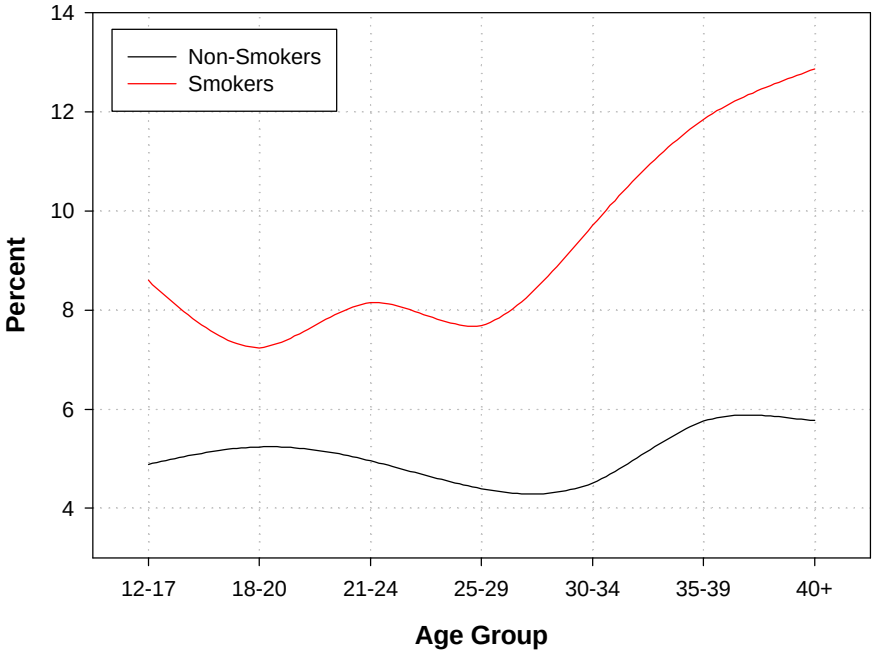
Smoking was reported by 28.3% of women delivering between 1994 and 1996. Of these, only 8% reported that they had quit during pregnancy. Smoking was more common among younger mothers with nearly 60% of women under age 18 reporting tobacco use (**Figure 4.12**) compared to less than 20% among women aged 35 and older. The effects of tobacco use on the risk of a low birth weight newborn appear to differ according to age. While smokers were at an increased risk of having a low birth weight baby at all ages, it was particularly pronounced among mothers over the age of 30.

Figure 4.12 Proportion of Women Smoking During Pregnancy by Age, 1994-1996.



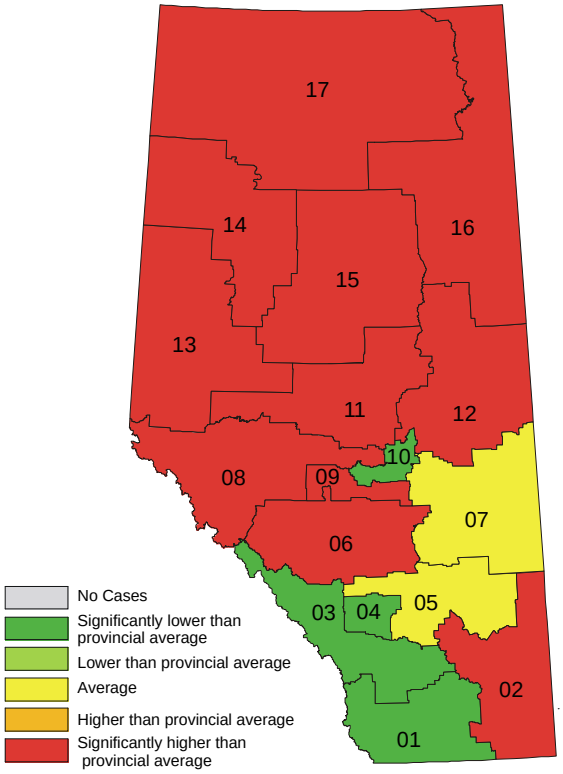
Low birth weight among non-smokers was fairly consistent across age groups although women over 35 were slightly more likely to have a low birth weight baby. The maternal age-specific incidence of low birth weight for smokers clearly emphasizes the adverse effect of tobacco use on birth weight. The detrimental effect of smoking is enhanced with increasing maternal age. Women aged 12 to 17 years who smoked had a low birth weight rate of 8.6% compared to 12.9% among women over 40 (**Figure 4.13**).

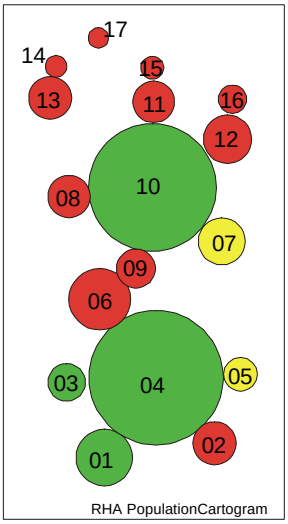
Figure 4.13 Proportion of low birth weight newborns by age of mother and smoking status, 1994 – 1996.

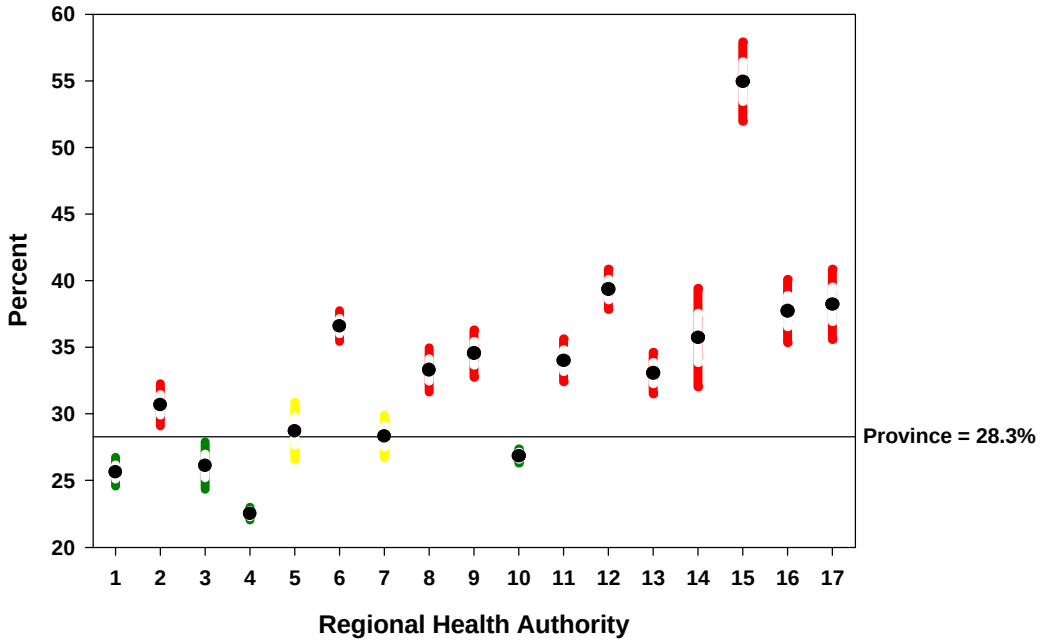


Significant regional variation exists for both smoking and smoking cessation across the 17 health regions. A pattern of high smoking rates is evident among the northern most regions of the province. **Figure 4.14** provides the regional smoking rates. Eleven of Alberta's 17 Regional Health Authorities had smoking rates significantly higher than the provincial rate of (28.3%). Smoking rates ranged from a low of 22.9% in the Calgary Regional Health Authority to a high of 55.1% among mothers living in the Keeweetinok Lakes Health Authority.

Figure 4.14 Regional distribution of smoking rates in Alberta, 1994-1996.





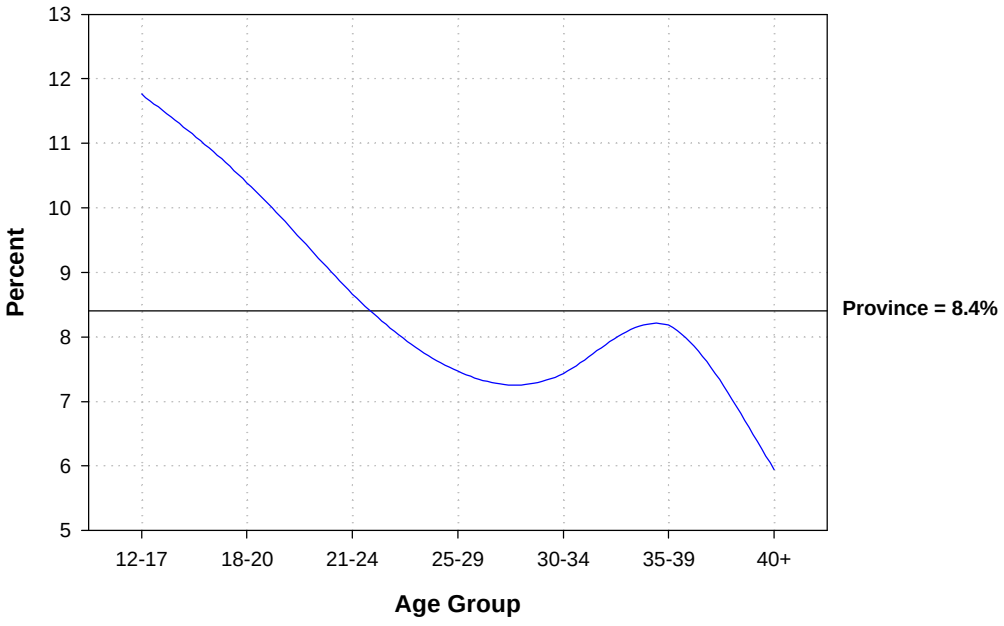


4.5 SMOKING QUIT RATES

The risk of having a low birth weight newborn was significantly reduced if the mother quit during pregnancy. However, the risk of a low birth weight newborn among quitters remained elevated relative to those women who did not smoke at all. The increase in birth weight associated with the cessation of smoking is important information supporting public health practices which support the reduction of tobacco use during pregnancy. Smoking cessation offers the potential for significant improvements in birth weight, and a coincident reduction in some of the long term sequelae related to LBW.

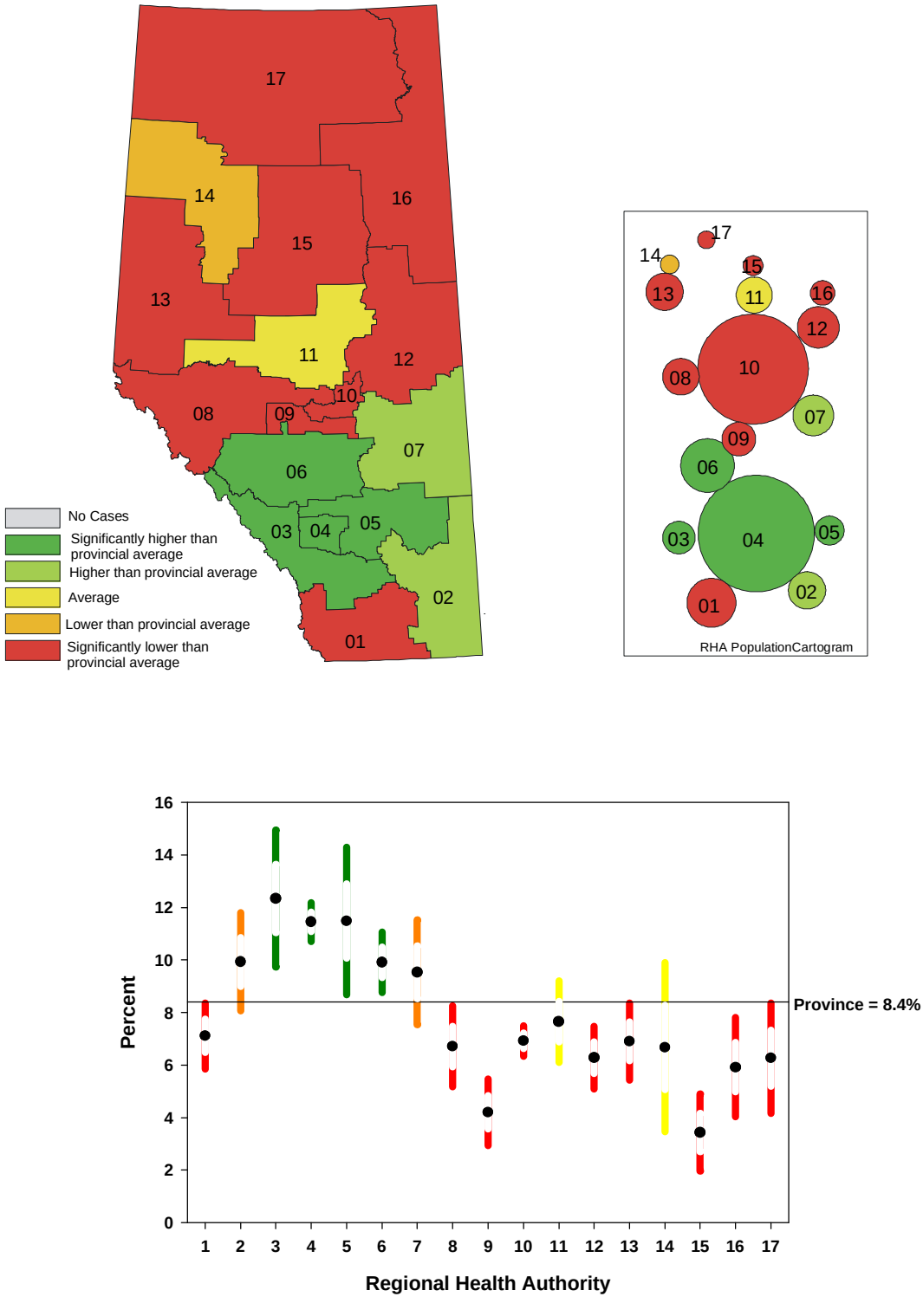
Overall, 8.4% of women who smoked indicated that they had quit during the current pregnancy. This lags substantially behind other jurisdictions where quit rates of up to 30% have been reported.[60] It is interesting to note that younger women were more likely to report quitting, despite being more likely to engage in this and other risk behaviours. Nearly 12% of women under 18 years of age reported quitting, compared to only 6% of women over 40.

Figure 4.15 Proportion of women who quit smoking during pregnancy, 1994-96.



Comparing the geographic distribution of smokers (**Figure 4.14**) with those who quit (**Figure 4.16**) provides interesting and valuable information. For example, in the Calgary Regional Health Authority where the overall proportion of smokers is relatively low, quit rates were the second highest. In contrast, the Northern health regions of the province had a greater proportion of women smoking during pregnancy and the lowest quit rates. An increased focus on tobacco reduction strategies, particularly among pregnant women, appear to be warranted, particularly among the northern most Health Regions of the Province.

Figure 4.16 Regional Distribution of Smoking Quit Rates in Alberta, 1994-1996.



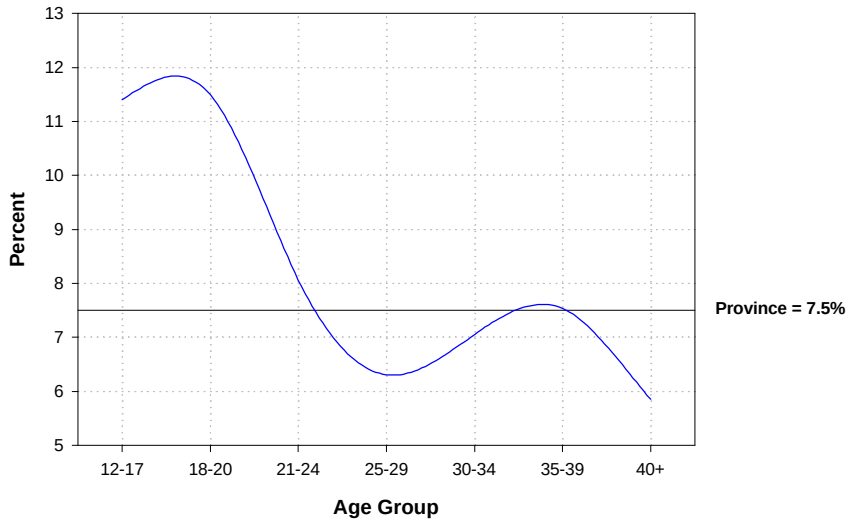
4.6 ALCOHOL

Alcohol use during pregnancy was reported by 7.5% of women . Unfortunately, the question related to alcohol use did not provide adequate information on the quantity and frequency of use during pregnancy. As a result, this variable includes those women who had a single drink during pregnancy as well as those with chronic use. Because it was not possible to separate out these disparate groups of drinkers, they were grouped together as women who drank during pregnancy. This approach reduces or masks the effects of alcohol consumption on birth weight and gestational age. Any effect attributed to alcohol consumption in the present analysis can be considered conservative, thus representing an underestimate of its influence.

The effects of alcohol reported in the literature suggest either a negative correlation[61] between use and birth weight and pre-term birth, or no association.[62 63 64] That is, those mothers who consumed alcohol, on average, had heavier newborns. Despite the increased birth weight associated with moderate alcohol consumption, increased use of alcohol is strongly related to adverse outcomes, such as Fetal Alcohol Syndrome and other developmental delays. These complications themselves provide ample evidence that alcohol should not be consumed during pregnancy.

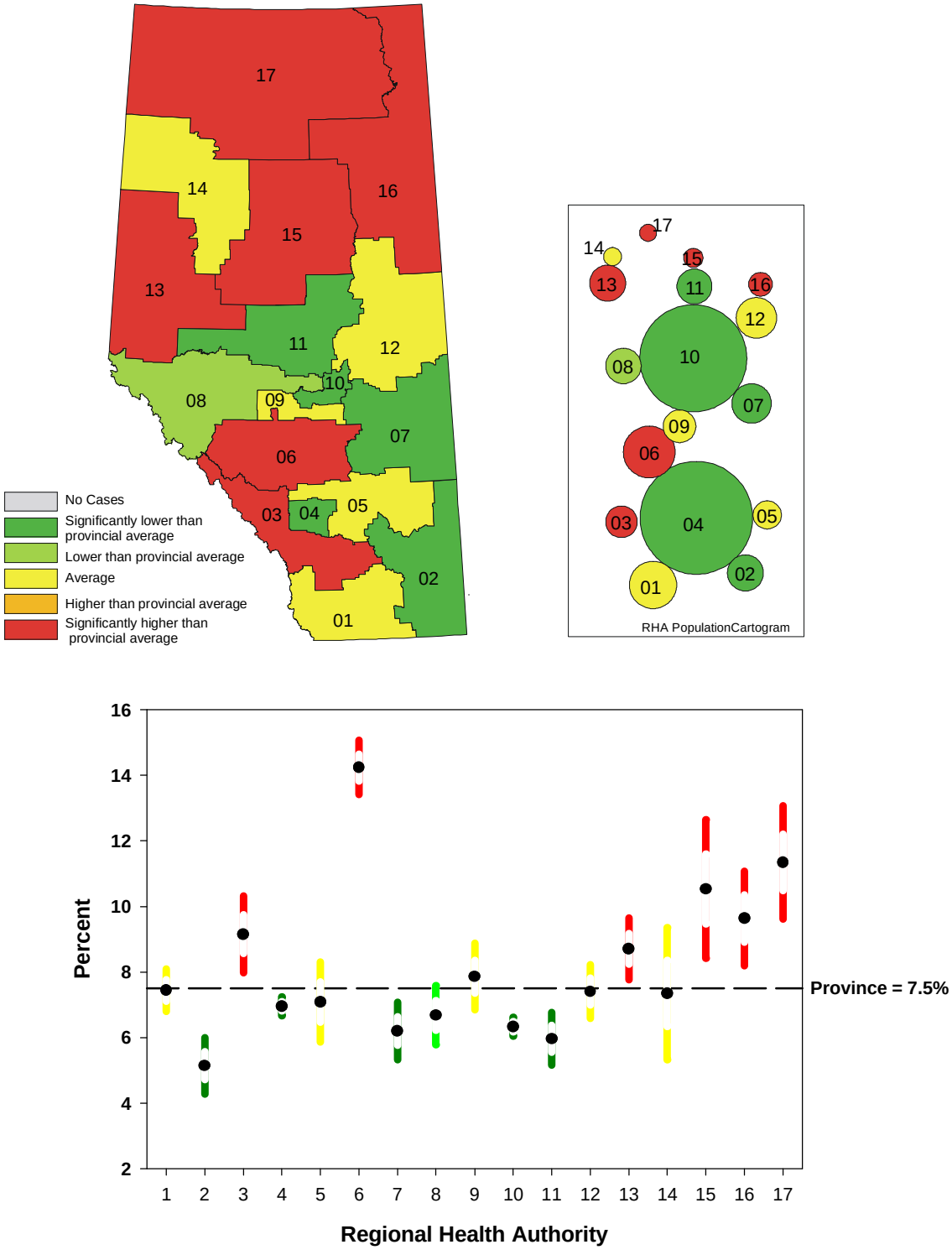
As with other risk factors, younger mothers appeared more likely to report alcohol consumption during pregnancy. Approximately 11.5% of women aged 12-20 indicated alcohol consumption, compared with 5.9% of women aged 40 and older. The reduction of alcohol use with increasing age may reflect increased awareness of the dangers of alcohol consumption during birth.

Figure 4.17 Percentage of mothers indicating some alcohol use by age at time of delivery, 1994-1996.



The highest rate was reported by the David Thompson Health Region with just over 14% of women drinking during pregnancy (**Figure 4.18**). This compares to the provincial rate of 7.5% and the lowest rate of 5.1% reported in Palliser.

Figure 4.18 Regional Distribution of Alcohol Consumption in Alberta, 1994-96.



4.7 ILLICIT DRUG USE

The PNOB (Physician Notice of Birth) collects information on whether the mother used street drugs during the current pregnancy and if so, what type of drug and frequency of use. Between 1994 and 1996, approximately 1.4% (n=1,479) of women who delivered reported the use of illicit drugs. Of these, the type of drug used was reported for 76% (n=1,128) of the cases. Cannabis was the most frequently reported drug with 77% (n=869) of the drug users reporting its use, followed by cocaine (17.5%).

A strong relationship with mother's age was noted (**Figure 4.19**), with younger mothers most likely to have used illicit drugs during the current pregnancy. Drug use ranged from a high of 6.4% among mothers aged 12 to 17 years to a low of 0.5% for mothers aged 35 and older.

Figure 4.19 Percentage of mothers reporting illicit street drug use during by age at time of delivery, 1994-1996.

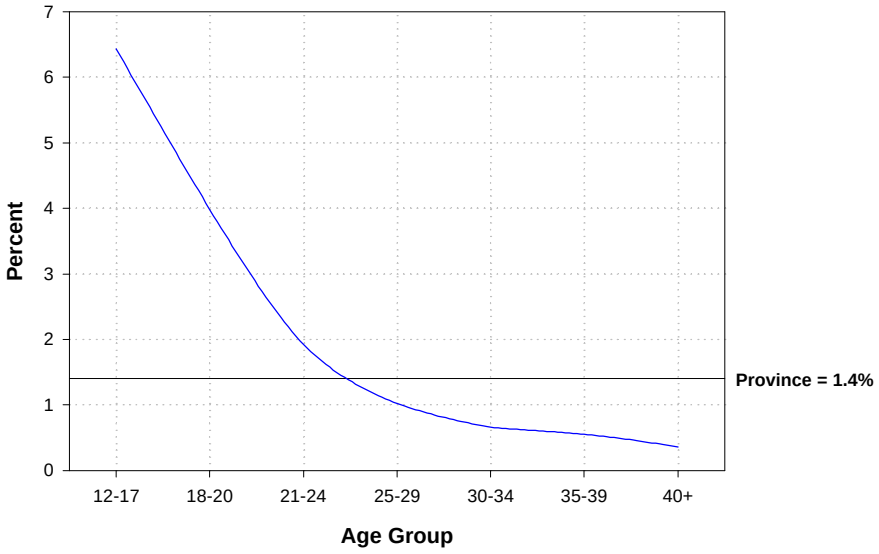
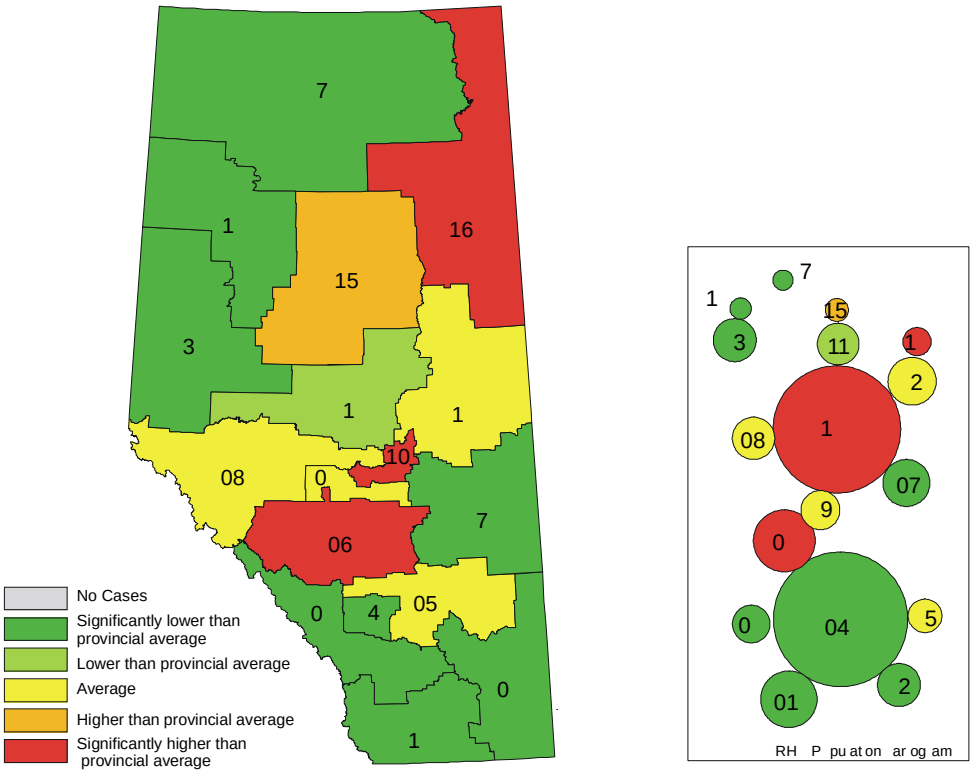
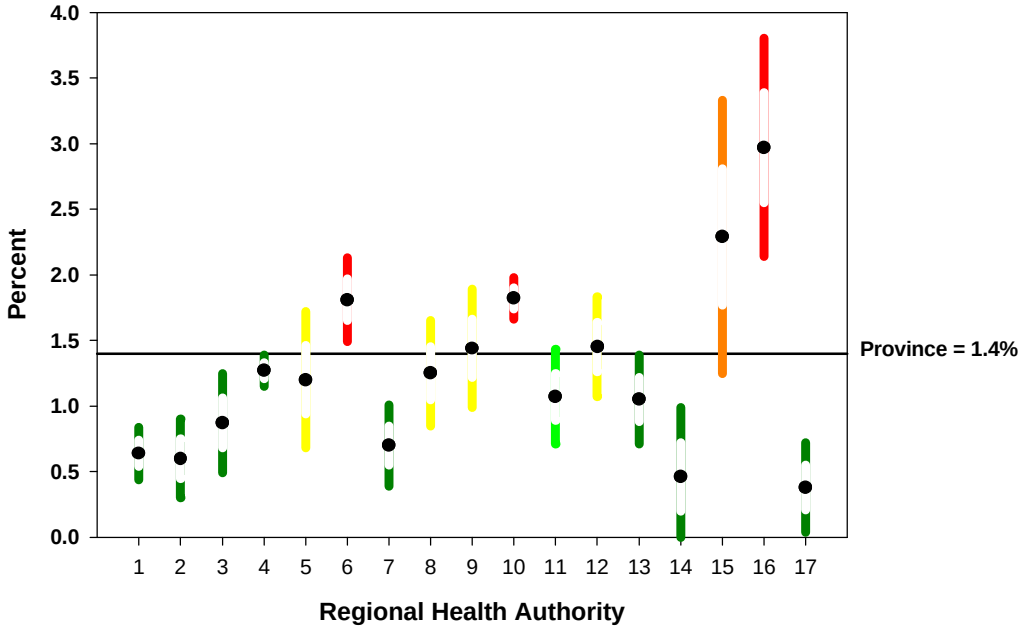


Figure 4.20 displays the geographic distribution of illicit street drugs across Alberta's 17 Regional Health Authorities. Three regions (David Thompson, Capital, Northern Lights) had significantly higher rates of drug use during pregnancy. Also of note was that Health Region 15 (Keeweetinok) also had a high proportion of women using illicit drugs during pregnancy. Illicit street drug use was lowest in the Northwestern Health Region (0.4%) and highest in Northern Lights where 3% of mothers indicated illicit drug use during the current pregnancy.

While the absolute number of women using illicit street drugs is low relative to the other risk factors examined, its impact on birth outcomes is significant.

Figure 4.19 Regional distribution of illicit street drug use in Alberta, 1994-96.





5.0 CONCLUSION

With any report , it is important to be aware of the limitations of the findings due to the source of the data. The data for this study were obtained from a form that is part of the patient record within hospital and is primarily used to direct patient care and follow-up. The PNOB may be completed by a variety of professionals and differences may occur due to biases in the recording of information. In particular, some of the data collected is highly sensitive and depends on both interaction and trust between health professionals and the mother. Questions about use of alcohol, illicit drug use and smoking may be inconsistently reported across jurisdictions for a variety of reasons. The impact of such a bias would be to underestimate the effect of the risk factor on the outcome Also, other factors that may increase the risk of LBW and pre-term delivery, such as socio-economic status, in vitro fertilization and assisted reproduction, delivery of a previous high risk infant, physical and emotional abuse, and maternal occupation can not be evaluated within this context as this data is not routinely collected, hence, not all risk factors can be taken into account in the data modeling.

Off-setting the limitations to the data are its obvious strengths. The data are population based, capturing all births, using a standard form (PNOB) for data collection. The completion of the PNOB, within 24 hours of the birth, for every birth in Alberta is a provincial standard. Understanding the determinants of an event is a prerequisite towards the development and implementation of appropriately targeted interventions. Population based data on the predictors and patterns of LBW and pre-term birth provide valuable information that can be used to monitor changes in both behaviours and outcomes.

This information provides a description of some maternal behaviours that impact birth weight and pre-term birth. As part of this analysis, a number of patterns are evident and potentially useful for focusing efforts to reduce the incidence of low birth weight and pre-term birth and ultimately to improve long-term outcomes.

Younger mothers were most likely to engage in multiple risk behaviours . The proportion using alcohol, tobacco and illicit drugs was consistently higher among teenage mothers. On a positive note, younger mothers appeared to be more successful in smoking cessation. Despite the greater proportion of younger mothers engaging in risky behaviours, the impact of multiple risk behaviours on poor outcomes was greater among the older mothers. Thus, if an older mother has the same risk profile as a younger one, her outcomes will, on average, be worse.

Older mothers (aged 35 and older) were most likely to be married, to have had 4 or more prenatal visits, to deliver twins or higher order multiples, and to have an infant with a visible birth defect. Older mothers were also at an elevated risk for both pre-term delivery and low birth weight.

In Alberta, the prevalence of smoking during pregnancy was 28.8%; similar to rates reported for New Zealand (33%) and Nova Scotia (32.4%), but higher than Ottawa, Ontario (18.7%). In New Zealand, approximately 30% of women will quit during pregnancy.[32] The quit rate in Alberta was comparatively low at 8.2%; indicating that more could be done to encourage women to quit during pregnancy. Furthermore, the proportion of women who quit varied by the age of the

mother and by Health Region. Younger mothers were more likely to quit smoking, despite having a higher proportion of smokers overall. In general, the variation across Health Regions showed that those regions reporting the highest smoking rates also appeared to have the lowest quit rates.

While only 1.4% of pregnant women who delivered admitted to the use of illicit street drugs, 1,479 infants were exposed to the effects of drugs in utero. This exposure greatly increased the risk of adverse outcomes, both short and long term. Again, a pattern emerges where younger mothers were more likely to engage in this behaviour.

Of the three major risk factors examined, tobacco was the most prevalent and had a significant negative impact on birth weight. Reduction in the use of tobacco during pregnancy appears to have the potential to reduce the likelihood of delivering a low birth weight infant. Additional work is needed to improve the data collected on alcohol consumption during pregnancy. While the use of illicit street drugs is relatively low (1.4%), the impact to the newborn was significant. Better identification of women who use illicit drugs may improve the design and delivery of appropriate interventions. This would best be incorporated into an overall drug reduction strategy.

This report describes the relationship between a number of factors and their impact on low birth weight and pre-term birth. It also provides a description of how these factors are distributed across Alberta's seventeen Regional Health Authorities, an understanding of which helps to facilitate public health planning. A number of regional differences were noted and these data allow for comparisons and provide the ability to monitor progress over time towards the improvement of birth outcomes in Alberta. Low birth weight and pre-term birth are complex problems influenced by a number of factors; some potentially modifiable. Ongoing surveillance of the factors reported here is needed to support the development of targeted interventions aimed at improving reproductive outcomes.

6.0 GLOSSARY

Birth or Live Birth (LB) – The complete expulsion or extraction from the mother, irrespective of the duration of the pregnancy, of a fetus in which, after expulsion or extraction there is breathing, beating of the heart, pulsation of the umbilical cord or unmistakable movement of voluntary muscle, whether or not the umbilical cord has been cut or the placenta attached.

Birth Weight - The first weight of the fetus or newborn obtained after birth, preferably within the first hour after birth, before the significant post-natal loss has occurred.

Gestational Age (GA) – The duration of gestation is measured from the first day of the last normal menstrual period. Gestational age is expressed in completed days or completed weeks (e.g. events occurring 280 to 286 completed days after the onset of the last normal menstrual period are considered to have occurred at 40 weeks of gestation).

Pre-term – Less than 37 full weeks of gestation or less than 259 full days.

Term – 37 to 42 full weeks of gestation or between 259 and 293 full days.

Post-term – More than 42 full weeks of gestation or 294 full days or more.

Low Birth Weight (LBW) – Birth weight of less than 2500 grams.

Very Low Birth Weight (VLBW) – Birth weight of less than 1500 grams.

Extreme Low Birth Weight (ELBW) - Birth weight of less than 1000 grams.

Multiparous – Having had two or more pregnancies which resulted in viable fetuses.

Primiparous – Bearing or having borne one child.

Small for Gestational Age (SGA) – An infant with a birth weight less than the 10^{th} percentile for gestational age.

Stillbirth (SB) – The complete expulsion or the extraction from the mother after at least 20 weeks' pregnancy, or after attaining a weight of 500 grams or more, of a fetus in which, after the expulsion or extraction there is no breathing, beating of the heart, pulsation of the umbilical cord or unmistakable movement of voluntary muscle.

Total Births (TB) – All live births and stillbirths.

APPENDIX 1. BASELINE CHARACTERISTICS OF ALBERTA MOTHERS WHO DELIVERED AN INFANT BETWEEN 1994 AND 1996 IN ALBERTA

		n	%	total n
Maternal Characteristics				
Maternal Age				
	12-19	8,508	7.5	
	20-34	91,438	80.7	
	35-52	13,306	11.7	113,252
Marital status				
	married	83,289	73.6	
	single	29,904	26.4	113,252
Fetal Loss (Spontaneous+Therapeutic)				
	none	80,866	71.4	
	1	32,386	28.6	113,252
Prenatal visits				
	0-2	1,921	2.2	
	3-5	17,846	20.4	
	6-12	58,837	67.2	
	13 or more	8,971	10.2	87,575
Used Alcohol				
	none	97.760	92.5	
	some	7,911	7.5	105,671
Use Street drugs				
	none	103,716	98.6	
	drugs	1,459	1.4	105,175
Smoking during pregnancy				
	none	77,189	71.7	
	current	30,422	28.3	107,611
	quit	2,569	8.4	
Labor				
	spontaneous	74,800	75.1	
	induced	24,830	24.9	99,630
Attend Prenatal Classes				
	yes	34,797	34.9	
	no	64,928	65.1	99,725

APPENDIX 2. BASELINE CHARACTERISTICS OF INFANT OUTCOMES FOR ALBERTA MOTHERS WHO DELIVERED BETWEEN 1994 AND 1996 IN ALBERTA

Infant Characteristics		n	%	total n
Sex				
	male	58,359	51.5	
	female	54,893	48.5	113,252
Gestational Age (completed weeks)				
	15-23 weeks	178	0.4	
	24	83	0.1	
	25	101	0.1	
	26	71	0.1	
	27-28	228	0.2	
	29-30	357	0.3	
	31-34	2,227	2.0	
	35	1,508	1.3	
	36	3,293	2.9	
	37+	105,206	92.9	113,252
Pre-term				
	< 37 weeks	8,582	7.1	
	≥ 37 weeks	105,412	92.9	113,252
Small for Gestational Age (SGA)				
	Not SGA	102,072	90.1	
	SGA	11,179	9.9	113,251
Low birth weight				
	> 2500 grams	106,526	94.1	
	≤ 2500 grams	6,726	5.9	113,252
Birth outcome for this birth				
	Live born	113,252	99.4	
	Stillborn	736	0.6	113,988
Visible Birth Defect				
	none	109,746	96.9	
	one or more	3,506	3.1	113,252
Number of infants				
	singleton	110,624	97.7	
	twins	2,556	2.2	
	triplets	72	0.1	113,252
Parity (live births + stillbirths)				
	1	45,646	40.3	
	2 or more	67,606	59.7	113,252
Infants per year				
	1994	37,953	33.5	
	1995	37,940	33.5	
	1996	37,359	33.0	113,252

APPENDIX 3. REGIONAL DISTRIBUTION OF MATERNAL AND NEWBORN CHARACTERISTICS.

Health Region	Total Live Births	Pre-term Births (%)	Low Birth Weight (%)	Mean Maternal Age	Percent Married (%)	Prenatal Care (4+)	Spontaneous Labour (%)	Used Alcohol (%)	Smoked (%)	Used Illicit Drugs (%)	Multiple Birth (%)	Stillbirth (%)
Chinook	6,765	7.3	6.2	27.5	74.9	95.8	75.8	7.4	25.9	0.7	2.5	0.8
Palliser	3,562	6.2	5.8	27.4	76.9	96.5	83.2	5.1	31.2	0.6	2.0	0.8
Headwaters	2,564	6.7	5.8	28.9	73.6	93.8	75.0	9.2	26.4	0.9	2.1	0.9
Calgary	33,786	7.6	6.8	29.5	79.3	96.2	80.2	7.0	22.9	1.3	2.4	0.6
HA 5	1,944	6.9	5.7	27.7	73.1	92.4	79.2	7.1	29.2	1.2	2.5	0.5
David Thompson	7,790	7.6	6.8	27.4	67.6	96.0	75.7	14.3	37.4	1.8	2.7	0.7
East Central	3,202	7.7	5.5	27.8	80.3	97.2	72.8	6.2	28.9	0.7	2.5	0.6
Westview	3,468	6.9	5.8	27.8	71.9	96.3	67.3	6.7	34.0	1.2	2.8	0.4
Crossroads	3,088	7.6	6.3	27.6	69.5	94.9	72.0	7.8	35.4	1.4	2.6	0.6
Capital	30,080	8.0	6.5	28.7	73.9	97.1	70.3	6.3	27.4	1.9	2.4	0.5
Aspen	3,665	6.9	5.9	27.6	71.6	96.3	67.8	6.0	34.7	1.1	2.2	0.7
Lakeland	4,421	7.0	5.8	27.1	63.8	90.3	72.0	7.4	39.9	1.5	1.9	0.7
Mistahia	3,894	6.8	6.0	26.8	68.0	96.6	70.2	8.6	33.8	1.1	1.9	1.1
Peace	978	6.7	5.7	25.8	61.5	93.5	73.9	7.3	36.4	0.5	2.4	0.4
Keeweetinok	1,491	9.5	6.6	25.8	40.9	78.2	70.0	10.5	55.1	2.3	2.3	0.7
Northern Lights	1,723	7.0	5.0	27.2	60.0	93.7	68.7	9.7	39.0	2.9	1.5	0.6
Northwestern	1,573	6.7	4.8	25.4	57.0	89.6	77.8	11.1	39.0	0.4	1.7	1.0
Total	**113,994**	**7.5**	**6.4**	**28.4**	**73.5**	**95.6**	**74.8**	**7.5**	**28.8**	**1.4**	**2.4**	**0.6**

APPENDIX 4. CALCULATION AND INTERPRETATION OF GEOGRAPHIC RATES

Within this report information has been classified by the Regional Health Authority of the mother under study. The information was presented in the form of a coloured map, a graph and a cartogram. This display method was developed in part to address issues associated with the variations in population sizes across the 17 Regional Health Authorities.

The method consists of several steps:

1. **Calculate the rates for each region**.

Health Region	Low Birth Weight (LBW)	Total Births	Proportion LBW
1	189	3,453	0.05
2	183	3,069	0.06
.	.	.	.
.	.	.	.
.	.	.	.
17	65	1,557	0.04

2. **Calculate the rate for the province**.

- Number of Low Birth Weight Newborns: 6,726
- Total Number of Live Births: 113,252
- Proportion Low Birth Weight: 6,726 / 113,252 = 0.059

3. Calculate standard error of a probability of a health event for each regional rate using the following formula:

$$\sqrt{\frac{p(1-p)}{n}}$$

Where: p is the proportion (estimate of probability) for the region
n is the number of births.

Health Region	Low Birth Weight	Total Births	Proportion LBW	Calculation	Standard Error
1	189	3,453	0.05	$\sqrt{\frac{0.05(1-0.05)}{3,453}}$	0.0038
2	183	3,069	0.06	$\sqrt{\frac{0.06(1-0.06)}{3,069}}$	0.0037
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
17	65	1,557	0.04	$\sqrt{\frac{0.04(1-0.04)}{1,557}}$	0.0051

4. Calculate the regional specific standard scores.

This is accomplished by subtracting the regional proportion from the provincial proportion and dividing these by the standard score derived for each region in step 3. This is repeated for every region.

$$\frac{\text{regional proportion} - \text{provincial proportion}}{\text{regional standard error}}$$

5. **Graph the standard scores calculated in step 4**.

To assist in the interpretation of the regional standard colours the following colour scheme is used to differentiate the rates that may differ from the provincial average.

Score	Interpretation	Colour
> 2	Higher than Provincial Average (significant difference in a conventional statistical test ($p<0.05$)	Red
1 to 2	Probably Higher than Provincial Average ($p > 0.5$ but < 0.95 that difference is not due to random variation)	Orange
1 to –1	Not Likely to differ from Provincial Average ($p< 0.5$ that difference is not due to random variation)	Yellow
-1 to -2	Probably Lower than Provincial Average ($p > 0.5$ but < 0.95 that difference is not due to random variation)	Light Green
< -2	Lower than Provincial Average (significant difference in a conventional statistical test ($p<0.05$)	Dark Green

The black dot represents the value of the rate for each region. The colour of the bars above and below the dot represent the score of the region. The portion of the bar closest to the black dot represents the value for a standard score of 1 or –1, while the part of the bars farthest from the dot represent the value for a score of 2 or –2.

The figure above illustrates how to interpret the graphic for an individual region. The yellow bars are used to show that provincial rate crosses between the 1 and –1 score range. The table lists other colour possibilities by score category.

6. **Generate maps using the same categories for each region as listed in step 5**.

The graph and map are placed in the same page. The map allows the reader to obtain a quick overview while more detailed information is present on the graph . The colour assigned to each region is based on the colour of the bars in the graph for the same region. This provides a spatial context to the distribution patterns and consistency among the two graphic elements.

7. **Cartogram**.

A cartogram is similar to a map, however, each region is represented by a circle in which its size is proportional to its population. This graphic is useful for interpreting reported rates by providing an indication of the population size of each region. Each RHA in the cartogram is filled with the same colour as was used for the RHA in the provincial map.

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