

## A B S T R A C T

This study examined the impact of infant and maternal factors on preterm delivery and low birthweight (LBW) in Alberta between January 1, 1994 and December 31, 1996. Data on 113,994 births were collected from vital statistics registration birth data. Logistic regression models for preterm and LBW delivery suggested the key risk factors were multiple and still birth (odds ratios >22.0). Other characteristics included female gender, birth defects, nulliparous women, maternal age 35 and greater, unmarried, history of abortion, maternal smoking, maternal street drug use, and having less than 4 prenatal visits (odds ratios 0.86-2.54). Interactions between smoking and alcohol, and smoking and parity were noted. Efforts to improve the currently low rates (8.2%) of smoking cessation during pregnancy are required. Social, economic and medical factors associated with delayed childbearing and birth outcomes should be investigated.

## A B R É G É

L'étude porte sur l'influence des caractéristiques de la mère et du nourrisson sur les accouchements prématurés et l'insuffisance de poids à la naissance (IPN) en Alberta entre le 1<sup>er</sup> janvier 1994 et le 31 décembre 1996. Nous avons recueilli des données sur 113 994 naissances à partir des inscriptions aux registres d'état civil. Selon nos modèles de régression logistique pour les accouchements prématurés et l'IPN, les principaux facteurs de risque auraient été les accouchements multiples ou de bébés morts-nés (ratios d'incidence approchés >22,0). Les autres caractéristiques étaient le sexe féminin, les anomalies congénitales, la nulliparité et le fait pour la mère d'avoir 35 ans ou plus, d'être célibataire, d'avoir déjà avorté, de fumer, d'utiliser des drogues illicites ou d'avoir effectué moins de quatre visites prénatales (ratios d'incidence approchés 0,86-2,54). Nous avons constaté des interactions entre le tabagisme et l'alcool, et entre le tabagisme et le rang des naissances. Il faudrait s'efforcer d'améliorer les faibles taux de renoncement au tabac durant la grossesse (8,2 % actuellement) et étudier les facteurs sociaux, économiques et médicaux associés à la procréation tardive et à l'issue de la grossesse.

# Characteristics of Preterm Delivery and Low Birthweight Among 113,994 Infants in Alberta: 1994-1996

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Despite the identification of potential risk factors for preterm and low birthweight (LBW) delivery, their incidences have increased in some areas.<sup>1</sup> Risk factors that have been identified for premature delivery and/or LBW include maternal smoking, alcohol consumption, street drug use,<sup>2-4</sup> as well as maternal age and multiple birth.<sup>1,5</sup>

Preterm and LBW infants are at an increased risk of neonatal mortality and morbidity (including visual and hearing deficits, speech delay, reduced growth, and developmental delays), increased hospitalizations and use of physician services.<sup>5-10</sup>

The purpose of this population-based study was to investigate the determinants of preterm and LBW delivery in Alberta. A population-based study provides a sufficient sample size for determining the independent contribution of modifiable and non-modifiable risk factors towards infant outcome. This sample size enhances generalizability, which has been a problem in previous studies on preterm and LBW delivery.<sup>11</sup>

## METHODS

All 113,994 births in the Province of Alberta between January 1, 1994 and December 31, 1996 were included in the study. Data were obtained from the Physician Notice of Live or Still Birth and

Newborn Record (PNOB) which, by law, is completed on all births. Information on infant factors such as birth outcome (live-born, stillborn), gestational age (best estimate as derived from the maternal last menstrual period and antenatal ultrasound examination), multiple birth, gender, birthweight (weight in grams in the delivery room), and visible birth defects is included on the PNOB. Information on parity, gravida, frequency of prenatal visits, marital status, smoking, alcohol consumption, and street drug use is also collected.

All data were double entered, verified, and analyzed using SPSS/PC version 9.0. Bivariate analysis included Odds ratios, Chi Square tests, and comparisons of means.

Maternal smoking was categorized as "current smoker", "quit during pregnancy" or "non-smoker". Those who quit were grouped with current smokers for analysis. Alcohol was coded as "no use" versus "some use".

Unconditional logistic regression was used to develop models for independent risk factors for preterm delivery and LBW. Variables that were significant ( $p < 0.05$ ) in bivariate analyses were modelled. Variables were also evaluated for interaction with smoking, alcohol, and street drugs. If an interaction was significant, both the main effect and the interaction term were included. Variables that were not significant in each model at this stage were identified and a final model for preterm delivery and LBW was developed that included all significant independent variables and interaction terms. The robustness of each model was tested by separately inputting variables that were not significant in bivariate analyses, but were associated with preterm and LBW delivery in the literature. Variables that became significant

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upon reentry were included in the final models. Both modifiable and non-modifiable factors were modelled.

## RESULTS

Baseline infant and maternal characteristics are presented in Table I and Table II, respectively. The infant and maternal data were over 88.0% complete, with the exception of number of prenatal visits, where the response rate was 77.2%. Over the three-year period, there were 113,994 infants born in Alberta, 51.5% of whom were male. The mean gestation was 39.0 weeks (range 15-47), and 92.5% 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. The average maternal age at delivery was 28.4 years (range 12-51). Of all births, the majority occurred among women aged 20-34 (80.7%). The prevalence of smoking was 28.8%, although 8.2% of these women reported quitting during pregnancy. Alcohol consumption was reported by 7.5% of women, while 1.4% reported using street drugs.

### Preterm delivery

Preterm birth was defined as an infant who was born before 37 completed gestational weeks. The total number of preterm infants was 8,581, representing 7.5% of all births (Table I). The incidence of preterm birth increased significantly from 7.2% to 7.8% over the three years ( $p \leq 0.004$  trend). Variables significant in the bivariate analysis that were eligible for regression analysis included maternal age, marital status, abortion history, smoking, alcohol, street drug use, prenatal visits, spontaneous labour, infant gender, stillbirth, birth defects, and multiple birth. Parity was not significant in bivariate analysis, but was entered in the model due to previous findings of significance.<sup>1</sup> Due to missing data on the variable for spontaneous labour, inclusion of this variable reduced the size of the model by over 8,000 cases, and was excluded from the model. Significant interactions identified in bivariate regression analysis included smoking and alcohol, smoking and maternal age, smoking and parity, and smoking and street drug use.

**TABLE I**  
**Baseline Characteristics of Infants Delivered, Alberta, 1994-1996**

Infant Characteristics	n	%	Total n
Sex			
Male	58,741	51.5	
Female	55,247	48.5	113,988
Gestational age (completed weeks)			
15-23	398	0.3	
24-26	323	0.3	
27-30	680	0.6	
31-34	2327	2.0	
35-36	4853	4.3	
37+	105,413	92.5	113,994
Preterm			
< 37 weeks	8581	7.5	
≥ 37 weeks	105,413	92.5	113,994
Small for Gestational Age (SGA)			
Not SGA	102,245	89.7	
SGA	11,741	10.3	113,986
Low birthweight			
> 2500 grams	106,730	93.6	
≤ 2500 grams	7264	6.4	113,994
Birth outcome for this birth			
Liveborn	113,258	99.4	
Stillborn	736	0.6	113,994
Visible birth defect			
None	110,368	96.8	
One or more	3626	3.2	113,994
Number of infants			
Singleton	111,307	97.6	
Twins	2612	2.2	
Triplets	75	0.1	113,994
Parity (livebirths + stillbirths)			
1	45,932	40.3	
2 or more	68,062	59.7	113,994

**TABLE II**  
**Baseline Characteristics of Mothers who Delivered an Infant, Alberta, 1994-1996**

Maternal Characteristics	n	%	Total n
Maternal age (years)			
12-19	8577	7.5	
20-34	91,989	80.7	
35-52	13,428	11.8	113,994
Marital status			
Married	83,798	73.5	
Single	30,136	26.5	113,934
Abortion			
None	81,348	71.4	
1	23,166	20.3	
2 or more	9480	8.3	113,994
Prenatal visits			
0-2	1961	2.2	
3-5	18,006	20.5	
6-12	59,010	67.1	
13 or more	8995	10.2	87,972
Use alcohol			
None	98,336	92.5	
Some	7970	7.5	106,306
Use street drugs			
None	104,326	98.6	
Drugs	1479	1.4	105,805
Smoking during pregnancy			
None	77,521	71.2	
Current	28,803	26.4	
Quit	2587	2.4	108,911
Labour			
Spontaneous	75,055	74.8	
Induced	25,250	25.2	100,305
Attend prenatal classes			
Yes	34,905	34.8	
No	65,417	65.2	100,322

**TABLE III**  
**Logistic Regression Model of Preterm Delivery, Alberta, 1994-1996 (n=84,145)**

Variable	exp B	95% CI
Multiple births		
Singleton	1.00	
Multiple	22.98	20.74,25.45
Stillbirth		
No	1.00	
Yes	25.14	19.94,31.69
Married		
Yes	1.00	
No	1.18	1.09,1.28
Sex		
Female	1.00	
Male	0.86	0.80,0.91
Maternal age (years)		
12-19	1.00	
20-34	1.00	0.88,1.13
35+	1.37	1.18,1.59
Parity		
1	1.41	1.31,1.53
1 +	1.00	
Abortion		
Never	1.00	
One or more	1.16	1.08,1.24
Smoking		
No	1.00	
Yes	1.35	1.23,1.48
Alcohol		
No	1.00	
Yes	0.75	0.61,0.92
Birth defect		
No	1.00	
Yes	2.00	1.75,2.30
Prenatal visits		
<3	2.54	2.26,2.85
4 or more	1.00	
Smoke and alcohol		
Neither	1.00	
Both	1.49	1.16,1.91
Smoke and parity		
Parity >1 and non smoker	1.00	
Parity 1 and smoke	0.70	0.61,0.81

When significant variables and interactions were analyzed in a second run of the model, use of street drugs, and the interactions between smoking and maternal age and smoking and street drugs became non-significant. The model was run excluding these variables and interactions, with negligible changes in the risk estimates. The final model was developed with 84,145 cases (Table III). Independent variables in this model included multiple births, stillbirth, marital status, infant gender, maternal age, parity, abortion history, smoking, alcohol, and birth defects. Interactions between smoking and alcohol and smoking and parity remained in the model. The risk of preterm delivery was most pronounced among multiple or still birth deliveries (odds ratios in excess of 22.0 each), with odds ratios ranging between 0.70 and 2.54 for the other variables and interactions.

#### Low birthweight

LBW was defined as a birthweight of less than 2500 grams. Significant variables in

bivariate analyses eligible for regression analysis included maternal age, marital status, abortion history, smoking, alcohol, street drug use, prenatal visits, spontaneous labour, infant gender, stillbirth, birth defects, multiple birth, and parity. Significant interactions in bivariate regression analysis included smoking and alcohol, smoking and maternal age, smoking and parity, and smoking and use of street drugs, which were analyzed in the model. Spontaneous labour reduced the size of the model by over 8,000 cases, and was excluded from the model. Variables that were not significant at this stage included alcohol use and the interaction between smoking and maternal age and smoking and street drug use. The model was then rerun excluding variables and interaction terms that were not significant, with negligible changes in risk estimates. Alcohol was included in the final model because of the significant interaction between smoking and alcohol. The final model was devel-

oped with 83,175 cases, and included multiple births, still birth, marital status, infant gender, maternal age, parity, abortion history, smoking, alcohol, use of street drugs, and interactions between smoking and alcohol and smoking and parity.

The LBW model suggested the key risk factors were multiple and still birth, with odds ratios in excess of 32.0 (Table IV).

#### DISCUSSION

Population data on the predictors and patterns of preterm and LBW delivery provide unbiased information that can be applied to improving perinatal care. Previously, the ability to access population data has been limited. However, the quality of data derived from vital statistics records has been found reliable.<sup>12</sup> In particular, evidence suggests that collection of information on maternal age, infant gender, birthweight, and delivery type are quite valid.<sup>12</sup> Data included on the PNOB are collected in the delivery room and also abstracted from the women's chart and are completed by nurses and signed off by the attending physician. Potentially sensitive issues such as smoking and alcohol consumption may have been underreported, which would have biased results towards the null value of no difference. Alternatively, the finding that smoking or abortion history increases the risk of preterm or LBW delivery may be subject to some recall bias, in that women who had an adverse pregnancy outcome may be more likely to recall and report either smoking or having had an abortion. While the high odds ratio for smoking makes this an unlikely explanation for the smoking effect, the impact of abortion on preterm and LBW delivery warrants further investigation.

The incidence of preterm birth varies between populations, and known risk factors explain few spontaneous deliveries.<sup>13</sup> We report a prevalence of 7.5%, which is consistent with reported rates between 6.0% and 10.0%.<sup>14</sup>

The LBW incidence of 6.4% in Alberta was greater than the national rate of 5.5%<sup>2</sup> and comparable to the estimates in the United States of 7.0%.<sup>15</sup> About 20.0% of LBW and preterm infants were multiple

birth, although multiples represent only 2.3% of births. Multiple birth rates have increased in recent years, commensurate with improved success in fertility techniques<sup>16</sup> and with an increased incidence of women over age 35 having children.<sup>1,17,18</sup>

The finding that women who smoked were significantly more likely to deliver preterm and LBW infants suggests smoking should be a critical target for intervention, as noted by others.<sup>14,19</sup> Smoking during pregnancy has also been linked to delayed motor development at one year of age, poor dental health and reduced height.<sup>20-22</sup>

In Alberta, the prevalence of smoking among pregnant women was 28.8%, which was similar to reported rates of 33.0% in New Zealand<sup>23</sup> and 32.4% in Nova Scotia,<sup>24</sup> but higher than 18.7% reported in Ottawa, Ontario.<sup>25</sup> Some studies have noted that approximately 30.0% of women report quitting during pregnancy,<sup>25</sup> which is substantially greater than the 8.2% reported by Alberta women. It has been suggested that 17 to 26% of LBW deliveries may be avoided by eliminating smoking during pregnancy.<sup>26</sup>

The excessive consumption of alcohol during pregnancy has been associated with a constellation of outcomes including decreased body weight, fetal malformations, CNS dysfunction and behavioural impairments described as Fetal Alcohol Syndrome.<sup>27</sup> In Alberta, 7.5% of mothers had alcohol use noted on their PNOB, and in the vast majority of cases consumption was described as occasional, light or moderate. Several studies have reported a protective effect on preterm delivery with low to moderate levels of alcohol consumption during pregnancy,<sup>28</sup> although often income and education were not controlled for which may offer some explanation.<sup>29,30</sup> This analysis did not reveal an elevated risk of LBW or preterm delivery among those who reported consuming alcohol, however we did note an interaction between smoking and alcohol use suggesting their combined use elevates the risk of preterm and LBW delivery above their independent effects, and this has been previously reported.<sup>31</sup> In this population, the heaviest smokers were more likely to report consuming alcohol, although Day et al. found the

**TABLE IV**  
**Logistic Regression Model of Low Birthweight Infants,**  
**Alberta 1994-1996 (n=83,175)**

Variable	exp B	95% CI
Multiple births		
Singleton	1.00	
Multiple	32.15	28.90,35.76
Stillbirth		
No	1.00	
Yes	32.02	25.17,40.74
Married		
Yes	1.00	
No	1.18	1.08,1.29
Sex		
Female	1.00	
Male	1.21	1.13,1.30
Maternal age (years)		
12-19	1.00	
20-34	1.15	1.00,1.31
35+	1.60	1.40,1.94
Parity		
1	1.75	1.60,1.91
1 +	1.00	
Abortion		
Never	1.00	
One or more	1.13	1.05,1.21
Smoke		
No	1.00	
Yes	2.02	1.83,2.24
Alcohol		
No	1.00	
Yes	0.86	0.68,1.07
Use street drugs		
No	1.00	
Yes	1.45	1.16,1.83
Prenatal visits		
1-3	2.41	2.12,2.74
4 or more	1.00	
Smoke and alcohol		
Neither	1.00	
Both	1.37	1.05,1.80
Smoke and parity		
Parity >1 and non smoker	1.00	
Parity 1 and smoke	0.67	0.58,0.78

heaviest use of alcohol and marijuana to be among light to moderate tobacco users.<sup>32</sup>

Although only 1.4% of pregnant women reported using street drugs during pregnancy, 1,479 infants were exposed to the effects of drugs in utero. Unfortunately, the data did 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 birthweight,<sup>33</sup> neurobehavioural abnormalities, and poor abstract/visual reasoning.<sup>34</sup> However, other research suggests we are uncertain about the long-term consequences of marijuana exposure.<sup>32,34-36</sup> The use of cocaine during pregnancy has been associated with spontaneous abortion, prematurity, LBW, and neurobehavioural deficits, although these findings have not been reported consistently.<sup>37-40</sup>

In Alberta, the proportion of births to women age 35 and greater has increased significantly from 8.4% of births in 1990

to almost 20.0% in 1999. Advanced maternal age has been associated with increased risk of LBW, preterm delivery and multiple births.<sup>1,5,6</sup> Furthermore, it has been noted that the recent increase in preterm births in Canada is largely attributable to changes in the frequency of multiple births, obstetrical intervention and improved estimates of gestational age.<sup>41</sup> If the population of women at risk of delivering LBW and preterm infants increases, rates of LBW and preterm delivery may also increase. This information would be important to health care administrators and those involved in health care planning. As well, strategies to reduce LBW and preterm delivery should be appropriately targeted and therefore information on the social, economic and medical factors associated with delayed childbearing need to be elucidated.

In summary, public health initiatives could focus on smoking cessation, given that only 8.2% of Alberta women reported



that they quit smoking during pregnancy. Furthermore, the impact(s) of delayed childbearing, multiple births and fertility measures require investigation.

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