BRITISH COLUMBIA PERINATAL HEALTH PROGRAM

*Optimizing Neonatal, Maternal and Fetal Health*

# Preterm Birth in British Columbia

**British Columbia Perinatal Health Program**
**In Focus Report / March 2008**

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## In Focus Report

**Preterm Birth in British Columbia** is Issue #1 2008 of the BC Perinatal Health Program's In Focus Reporting Series, replacing the previous In Focus Section of the British Columbia Perinatal Database Registry Annual Report. The goal of this publication is to provide information to health care providers and researchers about Preterm Birth, one of the most serious perinatal health challenges in industrialized countries.

Professor K. S. Joseph, as the guest author for this report, has provided expert advice and guidance throughout the development of this In Focus report. As a perinatal epidemiologist at Dalhousie University and the IWK Health Centre in Nova Scotia, Dr. Joseph has contributed to the scientific literature regarding the relationship between obstetric practice, perinatal care and public policy and fetal and infant health.

## About the British Columbia Perinatal Health Program

The Ministry of Health and the British Columbia Medical Association (BCMA) initiated the British Columbia Reproductive Care Program (BCRCP) in June 1988. The BCRCP became part of the Provincial Health Services Authority (PHSA) in 2001 when the government of British Columbia introduced five geographically based health authorities and one provincial health service authority. In 2007, a new organizational structure – the BC Perinatal Health Program (BCPHP) – was created to coordinate both the BCRCP and the Provincial Specialized Perinatal Services (PSPS). The BCPHP continues to work towards optimizing neonatal, maternal and fetal health in the province through educational support to care providers, outcome analysis and multidisciplinary perinatal guidelines. The BCPHP is overseen by a Provincial Perinatal Advisory Committee and has representation from the Ministry of Health Services (MOHS), the Provincial Health Services Authority (PHSA), Children's and Women's Health Centre of BC, Health Authorities, health care providers, and academic organizations.

One of the mandates of the BCRCP is "the collection and analysis of data to evaluate perinatal outcomes, care processes and resources via a province-wide computerized database". This mandate led to the development of the British Columbia Perinatal Database Registry (BCPDR), with its stated mission to collect, maintain, analyze and disseminate comprehensive, province-wide perinatal data for the purposes of monitoring and improving perinatal care. Rollout of the Registry began in 1994, with collection of data from a small number of hospital sites. Participation increased every year, resulting in full provincial data collection commencing April 1, 2000. The BCPDR is a relational database containing over 300 fields, and with complete provincial data, is a valuable source of perinatal information.

The BCPDR currently houses records for more than 400,000 births that have been collected from obstetrical facilities as well as births occurring at home attended by BC Registered Midwives. BC women who deliver in hospitals out of province are not captured in the BC Perinatal Database Registry.

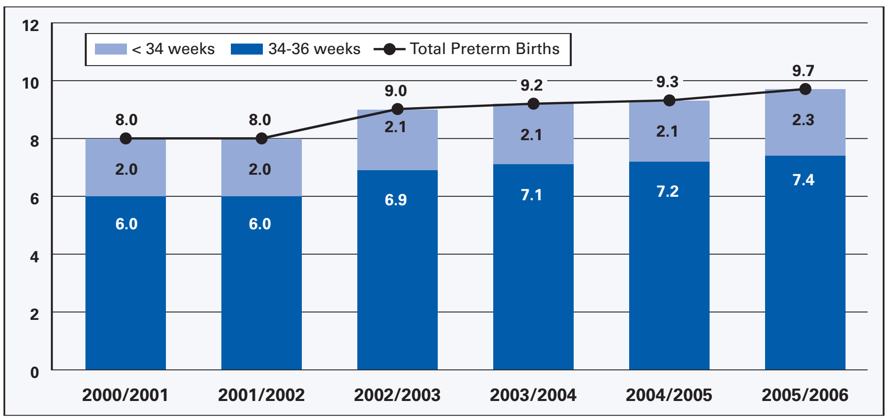
Data from the Canadian Institute for Health Information (CIHI) and matched files from the British Columbia Vital Statistics Agency complement the data elements. The 2000/2001, 2001/2002, 2002/2003 and 2003/2004 deaths represented in this report consist of deaths identified by the BCPDR supplemented by deaths identified by Vital Statistics records, in order to provide complete mortality data for babies up to one year of age.

Preterm birth has been described as the most important perinatal challenge facing industrialized countries, due to its association with serious adverse effects, including respiratory illnesses, brain hemorrhage, visual deficits, hearing impairment and neurodevelopmental disabilities such as learning problems and cerebral palsy.

Close to 10% of infants in BC were born preterm (before 37 completed weeks gestation) in 2005. Five years prior to that, 8% of infants were preterm. *(see Figure 1)*

**Figure 1**

**British Columbia Preterm Birth Rates (per 100 live births), overall and by gestational age groups, 2000/2001 to 2005/2006**



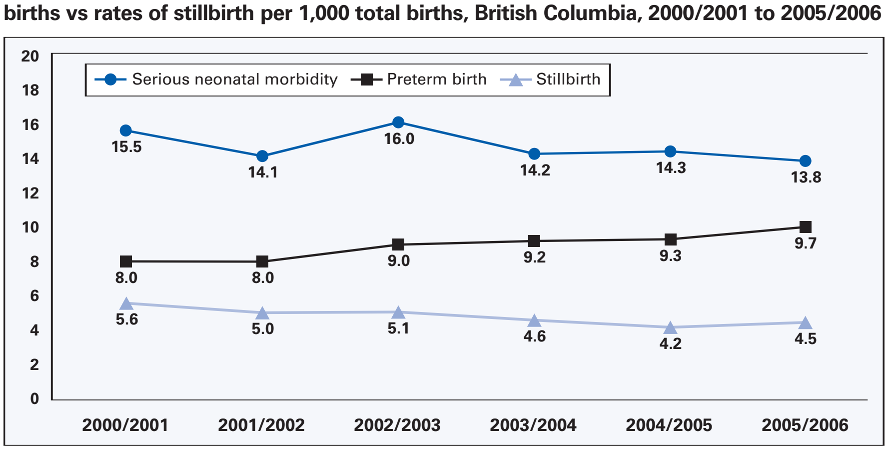

Source: BC Perinatal Database Registry

Over the last six years, the largest increases in preterm births were in those born 'near-term', 34 to 36 completed weeks gestation.

When compared to low-risk women,[1] preterm birth rates were higher in women with:

**Figure 3**

**Temporal trends in rates of preterm birth and serious neonatal morbidity per 1,000 live births vs rates of stillbirth per 1,000 total births, British Columbia, 2000/2001 to 2005/2006**




Source: BC Perinatal Database Registry

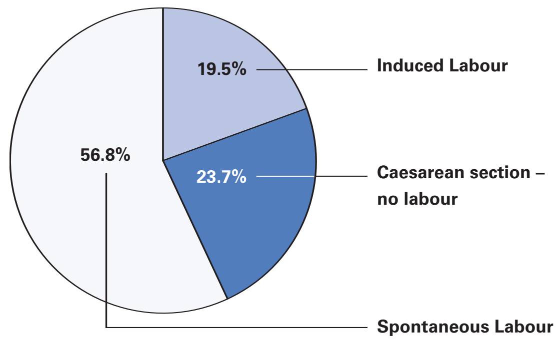
[1] Low-risk women – those who delivered singletons, had no previous history of preterm birth, and who did not have gestational diabetes or pregnancy-induced hypertension.

- Gestational diabetes
- Pregnancy-induced hypertension
- History of preterm birth

Just over half of preterm births were a result of spontaneous labour (56.8%). An increasing proportion of preterm births were a result of caesarean section prior to labour (23.7%). *(see Figure 2)*

**Figure 2**

**Proportion of preterm births in British Columbia by type of labour, 2005/2006**




Source: BC Perinatal Database Registry

The most common primary indication for induced preterm labour was prelabour rupture of membranes, while the most common primary indication for preterm caesarean section was 'Other', which included hypertension, twin/multiple pregnancy, and poor fetal growth, among others.

Total hospital days for preterm infants in BC increased in the last six years, although the average length of stay decreased slightly.

With a rise in preterm birth rates, there has also been a decrease in stillbirth and serious neonatal morbidity rates. *(see Figure 3)*

Increases in preterm birth imply a need for greater hospital resources and thus have implications for health planners. Increases in preterm births may be associated with population changes such as increases in advanced maternal age, higher pre-pregnancy weight, history of preterm birth and presence of gestational diabetes or hypertension, which has implications for both health care providers and public health initiatives. The majority of the increase in preterm births was confined to the 34-36 weeks gestation group and was the result of either induced labour or caesarean section before labour. While this report highlights some of the trends and issues relating to preterm birth in BC, a further need for research has been raised, including the need to study indications for and outcomes of near-term delivery (34 to 36 weeks gestation), as well as the effects of changing patterns of infant transport.

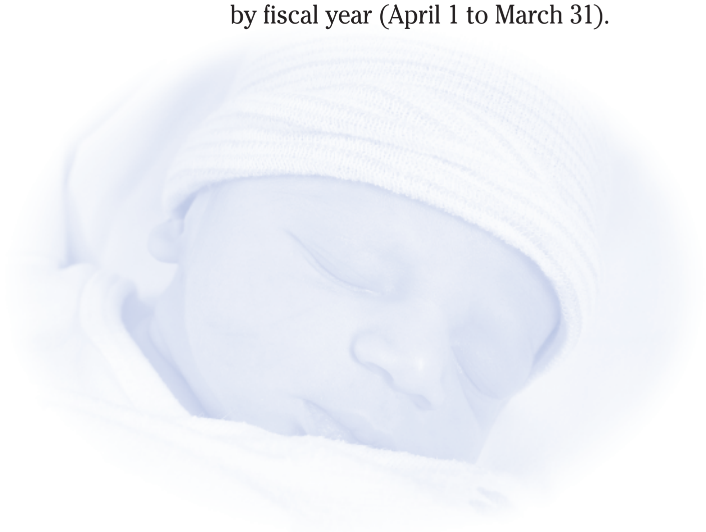
# Introduction

For decades, preterm birth has been described as the most important perinatal challenge facing industrialized countries [1,2]. The importance of preterm birth stems from the association between birth at early gestation and mortality and serious neonatal morbidity. In 1997-99, the infant mortality rate among live births at 28 weeks gestation in Canada (60.1 per 1,000 live births) was over 25 fold higher than the infant mortality rate among live births at 37-41 weeks gestation (2.3 per 1,000 live births) [3]. Similarly, serious neonatal morbidity such as bronchopulmonary dysplasia, intraventricular hemorrhage, periventricular leukomalacia, retinopathy of prematurity and related complications are much more common among preterm infants. Visual deficits, hearing impairment and neurodevelopmental disabilities such as learning problems and cerebral palsy are also more frequent, especially among those born at very early gestation [4,5].

Despite this recognition, prevention efforts have failed to reduce rates of preterm birth. For instance, preterm birth rates in Canada increased from 6.4% in 1981 to 8.2% in 2004 [6,7]. The rates declined to 7.9% in 2005 (Canada excluding Ontario) [8]. The increase in preterm birth in Canada was mirrored by similar increases in several industrialized countries. Preterm birth rates in the United States increased from 10.6% in 1990 to 12.7% in 2005 [9,10].

The rise in preterm birth, despite clinical and community programs attempting to reduce rates, is disconcerting. This In Focus Report describes the trends, causes and impact of preterm birth in British Columbia and uses information from the recent scientific literature to interpret the patterns in the province and provide an informed perspective on the issue.

The data used for this epidemiologic analysis were obtained from the British Columbia Perinatal Database Registry (BCPDR). The BCPDR is a comprehensive, province-wide perinatal database, which contains information on perinatal events, outcomes and care processes at a hospital, regional and provincial level. Standardized antenatal, intrapartum, immediate postpartum and newborn data on all deliveries and births in British Columbia are included in the database. Data from April 1, 2000 to March 31, 2006 were used for the purposes of this report, and included live births only (excluded stillbirths and late terminations). Data were organized by fiscal year (April 1 to March 31).



Two methodological issues of note relate to the modality of gestational age ascertainment and the categorization of preterm birth subtypes. Gestational age was determined based on a standard hierarchical algorithm that used information on gestational duration from several sources including the last menstrual period, earliest ultrasound prior to 20 weeks gestation, documentation on maternal chart and pediatric examination of the infant immediately after birth. Details of the algorithm used are provided in Appendix A. Preterm births were categorized into spontaneous and iatrogenic depending on whether labour onset was spontaneous. Cases of preterm birth following labour induction or caesarean delivery before the onset of labour were labeled as cases of iatrogenic preterm birth.

## Preterm birth rates

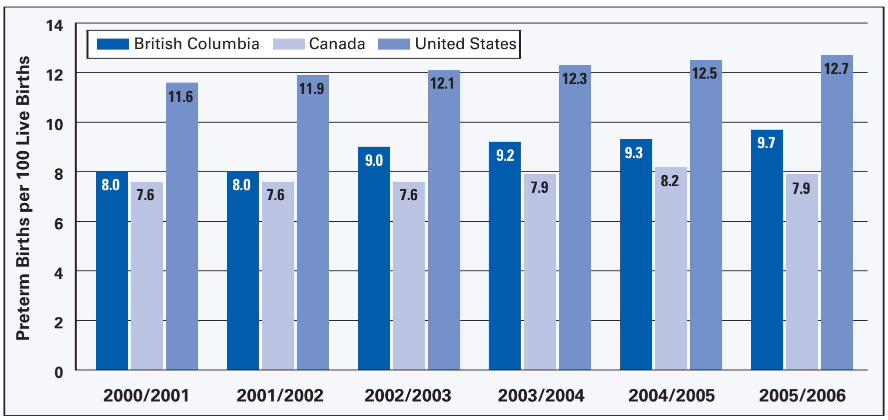
The rate of preterm birth (<37 weeks or <259 days gestation) in British Columbia increased from 8.0 percent in 2000/2001 to 9.7 percent in 2005/2006 (22 percent increase, 95% confidence interval 16 to 27 percent). These rates were higher than preterm birth rates in Canada, although the rising trend was approximately similar. Preterm birth rates in Canada (excluding Ontario) increased from 7.6 percent in 2000 to 8.2 percent in 2004 and then declined to 7.9 percent in 2005 [6,8], while in the United States the same rates increased from 11.6 percent in 2000 to 12.7 percent in 2005 [9,10]. *(see Figure 4)*

The absolute differences in preterm birth rates between geographic regions may not be particularly informative because of differences in the methods of gestational age ascertainment and related data issues. For instance, preterm birth rates in Canada were based on gestational age estimates that are influenced by clinical inputs, whereas in the United States the reported preterm birth rates were based on gestational age that is derived from menstrual dates [11].

Similarly, Statistics Canada's estimates of preterm birth in British Columbia (7.1 percent in 2000 and 7.5 percent in 2005 [6,8]) were substantially lower than the above estimates obtained from the BC Perinatal Database Registry. The difference arises because Statistics Canada data is obtained from the Notice of Birth, while the BCPDR uses several sources to determine the final gestational age (Appendix A).

**Figure 4**

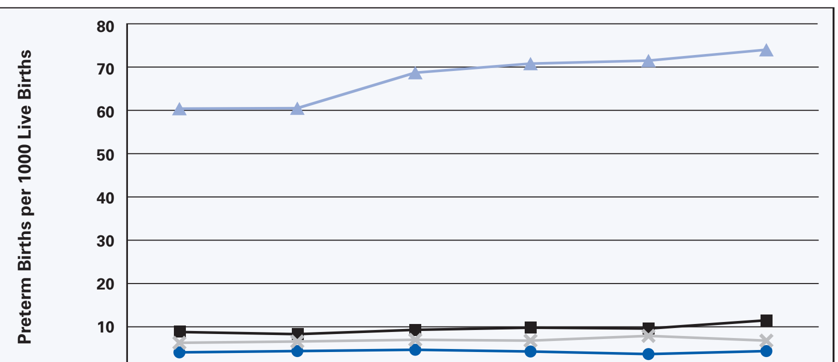
**Preterm birth rates in British Columbia (from the BCPDR), Canada and the United States, 2000 to 2005**




Source: BC Perinatal Database Registry, Statistics Canada, National Center for Health Statistics
Note: BC rates based on fiscal year; Canada and United States rates based on calendar year.

**Figure 5**

**Temporal increases in preterm birth rates by severity of preterm birth, British Columbia, 2000/2001 to 2005/2006**




| | 2000/2001 | 2001/2002 | 2002/2003 | 2003/2004 | 2004/2005 | 2005/2006 |
|---|---|---|---|---|---|---|
| < 28 wks | 4.1 | 4.4 | 4.7 | 4.3 | 3.7 | 4.4 |
| 28 to 31 wks | 6.3 | 6.6 | 7.0 | 6.8 | 7.9 | 6.8 |
| 32 to 33 wks | 8.8 | 8.3 | 9.3 | 9.8 | 9.6 | 11.5 |
| 34 to 36 wks | 60.4 | 60.5 | 68.7 | 70.8 | 71.5 | 74.0 |

Source: BC Perinatal Database Registry

### *Trends in severity of preterm birth*

Figure 5 shows increases in preterm birth within each segment of the preterm gestational age range. Modest relative increases were observed in preterm birth <28 weeks and in preterm birth 28-31 weeks (approximately 7 percent increase between 2000/2001 and 2005/2006), whereas larger relative increases were evident at 32-33 weeks (31.6 percent increase) and 34-36 weeks gestation (22.6 percent increase). In terms of absolute increases, almost the entire increase in overall preterm birth was restricted to the 34-36 weeks gestational age range (between 2000/2001 and 2005/2006 overall preterm birth rates increased 17 per 1,000 live births while those between 34-36 weeks increased 13.6 per 1,000 live births).

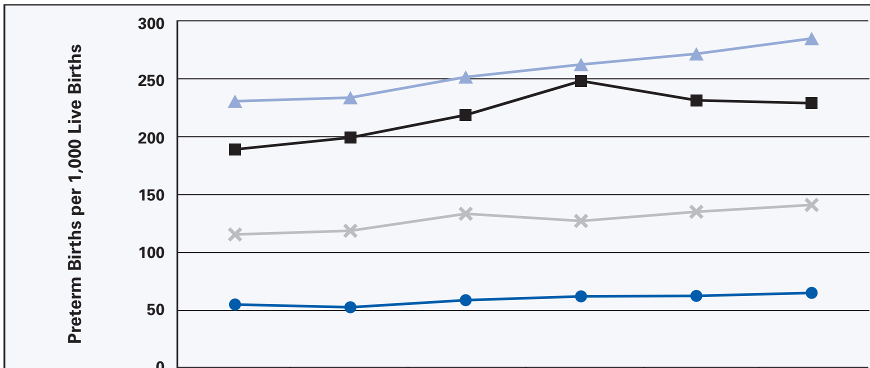
This pattern of increase in preterm birth, with most of the absolute increase occurring within the mild and moderate preterm birth range, is similar to findings from other studies in Canada and other countries [12-15].

## Trends within population subgroups

Relative increases in preterm birth occurred in all population subgroups, both low risk and high risk. However, the absolute increase in preterm birth was substantially greater among high-risk subgroups (not unexpected given the high rates of preterm birth in such populations, Figure 6). Thus, the rate of preterm birth among low risk pregnancies (i.e., singleton pregnancies not complicated by a history of previous preterm birth, gestational diabetes or pregnancy induced hypertension) increased from 55.2 per 1,000 in 2000/2001 to 65.2 per 1,000 in 2005/2006 (relative increase 18%, absolute increase 10 per 1,000 live births). Among women with previous preterm birth, on the other hand, the rate of preterm birth increased from 230.6 per 1,000 in 2000/2001 to 284.7 per 1,000 in 2005/2006 (relative increase 23%; absolute increase 54.1 per 1,000 live births). Preterm birth rates among women with gestational diabetes and pregnancy induced hypertension also increased by 21-22 percent on a relative scale and by 25.5 per 1,000 live births and 39.9 per 1,000 live births in absolute terms, respectively. *(see Figure 6)*

**Figure 6**

**Increase in preterm birth rates among low-risk pregnancies compared to pregnancies with specified risks, British Columbia, 2000/2001 to 2005/2006**




| | 2000/2001 | 2001/2002 | 2002/2003 | 2003/2004 | 2004/2005 | 2005/2006 |
|---|---|---|---|---|---|---|
| Gestational diabetes | 115.6 | 118.8 | 133.5 | 127.3 | 135.2 | 141.1 |
| Pregnancy Induced Hypertension | 189.0 | 199.2 | 218.7 | 248.1 | 231.4 | 228.9 |
| Previous preterm birth | 230.6 | 233.7 | 251.5 | 262.3 | 271.5 | 284.7 |
| Low risk pregnancies | 55.2 | 52.8 | 58.9 | 62.2 | 62.6 | 65.2 |

Source: BC Perinatal Database Registry

## Trends by preterm birth subtype

Preterm births were categorized into spontaneous preterm births (which occurred following spontaneous onset of preterm labour) and iatrogenic preterm births (which occurred following preterm labour induction and/or preterm caesarean delivery in the absence of labour).

### *Spontaneous preterm birth vs. iatrogenic preterm birth*

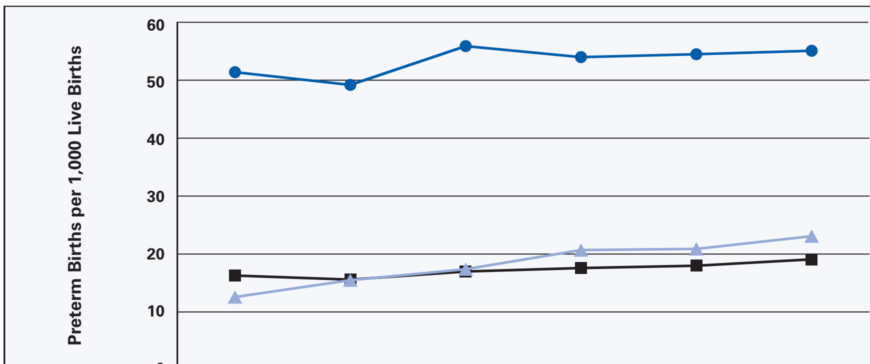
There was a small 7 percent relative increase in spontaneous preterm birth from 51.2 per 1,000 in 2000/2001 to 54.9 per 1,000 in 2005/2006 (Figure 7). The increase in iatrogenic preterm birth was much greater, with rates increasing from 28.5 per 1,000 in 2000/2001 to 41.8 per 1,000 in 2005/2006 (relative increase 47%; absolute increase 13.3 per 1,000 live births).

### *Frequency of preterm labour induction vs. preterm caesarean delivery*

The increase in iatrogenic preterm birth was primarily effected through an increase in preterm caesarean deliveries, which increased from 12.4 per 1,000 of all live births in 2000/2001 to 22.9 per 1,000 in 2005/2006 (Figure 7, relative increase 85%; absolute increase 10.5 per 1,000). Preterm labour induction rates increased by a smaller extent from 16.1 per 1,000 of all live births in 2000/2001 to 18.9 per 1,000 in 2005/2006 (relative increase 18%; absolute increase 2.8 per 1,000). *(see Figure 7)*

**Figure 7**

**Increase in spontaneous and iatrogenic preterm birth rates, British Columbia, 2000/2001 to 2005/2006**

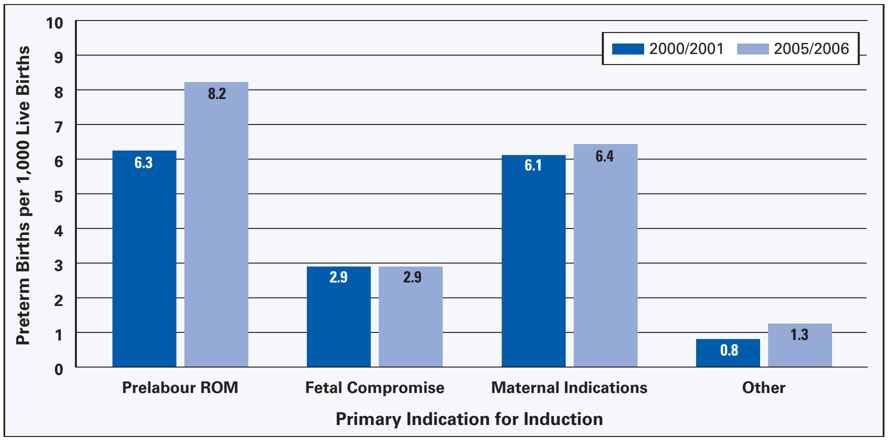



| | 2000/2001 | 2001/2002 | 2002/2003 | 2003/2004 | 2004/2005 | 2005/2006 |
|---|---|---|---|---|---|---|
| Spontaneous | 51.2 | 49.0 | 55.7 | 53.8 | 54.3 | 54.9 |
| Preterm labour induction | 16.1 | 15.4 | 16.8 | 17.4 | 17.8 | 18.9 |
| Preterm caesarean with no labour | 12.4 | 15.3 | 17.2 | 20.5 | 20.7 | 22.9 |

Source: BC Perinatal Database Registry

**Figure 8**

**Rates of preterm labour induction for specific primary indications, British Columbia, 2000/2001 to 2005/2006**




Source: BC Perinatal Database Registry

## Indications for iatrogenic preterm birth

### *Indications for preterm labour induction*

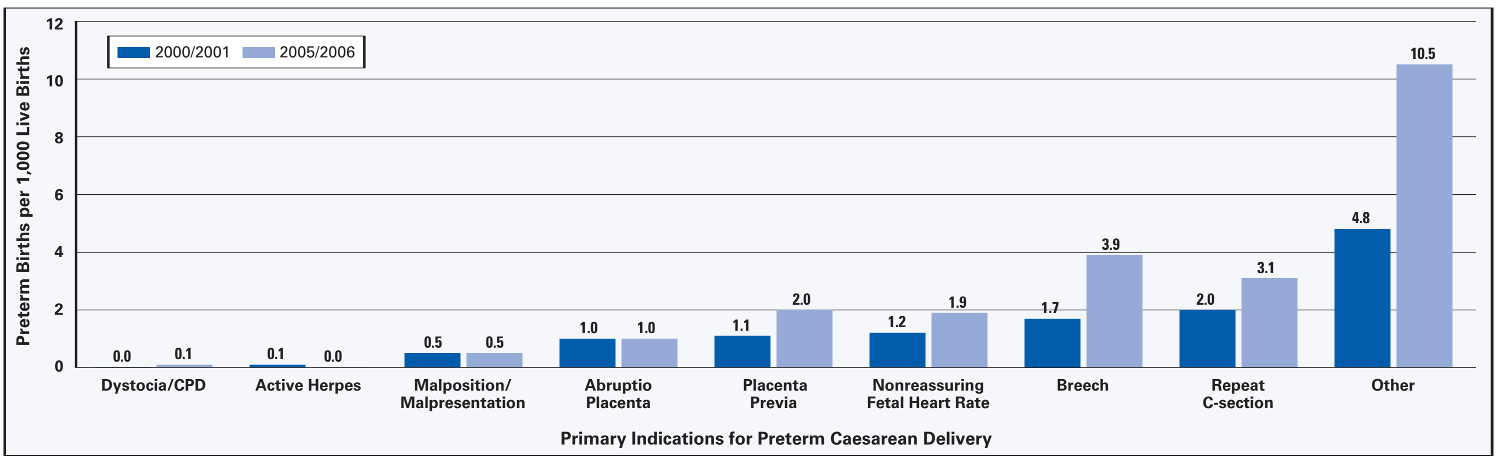
Most preterm labour inductions were carried out for prelabour rupture of membranes, maternal indications or fetal compromise. The small increase in preterm labour induction between 2000/2001 and 2005/2006 occurred secondary to increased labour induction for prelabour rupture of membranes. *(see Figure 8)*

### *Indications for preterm caesarean delivery*

The increases in preterm caesarean delivery occurred because of increases in several primary indications including breech presentation, nonreassuring fetal heart rate, repeat caesarean, and 'other' indications. *(see Figure 9)*

**Figure 9**

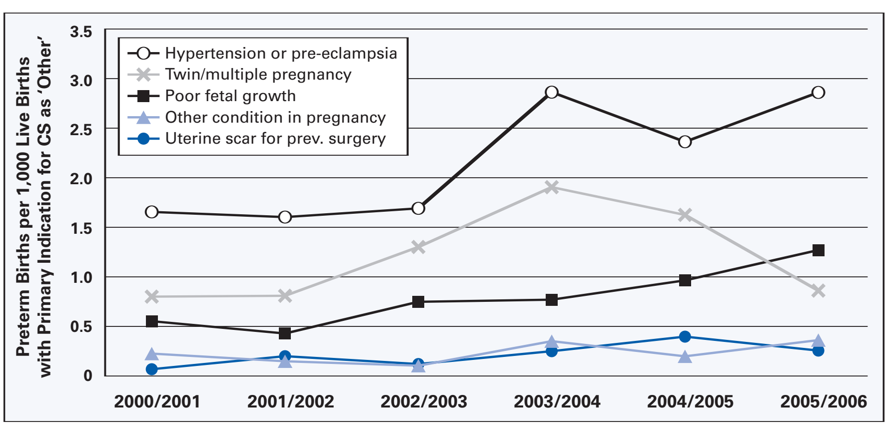
**Primary indications for preterm Caesarean Delivery, British Columbia, 2000/2001 and 2005/2006**




Source: BC Perinatal Database Registry
Note: CPD denotes cephalopelvic disproportion

**Figure 10**

**Diagnostic codes for preterm births with primary indication for Caesarean Delivery labeled as 'Other', British Columbia, 2000/2001 to 2005/2006**




Source: BC Perinatal Database Registry

Further investigation of the most responsible diagnoses where 'other' was coded as the primary indication for caesarean showed that the most common diagnoses were hypertension or pre-eclampsia, multiple pregnancy, poor fetal growth, uterine scar in previous pregnancy and other indications. *(see Figure 10)*

## Trends in causes of preterm birth

Changes in maternal characteristics such as older maternal age were important factors in the increase in preterm birth. Other changes of relevance included increases in maternal prepregnancy weight and declines in smoking. Increases in older maternal age were, in part, responsible for population increases in pregnancy induced hypertension and gestational diabetes. *(see Table 1)*

**Table 1**

**Changes in determinants of preterm birth, per 1,000 live births, British Columbia, 2000/2001 to 2005/2006**

| Indication | 2000/2001 | 2001/2002 | 2002/2003 | 2003/2004 | 2004/2005 | 2005/2006 |
|---|---|---|---|---|---|---|
| Age 35-39 | 162.7 | 165.1 | 165.2 | 169.7 | 174.8 | 177.7 |
| Smokers | 131.5 | 123.1 | 115.4 | 108.0 | 109.7 | 103.5 |
| Pre-Pregnancy BMI ≥ 30* | 74.9 | 77.8 | 73.0 | 73.5 | 78.1 | 79.5 |
| Gestational Diabetes | 60.8 | 59.5 | 67.8 | 58.8 | 67.9 | 69.0 |
| Weight ≥ 90 kg* | 48.1 | 50.1 | 49.0 | 48.7 | 53.4 | 54.4 |
| Pregnancy Induced Hypertension | 45.2 | 44.9 | 47.1 | 48.3 | 53.6 | 54.4 |
| Age 40+ | 30.9 | 33.0 | 34.6 | 36.2 | 38.0 | 39.7 |
| Multiple Births | 26.2 | 26.4 | 30.5 | 29.5 | 28.9 | 31.4 |

Source: BC Perinatal Database Registry
*Rates calculated after excluding missing/unknown values.

Delayed childbearing and increased use of assisted reproduction technologies increased the frequency of multiple births. Increased obstetric intervention (i.e., preterm labour induction and preterm caesarean delivery given fetal compromise), driven partly by the above-mentioned changes in maternal characteristics and also by concerns related to fetal safety, was also responsible for the increase in preterm birth (Figure 6). The changes in maternal characteristics observed in British Columbia were similar to those observed elsewhere in Canada [3,6].

## Impact of increases in preterm birth on use of hospital resources

A smaller increase (18%) in the number of days of hospital stay required by preterm infants (32,669 days in 2000/2001 to 38,565 days in 2005/2006) was noted relative to the 22% increase in the number of preterm births in British Columbia between 2000/2001 and 2005/2006. This was the result of a small decline in the overall average length of hospital stay for preterm infants (from 10.2 days to 9.9 days). *(see Table 2)*

Infants born at very preterm gestational ages (<28 weeks) had the longest lengths of stay in hospital. Singletons born at <28 weeks had an increase in the average length of stay (35.7 days to 46.0 days), while twins or multiple births born at <28 weeks had a decrease in average length of stay from 41.4 days to 38.6 days.

One limitation of this analysis is that the data reflected in Table 2 does not account for transfer of infants after birth (e.g. the length of stay describes the stay in the birth hospital only). Another limitation of this analysis is that it does not account for changes in survival rates of infants born in the various gestational age categories.

**Table 2**

**Number of preterm births by gestational age category, mean length of hospital stay and total number of days of hospital stay, British Columbia, 2000/2001 and 2005/2006**

| | 2000/2001 | | | 2005/2006 | | |
|---|---|---|---|---|---|---|
| | Number of live births | Average length of stay (days) | Total days of hospital stay | Number of live births | Average length of stay (days) | Total days of hospital stay |
| Singleton live births | | | | | | |
| <28 weeks | 124 | 35.7 | 4,425 | 126 | 46.0 | 5,795 |
| 28-31 weeks | 188 | 26.6 | 4,997 | 195 | 24.2 | 4,676 |
| 32-33 weeks | 253 | 13.8 | 3,480 | 337 | 14.7 | 4,948 |
| 34-36 weeks | 2,070 | 5.5 | 11,337 | 2,495 | 5.5 | 13,408 |
| Multiple live births | | | | | | |
| <28 weeks | 43 | 41.4 | 1,767 | 54 | 38.6 | 2,081 |
| 28-31 weeks | 69 | 27.3 | 1,877 | 81 | 23.6 | 1,898 |
| 32-33 weeks | 103 | 15.7 | 1,608 | 133 | 15.4 | 2,053 |
| 34-36 weeks | 383 | 8.4 | 3,178 | 522 | 7.2 | 3,706 |
| All preterm | 3,233 | 10.2 | 32,669 | 3,943 | 9.9 | 38,565 |

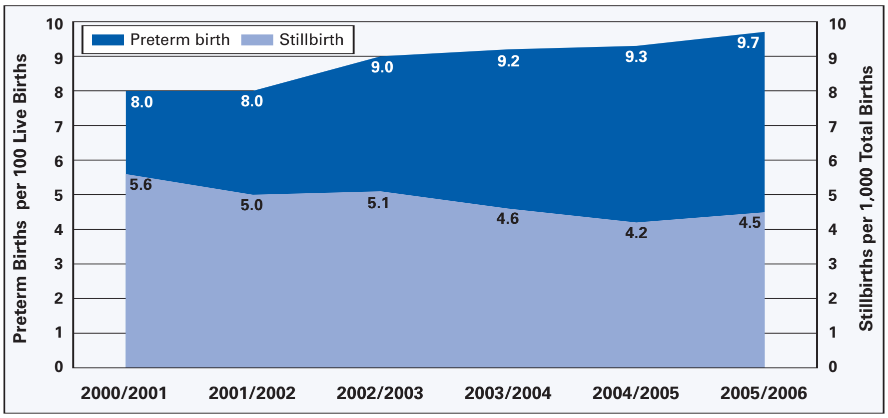
Source: BC Perinatal Database Registry

## Relationship between preterm birth and perinatal mortality/serious neonatal morbidity

Between 2000/2001 and 2005/2006, the 22 percent increase in preterm birth rates in British Columbia was accompanied by a decline in the overall stillbirth rate from 5.6 per 1,000 total births to 4.5 per 1,000 total births (21 percent decrease 95% confidence interval 4 to 35 percent). Figure 11 shows the inverse relationship between preterm birth rates and stillbirth rates in British Columbia between 2000/2001 and 2005/2006.

**Figure 11**

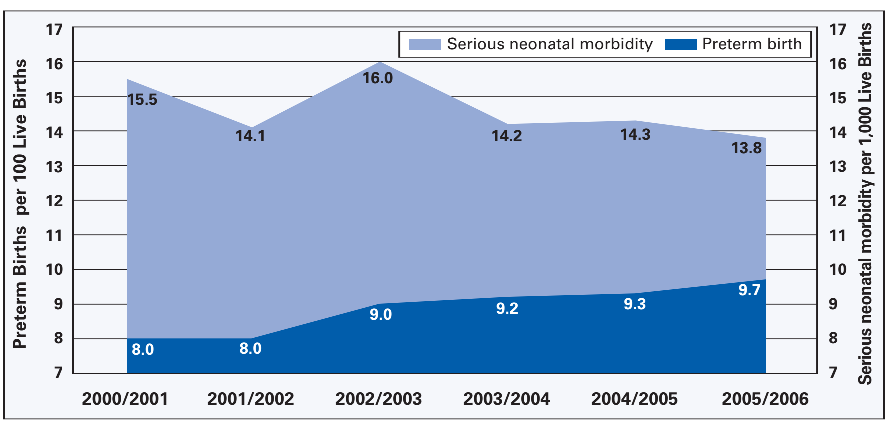
**Temporal trends in rates of preterm birth and stillbirth, British Columbia, 2000/2001 to 2005/2006**




Source: BC Perinatal Database Registry

**Figure 12**

**Temporal trends in rates of preterm birth and serious neonatal morbidity, British Columbia, 2000/2001 to 2005/2006**




Source: BC Perinatal Database Registry

Although iatrogenic preterm birth is most immediately designed to prevent stillbirth, obstetric goals transcend this restricted outlook and embrace the prevention of neonatal mortality and serious neonatal morbidity. Perinatal mortality rates declined from 7.4 per 1,000 total births in 2000/2001 to 6.3 per 1,000 total births in 2003/2004 (early neonatal death rates were not available for 2004 and 2005). Rates of serious neonatal morbidity (including 5 minute Apgar <4, Respiratory Distress Syndrome, bronchopulmonary dysplasia, intraventricular hemorrhage, periventricular leukomalacia, retinopathy of prematurity, and necrotizing enterocolitis) also declined from 15.5 per 1,000 live births in 2000/2001 to 13.8 per 1,000 live births in 2005/2006. The inverse association between rising rates of preterm birth and the declining rates of serious neonatal morbidity are shown in Figure 12.

The decline in rates of serious neonatal morbidity was due to declines in the rate of 5 minute Apgar <4 (3.2 per 1,000 live births in 2000/2001 and 3.0 per 1,000 live births in 2005/2006) and in the rate of Respiratory Distress Syndrome (12.1 per 1,000 live births in 2000/2001 to 10.6 per 1,000 live births in 2005/2006).

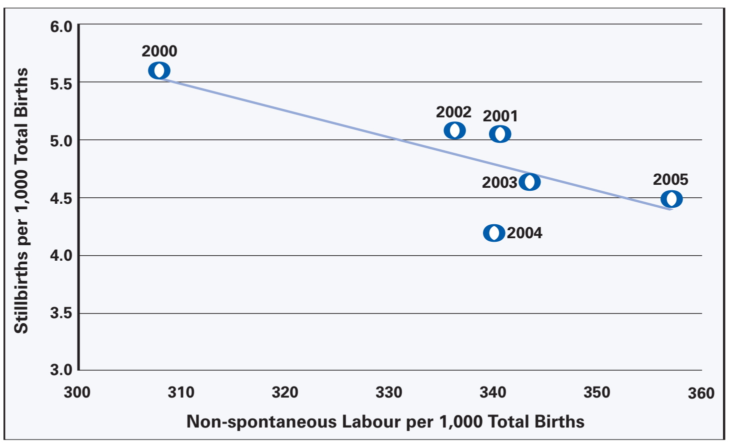
## Relationship between medically indicated early delivery and perinatal outcomes

One problem with analysis of the relationship between preterm birth and stillbirth, perinatal mortality and serious neonatal morbidity (as above) arises because of a lack of correspondence between groups being compared. Thus preterm intervention occurs in a small subpopulation but this is set against mortality and serious morbidity rates in the total population of births, including those delivered at preterm and term gestation. The reason for examining the effect of iatrogenic preterm delivery on outcomes in the combined preterm and term populations is because early delivery at preterm gestation could prevent stillbirth at term gestation. Thus, an iatrogenic preterm delivery at 36 weeks gestation may have prevented a stillbirth at 37 weeks.

The above-mentioned relationship between obstetric intervention and fetal mortality may also be more comprehensively depicted as the relationship between medically indicated early delivery (i.e., labour induction and/or caesarean delivery given fetal compromise or other indication) and stillbirth or serious neonatal morbidity. The rate of non-spontaneous labour at all gestational ages increased from 307.9 per 1,000 total births in 2000/2001 to 357.3 per 1,000 total births in 2005/2006 and over the same period, stillbirth rates decreased from 5.6 per 1,000 total births to 4.5 per 1,000 total births (Figure 13A) and rates of serious neonatal morbidity decreased from 15.5 per 1,000 live births to 13.8 per 1,000 live births (Figure 13B).

**Figure 13A**

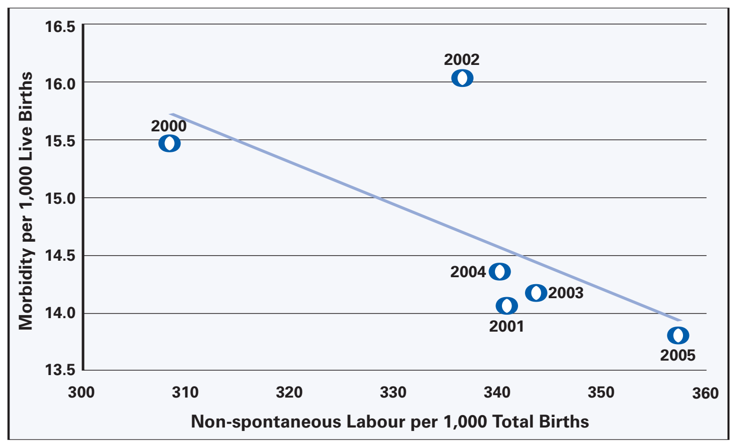
**Temporal increases in medically-indicated early delivery at all gestational ages and corresponding declines in stillbirth rates, British Columbia, 2000/2001 to 2005/2006**




Source: BC Perinatal Database Registry

**Figure 13B**

**Temporal increases in medically-indicated early delivery at all gestational ages and corresponding declines in serious neonatal morbidity rates, British Columbia, 2000/2001 to 2005/2006**




Source: BC Perinatal Database Registry

This analysis shows that rates of preterm birth in British Columbia increased by 22% between 2000/2001 and 2005/2006 from 8.0 percent to 9.7 percent. The increase was predominantly due to an increase in the frequency of mild preterm birth (i.e., those between 34-36 weeks gestation) following preterm caesarean delivery. The indications for the latter increase included breech presentation, poor fetal growth, non-reassuring fetal heart rate, hypertensive disorders and placental complications. A small increase in preterm labour induction also occurred due to an increase in such inductions for prelabour preterm rupture of membranes. These increases were a consequence of increase in population risk factors for preterm birth, such as older maternal age, high pre-pregnancy weight, multiple pregnancies and hypertensive disorders of pregnancy. Changes in obstetric practice because of increased fetal surveillance and related factors also likely contributed to the increase in iatrogenic preterm birth rates. These increases in preterm birth were associated with simultaneous declines in stillbirth rates, perinatal mortality rates and in rates of serious neonatal morbidity.

## The role of early delivery in modern obstetrics

The cornerstone of modern obstetrics is selective, carefully timed early delivery given fetal compromise or a maternal indication [16]. Medically indicated labour induction and caesarean delivery are typically used when the balance of risks and benefits indicate that birth and supportive neonatal care are preferable to an compromised intrauterine environment. Early delivery through labour induction was first introduced in the mid-18th century for contracted pelvis and in the 1950s early delivery after 35 weeks gestation was routinely used to prevent stillbirth in severe cases of Rh hemolytic disease [16,17]. More recently, with advances in the diagnosis of fetal compromise (biophysical profile, umbilical artery Doppler velocimetry, etc) and in neonatal care (antenatal corticosteroids, surfactant, assisted ventilation, etc), rates of medically indicated labour induction and caesarean delivery have increased substantially in industrialized countries at preterm, term and postterm gestation. The consequent "left-shift" in the population distribution of gestational age at birth has been responsible for rising rates of iatrogenic preterm birth and declining rates of postterm birth in industrialized countries.

Although it has been a longstanding belief that advances in perinatology could only be achieved through a prolongation of gestational duration, recent declines in perinatal mortality have been associated with a reduction in average gestational duration. This counterintuitive phenomenon can be explained using theoretical epidemiologic models[16]. Nevertheless, it is important to reiterate that obstetric early delivery, especially at preterm gestation is justified by the medical indication for which it is carried out. Labour induction and caesarean delivery without indication do not have a similar justification and fall outside the scope of this discussion.

## Confounding by indication in assessing effects of iatrogenic preterm delivery

This study showed inverse associations between iatrogenic preterm birth, on the one hand, and rates of stillbirth, perinatal death and serious neonatal morbidity on the other. This association was observed at an ecologic population level. Thus population rates of preterm birth increased between 2000/2001 and 2005/2006, whereas population rates of stillbirth declined. A simple comparison of perinatal outcomes among women who had an iatrogenic preterm delivery versus those who did not would not show a similar association. In fact, the latter association would be meaningless, as it would be confounded by indication. The fetal compromise or other indication for which iatrogenic preterm delivery was carried out would ensure that mortality and serious neonatal morbidity rates were substantially higher among those who required early delivery. Such confounding is commonly observed when the death rates in Intensive Care Units are compared with those in general hospital wards or when perinatal mortality rates among births occurring in hospital are compared with perinatal mortality rates among home births. The ecologic association demonstrated in this study (and more formally tested in other studies [11,18-20]) is generally free from such bias, however. Nevertheless, it is important to recognize that such ecologic associations do not necessarily imply causative relationships.

## Comprehensive assessment of iatrogenic preterm delivery

Although studies show that perinatal mortality has decreased with increased obstetric intervention, questions remain about the overall impact of such intervention. Studies show that a not insubstantial fraction of infant mortality is attributable to mild and moderate preterm birth in Canada and the United States. Infant deaths at 34-36 weeks gestation contributed to 8% of overall infant deaths in Canada in 1992-94, with this gestational age category contributing more to overall infant mortality than live births at 28-31 weeks gestation [21]. A more recent study from the United States showed that infant deaths among live births at 34-36 weeks gestation were 3 times as frequent as infant deaths at 37-41 weeks gestation in 2002 [22].

Concerns about the impact of obstetric intervention extend beyond perinatal mortality and encompass issues related to serious neonatal morbidity. In recent years this concern has moved well beyond the neonatal period and death and childhood disability have gained prominence as key outcomes of interest. Many clinical trials of obstetric intervention use perinatal mortality and serious neonatal morbidity as the primary outcome only because of concerns regarding the feasibility of longer term follow up. The consensus, nevertheless, is that death or serious developmental disability at 2 years of age is the conceptually ideal outcome for assessing the effects of obstetric intervention in contemporary state-of-the-art clinical trials. Thus, the overall assessment of the effects of multiple courses of antenatal steroid therapy focus not on the short term benefits such as reductions in Respiratory Distress Syndrome and related neonatal outcomes but on the more relevant longer term outcomes such as chronic lung disease and death or neuro¬developmental disability at 2 years of age [23-25]. Similarly, the recent consensus conference on low birth weight in Calgary identified the follow-up of infants born at 34-36 weeks as a priority research issue [26]. Similar concerns have been voiced previously as well [27]. Clearly, there is a need to integrate the longer term effects of obstetric intervention into the cost benefit equation that determines the appropriateness of early delivery given fetal compromise.

## Recent advances in obstetric and neonatal care

As mentioned previously, advances in obstetrics and neonatal care have enabled increases in early delivery and in the care of fetuses at preterm gestation. One concern especially among extremely low birth weight and extremely preterm infants has been the high rates of death and neuro¬developmental disability among such births. Studies documenting the temporal changes in rates of death and childhood disability among such extremely low birth weight infants are very informative in this regard.

Studies [28,29] from the United States show that between 1982-1989 and 1990-1998 there was a substantial increase in the frequency of various life saving interventions offered to infants with a birth weight between 500 and 999 g. The use of antenatal steroids increased from 0% to 41%, caesarean delivery rates increased from 32% to 45%, assisted ventilation rates increased from 81% to 87% and use of surfactant therapy increased from 1% to 62% from 1982-89 to 1990-98. Follow up of these infants to 20 months corrected age showed that death rates decreased from 51% to 32%, while rates of disability (neurosensory abnormality and/or Bayley Mental Development Index<70) among survivors increased from 28% to 35%. The changes in obstetric and neonatal care of infants with a birth weight of 500-999 g between the 1980s and the 1990s were responsible for a decline in death rates and an increase in disability rates i.e., the prevention of death resulted in increases in both disability-free survival and disability-associated survival.

This pattern of death and serious childhood disability has changed more recently. Follow up of infants with a birth weight of 500-999 g up to 20 months corrected age from the same centre showed that the cohort born between 2000-2002 experienced a mortality rate of 29% and a disability (neurosensory abnormality and/or Bayley Mental Development Index<70) rate among survivors of 23%. This experience of a change in patterns of death and disability has also been reported from other centres [30]. It appears that recent advances in the care of such extremely low birth weight infants is achieving the intended effect of reduced rates of both death and disability. Although these results do not necessarily carry over to live births that occur following iatrogenic preterm birth at 34-36 weeks gestation, they provide hope that prevention of perinatal death, serious neonatal morbidity and childhood disability are possible with improvements in obstetrics and neonatal care. Nevertheless, the need to further improve care, develop better therapies and interventions and carefully monitor population perinatal health remains.

## Limitations

Several limitations need to be acknowledged. Perhaps the most important one relates to the determination of gestational age. Dating of pregnancy duration has improved enormously with the routine use of early ultrasound dating of pregnancy. Nevertheless, this, and related improvements in the measurement of gestational age, have not entirely solved the problems of data accuracy within contemporary population databases. The differences in the rate of preterm birth in British Columbia as determined by data from the British Columbia Perinatal Database Registry and that obtained from the vital statistics records at Statistics Canada are a case in point. Nevertheless, this limitation affects the absolute rates of preterm birth, whereas the primary issue in this study was related to temporal trends in preterm birth. Temporal trends in preterm birth are less likely to be affected by such potential errors.

Some of the primary indications recorded for caesarean delivery at preterm gestation included previous caesarean delivery and declined vaginal birth after caesarean section. However, at preterm gestation, it would be more important to record the direct indication for which early delivery was required. The need for a repeat caesarean could be better viewed as a secondary indication.

Perinatal mortality rates were not available for the final two years of the study (2004 and 2005). Nevertheless, the study did show declining rates of stillbirth and serious neonatal mortality across the full study duration and a decrease in perinatal mortality between 2000 and 2003. As mentioned, the demonstration of such ecologic associations does not necessarily imply causative relationships.

Rates of preterm birth have increased in British Columbia in recent years. This increase is similar to increases in preterm birth observed in other parts of Canada and in other countries. Most of the increase was confined to the mild preterm (34-36 weeks gestation) birth range and was iatrogenic in origin. Part of the increase in medically indicated preterm birth was associated with population changes in risk factors for preterm birth, namely, increases in the frequency of older mothers, high pre-pregnancy weight, multi-fetal pregnancies, pregnancy induced hypertension and diabetes mellitus. It is encouraging to note that during this period when preterm birth rates increased, stillbirth rates, perinatal mortality rates and rates of serious neonatal morbidity declined in British Columbia.

The increase in the frequency of preterm birth implies an increasing need for hospital resources, thus monitoring of such population changes is essential. Further research, especially through the long term follow up of late preterm births, is also required for facilitating more fully informed obstetric decision making. If increases in iatrogenic preterm birth are responsible for subtle neurobehavioural changes, this can only be identified through the longitudinal follow up of such infants. The perinatal health effects of changes in population characteristics (delayed childbearing, prepregnancy weight) and health services (including specific assisted reproduction techniques) also require monitoring. On a clinical level, it is important to recognize that advances in fetal monitoring, diagnostic technology and neonatal care have improved the survival of newborns at early gestation. Nevertheless, delivery at early gestation is typically associated with higher rates of shortterm and long-term morbidity. Clinicians should always be cognizant of the need to carefully balance such risks against the benefits of early delivery when attempting to optimize the management of complicated high risk pregnancies.

Finally, from a public health standpoint, it is increasingly evident that the index of preterm birth no longer serves as a suitable proxy for population perinatal health. Increases in iatrogenic preterm birth for fetal compromise and maternal indication have transformed this index into one that reflects both perinatal health and the level of obstetric and neonatal care services in the population.

# Appendix

## Appendix A – Final Gestation Age

The field chosen to calculate the final gestational age was determined by:

| DETERMINING FACTOR | CHOOSE THIS FIELD FOR FINAL GESTATIONAL AGE CALCULATION |
|---|---|
| If calculated GA by Last menstrual period date and calculated GA by First ultrasound differs by **< 7 days** | **Last menstrual period date** |
| If calculated GA by Last menstrual period date and calculated GA by First ultrasound differs by **> 1 week and < 2 week** AND age at First ultrasound **> 12 weeks** | **Last menstrual period date** |
| If calculated GA by Last menstrual period date and calculated GA by First ultrasound date differs by **> 1 week and < 2 week** AND age at First ultrasound **< 12 weeks** | **First ultrasound** |
| If calculated GA by Last menstrual period date and calculated GA by First ultrasound date differs by **≥ 2 weeks** | **First ultrasound** |
| If Last menstrual period date is **blank** | **First ultrasound** |
| If Last menstrual period date and First ultrasound are **blank** | **Gestational age by exam** |
| If Last menstrual period date, First ultrasound and GA by exam are **blank** | **Gestational age by documentation** |

## Appendix B – Glossary

**Bayley Mental Development Index –** part of the Bayley Scale of Infant Development that measures sensory/perceptual acuities, discriminations, and response; acquisition of object constancy; memory learning and problem solving; vocalization and beginning of verbal communication; basis of abstract thinking; habituation; mental mapping; complex language; and mathematical concept formation.

**Iatrogenic preterm birth –** birth occurring following preterm labour induction and/or preterm caesarean section in the absence of labour.

**Length of stay –** number of days an infant remains in hospital after delivery.

**Low risk pregnancies –** singleton pregnancies not complicated by a history of previous preterm birth, gestational diabetes or pregnancy induced hypertension.

**NSL –** Non-spontaneous labour. Caesarean section before labour or labour that has been induced.

**Preterm birth –** birth occurring prior to 37 completed weeks (<259 days) of gestation.

**Spontaneous preterm birth –** birth occurring following spontaneous onset of preterm labour.

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