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**Community Remoteness and Birth Outcomes among
First Nations in Quebec**

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Résumé

OBJECTIF: Chez les Autochtones, la relation entre le degré d'éloignement et les issues de naissance est inconnue. L'objectif de cette étude est d'évaluer cet impact parmi les Premières Nations du Québec. **MÉTHODE :** Nous avons utilisé les données vitales de Statistique Canada pour la province du Québec pour la période 1991-2000. L'ensemble des naissances géocodées parmi les communautés des Premières Nations groupées en quatre zones en se basant sur le degré d'éloignement a été analysé. Nous avons utilisé la régression logistique multi-niveaux pour obtenir des rapports de cotes ajustés pour les caractéristiques maternelles. **RESULTATS :** Le taux de naissances prématurées varie en fonction de l'éloignement de la zone d'habitation (8,2% dans la zone la moins éloignée et 5,2% dans la Zone la plus éloignée, $P < 0,01$). En revanche, plus la zone est éloignée, plus le taux de mortalité infantile est élevé (6,9 pour 1000 pour la Zone 1 et 16,8 pour 1000 pour la Zone 4, $P < 0,01$). Le taux élevé de mortalité infantile dans la zone la plus éloignée pourrait être partiellement expliqué par le fort taux de mortalité post-natale. Le taux de mort subite du nourrisson est 3 fois plus élevé dans la zone 4 par rapport à la zone 1. Cependant la mortalité prénatale ne présente pas de différences significatives en fonction de la zone malgré une fréquence élevée dans la zone 4. La morbidité périnatale était semblable en fonction de la zone après avoir ajusté pour l'âge, l'éducation, la parité et le statut civil. **CONCLUSIONS :** Malgré de plus faibles taux d'enfants à haut risque (accouchements prématurés), les Premières Nations vivant dans les communautés les plus éloignées ont un risque plus élevé de mortalité infantile et plus spécialement de mortalité post-néonatale par rapport aux Premières Nations vivant dans des communautés moins éloignées. Il y existe un grand besoin d'investissement en services de santé et en promotion de la santé dans les communautés les plus éloignées afin de réduire le taux de mortalité infantile et surtout post-néonatale.

Mots-clés : mortalité infantile, naissance prématurée, poids bas, haut poids, mortalité postnatal, éloignement, Première Nation, Autochtone

Abstract

OBJECTIVE: It is unknown whether Aboriginal birth outcomes may be affected by the degree of community remoteness. We assessed community remoteness and birth outcomes among Quebec First Nations. **METHODS:** We used Statistics Canada's vital data for the province of Quebec, 1991-2000. Postcode geo-coding linkage was used to identify all births in First Nations communities (reserves). Communities were grouped into four zones based on the degree of remoteness. Multilevel logistic regression was used to obtain the ORs adjusting for maternal characteristics. **RESULTS:** Preterm birth rates rose progressively from the most remote (5.2%) to the least remote (8.2%) zone ($P<0.001$). In contrast, infant mortality rose progressively from the least remote (6.9/1000) to the most remote (16.8/1000) zone ($P<0.01$). The excess infant mortality in the more remote zones could be largely explained by the high postneonatal mortality. Postnatal SIDS was 3 times higher in the most remote compared to the least remote zone. Perinatal mortality was highest in the most remote zone but the differences were not significant across the four zones. Similar patterns were observed after adjusting for maternal age, education, parity and marital status. **CONCLUSIONS:** Despite lower rates of preterm deliveries, First Nations living in more remote communities suffered a substantially higher risk of infant death, especially postneonatal death, compared to First Nations living in less remote communities. There is a greater need for improving maternal and infant health in more remote Aboriginal communities.

Keywords: infant mortality, preterm birth, low birth weight, high birth weight, postneonatal death, First Nations, community remoteness, Aboriginal people

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List of Abbreviations

1.FN	First Nations
2.AI/AN	American Indian and Alaska Natives
3.HBW	High birth weight
4.LBW	Low birth weight
5.SGA	Small for gestational age
6.LGA	Large for gestational age
7.GDM	Gestational diabetes mellitus
8.NIDDM	Non-insulin dependent diabetes mellitus
9.T2DM	Type 2 diabetes mellitus
10.IHS	Indian health services
11.UIHO	Urban Indian health organization
12. FNQLHSSC	First Nations of Quebec and Labrador Health and Social Service Commission
13.NWT	Northwest Territories
14.SIDS	Sudden Infant Death Syndrome
15. OR	Odd ratio
16. BCVS	British Columbia Vital Statistics
17.FMT	French mother tongue

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Section I

Introduction

Literature Review

1.1 Introduction

The term “Indigenous Peoples” or “Aboriginal peoples” can be used to describe any ethnic group of people who inhabit a geographic region with which they have the earliest known historical connection (http://en.wikipedia.org/wiki/Indigenous_peoples). The Canadian constitution recognize three groups of Aboriginal peoples in Canada: North American Indians or First Nations, Inuit, Métis.[1] In recent years, North American Indians in Canada preferred to be called “First Nations”, and considered the term “American Indians” disrespectful. Therefore, throughout the rest of the thesis, I retain the term “First Nations”, which should be taken to be synonymous with the term “American Indians” or “Indians” in its legal usage. I used the term “Aboriginal” to refer to all Aboriginal peoples in Canada, and the term “Indigenous” to address Aboriginal peoples internationally. In spite of the publicly funded health care system in Canada, Aboriginal populations (First Nations, Inuit, Métis) generally suffer much poorer birth outcomes compared to those of the non-Aboriginal population. [2-8] This situation is not limited to Canada; evidence exists for persistent disparities in the birth outcomes of Indigenous versus non-Indigenous populations in both the US [9] and Australia [10, 11]. Data on Aboriginal birth outcomes in Canada remain incomplete due to the lack of an Aboriginal birth identifier on birth registration forms in most provinces.[12] Available data suggest that fetal and infant mortality are significantly increased among Canadian First Nations and Inuit as compared to non-Aboriginal populations.[6, 12-14]

With the intention of reducing adverse birth outcomes disparity gap, researchers have investigated various birth outcomes in relation to some individual characteristics such as socioeconomic and health-risk behaviors as well as community characteristics such as urban versus rural residential locations.[6, 15-18] To our knowledge, there are no studies examining the association of birth outcomes with the degree of remoteness of Aboriginal communities in Canada. Studies on the birth outcomes of Native Americans in the U.S. have centered on metropolitan areas since the majority of the native population reside in those areas. In Canada, however, a significant number of Aboriginal individuals reside in remote communities. Thus, it is important to address remoteness and its relation to birth

outcomes. This thesis is focused on understanding patterns of birth outcomes in relationship to remoteness in First Nations communities. It will provide evidence that may help guide policy makers and other health care professionals in designing and implementing effective strategies for improving Indigenous maternal and infant health.

The federal health agency - the First Nations and Inuit Health Branch of Health Canada (FNIHBC) - plays a significant role in providing funds and maintaining health care services for First Nations on reserve communities. Indian and Northern Affairs Canada (INAC) is one of the federal government departments responsible for meeting the Government of Canada's obligations and commitments to First Nations, Inuit and Métis, and for fulfilling the federal government's constitutional responsibilities in the North. The Band Classification Manual[19] provides a listing of First Nations and their remoteness and environmental indices, as well as the city centre, the service centre, and the most populous reserve that are used to determine the indices. The intent of these indices is to provide a sense of geographic and economic reality in the funding process. The geographic zones (zone 1 - the least remote - and zone 4 - the most remote of all four zones) are exactly the same with the remoteness classification of First Nations zone, one being the least and zone four the most remote of all the four zones; although zone four is again divided into 7 sub-zones (0 to 6). The geographic classification that is exactly the same as remoteness classification was considered as parameter of interest (First Nations residents' locations). Although I am aware that this manual and parameter of remoteness described in this manual was not developed for research purpose, it is the only available document for classifying the remoteness of First Nations communities. Taking advantage of this practical isolation indicator, we assessed First Nations birth outcomes in relation to community remoteness in Quebec.

This thesis is based on a manuscript written by the first author and it includes four sections. The first section provides an overview of Aboriginal health and birth outcomes, and individual and community characteristics in relation to those birth outcomes. Section 2 states hypothesis and objective of the study. Section 3 addresses methodology of the study.

Section 4 presents the results of the study, including the research article. Finally, section 5 includes a general discussion and the conclusion.

1.2 Literature Review

1.2a Historical Overview of the First Nations population

In order to comprehend the current health matters of the First Nations population in Canada, it is imperative to acquaint ourselves with a few historical events pertinent to the relationship between the Aboriginal peoples in Canada and the health care system of the Canadian government. In 1876, the Indian Act entitled all registered First Nations people living on reserves to health care, education and housing. In 1945, following a change in the Indian Health Service Policy, the Department of National Health and Welfare took over the responsibility for delivering health services to First Nations. Subsequently, prior to 1985, under certain provisions of the *Indian Act*, registered Indian women who married men who were not Registered Indians automatically lost their status and as a result, their band membership. This meant that these women could no longer pass their status on to their children. The opposite was true for Registered Indian men, as the Indian Act conferred status to their non-registered spouse. The 1985 *Act to Amend the Indian Act*, also known as Bill C-31, C-31 changed the registration system so that entitlement was no longer based on gender discriminatory rules. In 1992, the federal government devoted a substantial component of the Brighter Future Program to community mental health service in Aboriginal communities.

The Constitution Act (1982) recognizes three broad categories of Aboriginal peoples: Indians (or First Nations), Inuit and Métis. These are three separate Indigenous groups, each with a unique culture, language and spiritual tradition. First Nations, the main population of this study, were known as “Indians” prior to 1970. According to Aboriginal People Survey in 2006, the number of people who identified themselves as an Aboriginal person, that is, North American Indian (First Nations people), Métis and Inuit, surpassed

the one-million mark, reaching 1,172,790 from which 698,025 were First Nations people (both Status and non-Status Indians). [20] Despite urban migration over recent decades, approximately half of registered First Nations populations remain on reserves in Canada. Approximately half of First Nations with status (51%) live off-reserve, with 76% of those living in urban areas. [21][22] In addition to universal health coverage that is available to all citizens and permanent residents of Canada, some of First Nations (only those registered as “Status Indians”) are entitled to some additional service at no cost. These services include prescription medications, eye-glasses, dental care, individual mental-health counseling and transportation to access medical services.[23] In practice, however, some of these additional services are not available in remote communities. More importantly, a recurring problem in the provision of culturally appropriate health services for Aboriginal people in northern Canada is the issue of medical transfers. Aboriginal pregnant women are frequently transferred to southern Canada through case referrals for more advanced medical care and for delivery.

1.2b Aboriginal-First Nations Health

On average Canadian Aboriginal peoples (First Nations, Inuit, and Métis) live shorter than their fellow Canadians,[24] [25] and sustain a disproportionate share of the burden of physical and mental illness.[8] For First Nations men, life expectancy at birth is 70 years while it is 70 years for the general population in Canada. For First Nations women, it is 73 years (general population of Canada 82 years).[24] This reflects a difference of 3 and 9 respectively, from the 2001 life expectancy of the Canadian population. Recent analysis of the 2001 Aboriginal Populations Survey indicates that even at the same level of income, off-reserve Aboriginal peoples suffer disproportionately from chronic conditions and are nearly two times as likely to report fair or poor health as compared to non-Aboriginal peoples.[26] Although mortality due to cancers in First Nations was reportedly lower than in the overall Canadian population, the rate of acute myocardial infarction of First Nations peoples was 20% higher and the rate of stroke of First Nations peoples was twice as high.

In 1999, the reported rate of suicide in Aboriginal populations was more than twice the rate of fellow Canadians.[25]

Higher rates of infectious disease such as hepatitis A and B, gastroenteritis, meningitis and gonorrhoea were reported for Aboriginal populations of Canada.[8] In spite of Canada being one of the countries where tuberculosis case rates are reaching the lowest levels ever, Aboriginal populations remain a high risk group.[27] In 1990 among First Nations peoples, tuberculosis rates were estimated to be 6 to 11 times higher than that of the general population. The incidence of genital chlamydia among First Nations individuals was about 1,071.5/100,000 persons, which translates into a rate six times higher than the rate in the remainder of the Canadian population.

Type II diabetes mellitus (T2DM) is one of many serious health problems among the Aboriginal population in Canada.[28-31] Prior to the 1950s, diabetes was rare but a rapid increase of its prevalence has been reported in a few regions of Canada. To illustrate, in Saskatchewan since 1934, the prevalence of type II diabetes mellitus has jumped from 0% to 10%, and over a ten year period (1980-1990) this rate doubled.[31] The overall prevalence of non-insulin dependent diabetes mellitus (NIDDM) among Ojibwa-Cree pregnant women in Ontario was 11.6% (152 of 1,305) with a gestational diabetes mellitus (GDM) prevalence of 8.4% (110 of 1,305).[32] In the Eastern James Bay region of Northern Quebec (mostly First Nations communities), the prevalence of GDM was 12.8% (75 of 579, January 1995 to December 1996).[30] The prevalence of GDM in the Aboriginal population of Saskatchewan has been reported as 11.5 while the overall rate was 3.5% (Prospective survey, January-July 1998).[33] The epidemic of diabetes manifests itself to a greater extent among women and certain tribal groups.[31] Central obesity, dietary acculturation or substitution of traditional food items by modern or western food enriched with carbohydrates, and a lack of physical activity were identified as significant risk factors for diabetes in Aboriginal populations.[30-33]

Obesity is a serious public health issue among children, adolescents and adults of Aboriginal communities in Canada and amplifies their risk of diabetes.[34, 35] In the late

nineteenth century, a survey carried out by Young and Sevenhuysen in northern Canada reported almost 90% of First Nations women between 45 and 54 years old with a body mass index of 'overweight' or 'obese'. [36] Among First Nations individuals aged 2-19 in Sandy Lake, Ontario, the prevalence of over weight individuals ranged from 28-38% (Cross-sectional survey, July 1993-December 1995). [37] A retrospective study from January 1994 to July 1997 reported dramatically high prevalence estimates of pediatric obesity among the Cree population. The study used 2 different growth references; according to the International Obesity Task Force (IOTF) standards, 52.9% of Cree children were overweight (31.6%) or obese (21.3%), while according to the Center for Disease Control and Prevention (CDC) standards, its prevalence rates corresponded to 64.9% overweight (27.5%) and obese [35]. [35] The author of this study suggests that the construction of a mass hydroelectric project in 1970 and the subsequent change in the lifestyle of the James Bay Cree population of Northern Quebec has contributed to these numbers.

1.3 Aboriginal-First Nations Birth Outcomes

1.3a LGA, HBW, SGA, LBW and preterm birth

Birth weight is considered an important determinant of infant health. When the weight of a newborn is more than the 90th percentile or ≥ 4000 g, it is considered large for gestational age [38] or a high birth weight (HBW), respectively. Similarly, when the weight of a newborn is less than the 10th percentile or ≤ 2500 g, it is considered small for gestational age (SGA) or low birth weight (LBW), respectively. While the terms Macrosomia, HBW and LGA are often used interchangeably, large for gestational age (LGA) defines a different population from high birth weight (HBW).

Overall, a different distribution curve for birth weight was observed for First Nations peoples compared with the rest of the Canadian population. [12, 23, 36, 39, 40] In general, lower rates of LBW and SGA and higher rates of HBW (>4000 g) and LGA were reported in First Nations infants compared to non-Aboriginal infants. [6, 29, 41, 42] In Ontario

earlier records for the period of 1968-69 and 1974-77 reported the mean birth weight of First Nations at 310 g higher than the general population (3608 g versus 3298 g).[43] A similar pattern was observed in other provinces of Canada. For the period 1982-1986 in British Columbia, the prevalence of HBW \geq 4000 g was 15.9% in Native, versus 14.1% for non-Native infants.[23] For the period 1995-1996 in northern Quebec the rate of HBW was 37.4% among Cree women, with a 4.5 fold increased risk of macrosomia (greater than 90th centile of weight) among Native mothers with gestational diabetes mellitus relative to non-Native mothers.[29] Table-1 demonstrates an increasing trend of HBW rates versus a decreasing trend of LBW rates for registered First Nations individuals from 1985 to 1997.[6]

The clinical repercussions of large birth size within First Nations communities have been investigated to a lesser degree. Although macrosomia increases the chance of instrumental and caesarean section deliveries for the general population, the rate of these procedures were not as high as expected in First Nations populations.[29]

Table 1: Rates of high birth weight (≥ 4500 g) and low birth weight (< 2500 g) for First Nations in Quebec, 1985-87 and 1995-97 [44]

Time Period	High Birth Weight		Low Birth Weight	
	First Nation	French	First Nations	French
1985-187	5.4	1.1	3.6	5.7
1995-1997	6.9	1.3	3.1	5.1

Unlike the Aboriginal people of North America, Australian Aboriginals showed higher rates of LBW and SGA birth compared to the general population. [45-47] A prospective ultrasound-based study carried out in the Aboriginal population in far northern Queensland Australia reported the average weight of a newborn to be 450 g lighter than their white counterpart. In that particular study, high rates of LBW were attributed to a high prevalence of substance use such as alcohol and tobacco smoking during pregnancy.[47]

In the United States of America, the rates of HBW and LBW were higher among American Indians and Alaskan Natives (AI/AN).[9, 48] A nationwide population-based study for the period of 1991-2000 reported the rate of LBW as 6.8% for AI/AN populations.[49] Moreover, considerable variations exist among rates of LBW for this population between metropolitan areas. For example in New York City (1989-1991) the rate of LBW was 9.2%, and in the DC and Baltimore it was 8.0%. Compared with the general population, LBW rates were 1.5 to 2 times higher among AI/AN.[48] Authors of those studies suggested the underlying causes to be poverty, low maternal education and limited access to health care.

Most of those cited studies suggest factors such as socio-economic characteristics, Aboriginal ethnicity, parity, nutrition, gestational age and sex of infant, as common risk factors for both low and high birth weight of Aboriginal populations in Canada, USA and Australia. Diabetic mothers [32] and high pre-pregnancy weight along with nutritional

factors were associated with higher odds of giving birth to high birth weight babies while smoking and alcohol consumption were negatively correlated with birth weight.

Preterm birth is defined as birth before 37 completed weeks of gestation, and is among the leading causes of neonatal mortality.[50] Among Aboriginal groups, Inuit people carry the highest burden of preterm births (1998-2000, 18.2%).[51] There is no consistent provincial and territorial tracking of preterm birth rate among First Nations. In British Columbia for the period of 1982-1986, the preterm birth rate among First Nations women with Indian status was almost twice that of non-Natives (11.3% versus 5.6%). However, a prospective cohort study investigating the birth outcomes of the Aboriginal population in Alberta did not report any difference in the rates of preterm birth or low birth weight of First Nations compared with the corresponding non-Indigenous population.[41] Table-2 shows high preterm birth rates among First Nations in many provinces of Canada.

Table 2: Preterm birth rates among First Nations (FN) versus non-Indigenous women in Canada

Study	Study Type, Data Source, Aboriginal Birth Identifier, and Study Subjects	Rate, RR/OR (95% CI)
Luo 2008 community Report	Retrospective birth cohort, linked vital data, Manitoba 1991-2000, Statistics Canada. Self identifier on birth registrations. 26,176 FN, 129,623 non-FN	FN 8.2% Non-FNs 7.36% RR 1.1 (1.1-1.2)
Luo 2008 Community Report	Retrospective birth cohort, linked vital data, Quebec 1991-2000, Birth by mother tongue, 5193 FN, 653424 French	FN 7.3% French MT 6.6 % RR 0.9 (0.8-1.0)
Luo 2004	Retrospective birth cohort. Linked vital data, 1985-1997 Quebec, Statistics Canada. Singleton births by Mother Tongue: 7817 FN, 905,565 French	FN 5.5%, French MT: 6% RR 0.9
Luo 2004	Retrospective birth cohort. Linked vital data, British Columbia 1981-2000. FN birth identifier based on linkages from multiple sources. 56,771 FN, 446932 non-FN	Rural: FNs 9.2%, non-FNs 5.0%, RR 1.8 Urban: FNs 9.9%, non-FNs 6.3 % RR1.6 (1.5-1.6)
*BCVS, 2004	Linked vital data, British Columbia 1992-2002, Status Indians flag, 34319 FN, 446932 non-FN	FN 9.1%, non-FN 6.2% RR 1.5
Wenman 2004	Hospital-based prospective cohort, Edmonton 1994-1995, Self-identification: 53 Aboriginal (19 Métis, 34 FN), 1612 non-Aboriginal births	Aboriginal 9%, non-Aboriginal 7%, RR 1.3
Dyck 2002	Hospital-based prospective cohort, Saskatoon 1998, Self report ethnic origin: 253 Aboriginal (AB), 1382 non-Aboriginal births	FN 7.4% non-FN 6.0% RR .12
Morrison 1986	Retrospective cohort, un-linked vital data, 1976-1983 Indian Reserves in five provinces, unlinked vital data of Statistics Canada, standardised mortality ratio (SMR), non-reserve mortality as the references.	Reserve 9.6%, Non-Reserve 10.1% , RR 1.0

In the USA for the period 1991-2000 premature birth rates were higher among AI/AN than the general population (12.3% vs. 10.9 % in general population).[49] Vaginal bleeding during pregnancy, two or more previous spontaneous abortions, vaginal infection, chronic disease during pregnancy such as diabetes, and fewer antenatal visits were reported as risk factors for preterm birth among Aboriginal populations in Canada [39] and the USA. [51-53]

1.3b Fetal and Infant Mortality

Infant mortality is defined as death occurring in the first year of life (0-364 days of life). It is usually divided into two categories; neonatal and postneonatal. Neonatal mortality refers to infant death during 0-27 days of life, and infant death from an age of 28 to 364 days of age is considered postneonatal death. Infant mortality rates of Indigenous populations of developed countries fell steadily during the last two decades, but have always lagged behind national rates. The rates of infant mortality of First Nations in different provinces and territories of Canada are summarized in Table-3. The decline in infant mortality rates for First Nations (from 51.4/1000 in 1961-65 to 5.2/1000 in 1991-2000) and Inuit (from 114.7% to 16.5% in the same time periods) is indicative of a remarkable improvement in Aboriginal child health, however, the relative risk ranges from 2 to 2.5 and shows no apparent improvement.[22]

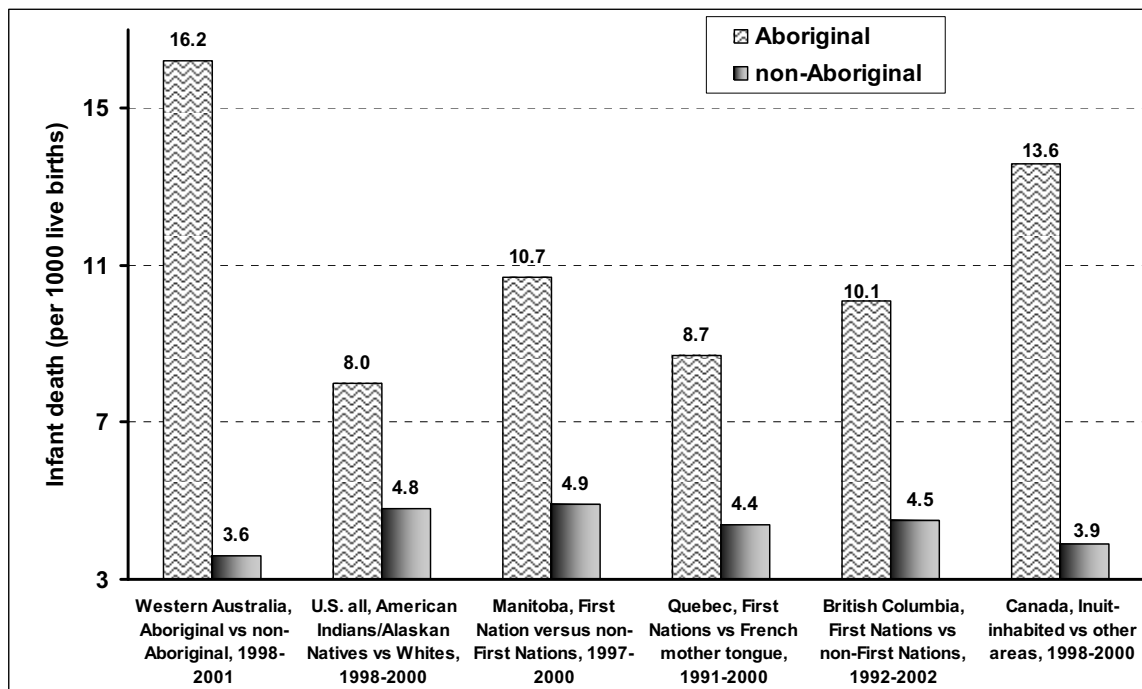
Table 3: Infant, postneonatal and neonatal mortality of different provinces of Canada

	Infant mortality		Postneonatal mortality		Neonatal mortality		Study
	Ontario	FN Canada	FN Canada	FN Canada	FN Canada	FN Canada	
1972-176	45.6	15.5	27.4	4.9	18.2	10.6	<i>Young (1983)</i>
1977-1981	27.8	12.2	15.9	4.0	11.9	8.2	<i>Young (1983)</i>
Quebec*	FN	FMT	FN	FMT	FN	FMT	
1985-97	8.4	5.2	5.7	1.6	2.7	3.6	Luo 2004
1991-2000	8.7	4.5	5.6	1.4	3.1	3.0	Luo 2008
British Columbia	FN	Non-FN	FN	Non-FN	FN	Non-FN	
1982-1986					6.9	4.9	Thomson 1990
1991-1997	11,3	5,1					Rockwell 2001
1992-2002	10.1	4.5	5.3	1.3	4.7	3.2	BCVSA 2004
Saskatchewan	FN	Non-FN	FN	Non-FN	FN	Non-FN	
1984-1986	16.6	6.4	10.1	3.8	6.5	6.0	Edouard 1991
Manitoba	FN	Non-FN	FN	Non-FN	FN	Non-FN	
1991-2000	10.2	5.4	6.1	1.7	3.7	3.3	Luo 2007
2002	12	5.9	6.0	1.8	6.0	4.1	Anonymous 2003
NW T**	FN	Canada	FN	Canada	FN	Canada	
1961-1965	76.7	25.3					Hobart 1976
1966-70	44.7	21.3					Hobart 1976
1973.4-1974.3	FN	White	FN	White	FN	Whites	
	48.5	8.2	29.8	NA	18.6	8.2	Spady1982
	FN	Canada	FN	Canada	FN	Canada	
1976-1980	29	119	16.7	4	12.3	7.9	Muir 1988
1981-1985	18.8	8.6	11.1	3	7.7	5.6	Muir 1988

*First Nations mothers versus French Canadian mothers in Quebec ** Northwest Territories

The infant mortality rate for Australian Aboriginals was higher than that of the USA and Canada; figure 1 (below) illustrates this comparison. The absolute infant mortality for Australian Natives has dropped significantly from 25 (1980-84) to 16.1 (1998-2001) per 1000 in Western Australia, but relative risk rose significantly from 3 to 4.[10] Similar to Canada as shown in Table 3, Australian studies reported a local variation of infant death rates among Aboriginal populations. For example, the infant mortality rate among Aboriginals in the Northern Territories was approximately three-fold higher than the rates in Queensland in 1990.[54] In the USA, since the creation of the Indian Health Service in 1955, the rate of infant mortality has dropped from 62.7/1000 to 8.7/1000 in 1993. [55] However, in 1998-2000, American Indian infants were 1.7 times more at risk of infant death than white infants in the U.S.

Figure 1: Infant mortality rates for Aboriginal and non-Aboriginal populations in Australia, USA and Canada



Stillbirth is defined as the complete extraction or expulsion of the conception product from the mother at ≥ 20 weeks of gestation or a birth weight of ≥ 500 g without any sign of life. A research paper covering 190 countries identified problems with the identification and registration of stillbirth as a reason for eliminating stillbirth from most research databases. Stillbirth rates tend to be under-reported and underestimated.[56] The same suggestion has been proposed for stillbirth rates among Aboriginal peoples in Canada.[5] In Canada, the rate of stillbirths, like the infant mortality rate, has improved during the last few decades. However, one study reported a significant increase in the rate of stillbirths from 1985-87 to 1995-97 among First Nations in Quebec[44], the leading causes of stillbirth being asphyxia and congenital conditions (accounted for 40.9% and 13.6%, respectively).

An Australian study based on 6 years of data [57] in Queensland reported a crude stillbirth rate of 14.4/1000 for Aboriginals and 6.1/1000 for white populations. The author also noted that gestational age specific stillbirth rates for Aboriginal populations were not significantly different from that of white populations.[57]

1.3c Cause-Specific Infant Mortality

Major causes of death differ during neonatal and postneonatal periods. It is well established that postneonatal death echoes the extent of infectious disease, quality of nutrition and general socioeconomic conditions in an infant's living environment, while neonatal mortality reflects congenital conditions, maternal health, and the general circumstances surrounding the infant at birth. [10] In Quebec, the major causes of infant death of First Nation and Inuit babies for the period of 1985-1997 were congenital anomalies (41%), immaturity (24.3%), asphyxia (9.4%), SIDS (9.1%) and infection (5.2%).[6] The same study reported a different risk profile of cause-specific infant mortality for First Nation and Inuit versus French mother tongue individuals. For example, Inuit infants had a much higher risk of death (6.3/1000) due to immaturity related conditions than a First Nation infants (0.9/1000) or a French mother tongue infants (1.2/1000). But risk of infant death due to congenital anomalies was not significantly different for infants of

Aboriginal versus non-Aboriginal mothers. Sudden infant death syndrome (SIDS) was reported as the leading cause of postneonatal mortality in the Aboriginal population of Manitoba and British Columbia, and accounted for 50% infant death among First Nations in British Columbia in 1981-2000.[12]

Several U.S investigators have examined birth outcomes of American Indians and Alaskan Natives (AI/AN) served by the Urban Indian Health Organization (UIHO) and Indian Health Services [55], attributed disparities found for infant mortality, particularly postneonatal mortality, to inadequate services, prevalence of high-risk behaviors in pregnancy (smoking and drinking) and poor socioeconomic status. [9, 58, 59] This finding mirrored those of Canada [5, 13, 38] and Australia.[10, 12, 60, 61] In Western Australia, SIDS was reported as the leading cause of infant mortality for Aboriginals, while immaturity-related conditions were the leading cause of infant death for non-Aboriginal infants.[10] In another study by the same author, the relative risk of SIDS for Aboriginal infants of Western Australia was reported at 7.9 compared to that of non-Aboriginal infants.[11] Similar to Australia, SIDS in the USA was considered the primary cause of infant mortality of American Indian /Alaska Native children (1989-1991) while congenital anomaly was reported as the most frequent cause of infant death for the white population for periods of 1989-1991 and 1998-2000. In the USA, the neonatal mortality of Native Americans in areas covered by IHS was 4.1/1000, a rate lower than that of whites (5.3 /1000) while the postneonatal rate was 4.6/1000, a rate higher than that of whites (2.5/1000). The rate of SIDS was high among Cree infants in Quebec. [38] Several studies in the USA, Australia and Canada have suggested some common factors that were identified as risks for infant death and sudden infant death syndrome, such as low socioeconomic status, single motherhood with young maternal age[62],high parity[63, 64], cigarette smoking [65], premature birth/low birth weight or SGA [66, 67], maternal anemia, intrauterine growth retardation, cold weather, male sex of infant and the prone sleeping position. [13, 55, 68]

1.3d Determinants of Birth Outcomes

Personal socio-economic status (SES) (as measured for example by income and education attainment) is considered an important health determinant. A number of perinatal epidemiological studies in general populations have demonstrated striking socio-economic disparities in key birth outcomes such as preterm birth, low birth weight, and infant mortality [69, 70]. Underprivileged socioeconomic status may partly explain the unfavorable birth outcomes among Aboriginal populations in Canada [3, 12, 71] as well as in the USA [61, 72, 73] and Australia. [9, 15, 48, 73-76] But the effects of the SES on birth outcomes of Aboriginal peoples are not well studied in Canada. This can be attributed to the lack of income and education or other socioeconomic status indicators at the individual level in population-based perinatal data in most Canadian provinces. The availability and quality of the Native or Indigenous birth identifiers in the population-based surveillance databases of Canada[12], the USA[72, 75] and Australia[10, 53] represent a major bottleneck in our knowledge of birth outcomes among Aboriginal populations. Overall, rates of unemployment are higher for Aboriginal peoples compare to non-Aboriginal Canadians. According to 2006 census, rate of employment for First Nations on-reserve adult population (over 18 years of age) was 49%. Single mothers, teenage pregnancies and low incomes are disproportionately higher among Aboriginal peoples in Canada [20, 77]USA [49] and Australia[78]. These factors may partly account for their higher risks of adverse pregnancy outcomes. Education is an important dimension of SES, and is strongly and consistently associated with pregnancy outcomes. Several studies found an inverse relationship between the number of years of education of mother and infant mortality[79], small for gestational age or preterm birth, and stillbirth[80]. High-risk behaviors such as tobacco smoking or alcohol consumption during pregnancy are independent predictors of many adverse birth outcomes. These have been found to be associated with decreased birth weight in Canadian [15] Aboriginal populations. They are also associated with preterm birth in Australian Indigenous populations [10, 52, 53, 81] and U.S. Native American population [61, 72]. Independent of individual-level factors and their impact, recent

evidence suggests that community level characteristics may be important determinants of birth outcomes. [58, 82-84] A higher risk of some adverse birth outcomes was reported in poorer neighborhoods.[80] Generally, certain birth outcomes, such as infant mortality (neonatal and postneonatal mortality) and stillbirth, seem to be higher in relatively isolated rural areas with less metropolitan influence in the general population.[39] Studies have reported disparities among birth outcomes of Aboriginal versus non-Aboriginal populations in urban areas of the USA[48, 49, 73], Canada[12], and Australia[53, 78, 85]. In a U.S study, researchers found higher postneonatal deaths due to infection, injuries and SIDS for the AI/AN population in rural over urban areas, and a lower rate of LBW in the urban AI/AN population.[86] Limited access to health care facilities or inadequate prenatal care may be the cause for a higher frequency of adverse outcomes in rural areas. However, the higher frequency of adverse birth outcomes observed for some Aboriginal populations living in urban areas with access to advanced medical facilities puzzled researchers in Australia [53, 78] and the USA [86]. Several researchers suggested that local access to obstetrics and neonatal care with surgical facilities within an appropriate cultural context could be an important means to reduce adverse birth outcomes [85, 87]. However, research suggests that factors other than socioeconomic differences affect the health of Indigenous people, including dispossession, discrimination, sense of control and power, identity and stress, and that these factors may contribute to and help to explain what are often seen as intractable health and social problems.[78]

Section II

Hypothesis

Objective

Hypothesis

Little is known about the degree of community remoteness or isolation in relation to birth outcomes. Since poverty and lack of high-quality perinatal care services are often a socioeconomic reality in remote areas, and that First Nations communities in more remote areas more likely face challenging health issues concerning birthing, neonatal and infant care, we hypothesize that birth outcomes among First Nations may differ by the degree of community remoteness, where the less remote communities may have better birth outcomes compared to the more isolated communities, and the risk differences may be partly explained by maternal socioeconomic characteristics.

Objective

We aimed to assess the risks of adverse birth outcomes in relation to the degree of community remoteness among First Nations in Quebec. Understanding the potential differential patterns in birth outcomes by community remoteness may provide essential information for developing targeted maternal and infant health promotion programs to reduce adverse birth outcomes in Quebec and other Aboriginal communities.

Section III

Methodology

3. Methodology

3.1 Subjects and design

This study is a geocode linkage based retrospective cohort of all births to residents of First Nation's reserves in Quebec, 1991-2000. We used Statistics Canada's linked stillbirth, live birth and infant death data files. The validity of the Canadian linked vital data has been well documented.[88] The study was approved by the research ethics board of Sainte-Justine hospital, a teaching hospital of the University of Montreal, as well as the First Nations of Quebec and Labrador Health and Social Services Commission.

3.2 Geocoding linkage identification of First Nations reserves

Geocoding is a process of finding associated geographic coordinates from other geographic data such as postal code or street address. The geocoding linkage of maternal place of residence for all births was done in Statistics Canada. Births to residents of First Nation's reserves were identified through maternal residential postal codes as recorded on the birth registration. A list of postcodes for all 40 First Nation reserves/communities (only one postcode for each reserve/band) in Quebec was obtained and verified by our collaborator in First Nations of Quebec and Labrador Health and Social Service Commission (FNQLHSSC). The FNQLHSSC has the mandate in the coordination of health and social services to all First Nations communities in Quebec except for Cree communities (which are served by the Cree Health Board). A total of 11,390 births were recorded to residents of mothers of the areas covered by those postal codes. In a preliminary analysis, we only considered births to First Nations mother tongue individuals as births to on reserve First Nations residents, but found that the total number (n=4,088) was much lower than expected during the study period. We subsequently decided that the best estimates could be obtained by imputations based on the uniqueness of the postcode to a First Nation community. We imputed all births to residents of areas with postal codes unique to First Nations reserves

[89] as First Nations, because: 1) these reserves are relatively isolated from other communities; 2) over 90% of the residents are First Nations. Moreover; 3) about 40% of First Nations individuals no longer speak their native mother tongue, according to the 2001 census. In areas with postal codes shared by a First Nation community and an adjacent non-First Nation community, [18] we considered only births to women whose mother tongue was a First Nation language as births to ‘on reserve’ First Nations. Based on this algorithm. A total of 7,791 births were captured as First Nations births on reserve, constituting the primary study cohort. In addition, we conducted sensitivity analyses to assess whether there were substantial changes in result patterns based on different definitions of First Nations births on reserve.

3.3 Community remoteness measure

We defined community remoteness according to the First Nations band classification manual developed by Indian and Northern Affairs of Canada (INAC). The classification was motivated by the need to create a reference for the “difficulty to deliver services” index, which was used for the allocation of funds to support social service programs on reserve.[19] All First Nations communities are rural, according to Statistics Canada’s recommended definition of rural and urban areas – urban refers to any census metropolitan area or agglomeration area (CMACA) with a population of 10,000 or more, while all the remaining residual areas are rural. First Nations communities (bands) are grouped into four zones according to year-round access to roads and the distance from the nearest service center, based on the INAC classifications of all First Nations bands (communities). INAC Zone 1 (the least remote) is located within 50 km of the nearest service center with year-round road access. Zone 2 is between 50 and 350 km from the nearest service center with year-round road access. Zone 3 is over 350 km from the nearest service center with year-round road access. Zone 4 (the most remote) has no year-round access to a service center and, as a result, experiences much higher costs and greater inconvenience with regard to transportation. The service center is the municipality where First Nations individuals have access to social services and living supplies. Local health care centers are often located in

these municipalities. The nearest service center would provide supplies, material and equipment for construction, office operation, a pool of skilled and semi-skilled labor, and at least one financial institution such as a bank, trust company or credit union. Road access includes surface transportation on year-round paved or graveled roads linking a First Nation community with the nearest service center. An INAC zone could therefore be considered as a practical measure of the degree of remoteness of a community. Such INAC zone classification is only available for and applicable to on reserve First Nations communities. Of the 40 First Nations communities/bands, there are 18 communities in INAC Zone 1 (least remote), 12 communities in Zone 2, 6 communities in Zone 3, and 6 communities in Zone 4 (see Appendix -3). Variations in First Nations birth outcomes across these INAC zones have not been previously examined.

Available maternal and pregnancy characteristics included maternal age (<20, 20-29, 30-34, ≥35 years), education (<11 years, 11 years (high school graduation), ≥12 years (college or higher), marital status (single, common law unions, married), parity (primiparous, multiparous), plurality (singleton, plural), infant gender (male, female), gestational age (in completed weeks), and birth weight (in grams).

3.4 Outcomes and analyses

Birth outcomes examined included preterm birth (gestational age <37 completed weeks), small-for-gestational-age birth (SGA, <10th percentile, based on the Canadian fetal growth standard),[69] low birth weight (LBW, <2500 g), high birth weight (HBW, >4000 g), large-for-gestational-age birth (LGA, >90th percentile), stillbirth (fetal deaths ≥20 weeks), neonatal death (died during 0-27 days of postnatal life), perinatal death (stillbirth + neonatal death), postneonatal death (died during 28-364 days of postnatal life) and infant death (neonatal death + postneonatal death). Rates were expressed per 100 total births for preterm, SGA, LBW, LGA or HBW birth, and for per 1000 total births for stillbirth, and per 1000 live births for infant, neonatal and postneonatal mortality. Causes of infant death were investigated according to the classification of the International Collaborative Effort on Perinatal and Infant Mortality,[90] based on the International Classification of Diseases

(ICD)-9 codes for deaths in 1991-1999 or (ICD)-10 codes for deaths in 2000-2001. The causes of death included congenital anomalies, immaturity related conditions, asphyxia, sudden infant death syndrome (SIDS), infection, external causes, and other causes. Analysis of SIDS was restricted to the postneonatal period because SIDS mostly spared the neonatal period,[91] and over 95% of the reported SIDS cases in our study were in the postneonatal period.

Chi-square tests for differences and Cochran-Armitage tests for trends were used to assess the differences and trends in outcome rates across the communities by remoteness (INAC zone). Crude and adjusted odds ratios [92] with 95% confidence intervals were calculated for assessing whether the associations could be explained by the differences in observed characteristics (maternal age, parity, education and marital status, plurality and infant sex). The least isolated INAC zone 1 served as the reference group. We assessed the adjusted ORs using both ordinary (single-level) and multilevel (community as a random effect variable) logistic regression models. Virtually identical adjusted ORs were obtained in the two sets of models due to very small intraclass correlations. We therefore reported the adjusted ORs from single-level analyses. All data management and analyses were carried out using Statistics Analysis System (SAS) for Windows, Version 9.0 (SAS Institute: Cary, North Carolina).

Section IV

Article

Article

“Community Remoteness and Birth Outcomes among First Nations in Quebec”

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Results of this article have been accepted for oral and poster presentations in many conferences including Scientific Day of Research Centre in Sainte Justine Hospital, Montreal; 2008 meeting of the Society of Perinatal Epidemiology and the Society of Epidemiological research in Chicago 2008, IUHPE 8th annual meeting in Italy, 2008.

Community Remoteness and Birth Outcomes among First Nations in Quebec

ABSTRACT

OBJECTIVE: There is limited information as to whether Aboriginal birth outcomes may be affected by the degree of community remoteness. We assessed community remoteness and birth outcomes among Quebec First Nations.

METHODS: We used Statistics Canada's vital data for the province of Quebec, 1991-2000. Postcode geo-coding linkage was used to identify all births in First Nations communities (reserves). Communities were grouped into four zones based on the degree of remoteness. Multilevel logistic regression was used to obtain the ORs adjusting for maternal characteristics.

RESULTS: Preterm birth rates rose progressively from the most remote (5.2%) to the least remote (8.2%) zone ($P < 0.001$). In contrast, infant mortality rose progressively from the least remote (6.9/1000) to the most remote (16.8/1000) zone ($P < 0.01$). The excess infant mortality in the more remote zones could be largely explained by the high postneonatal mortality. Postnatal SIDS was 3 times higher in the most remote compared to the least remote zone. Perinatal mortality was highest in the most remote zone but the differences were not significant across the four zones. Similar patterns were observed after being adjusted for maternal age, education, parity and marital status.

CONCLUSIONS: Despite lower rates of preterm births, First Nations populations living in more remote communities suffered a substantially higher risk of infant death, especially postneonatal death, compared to First Nations groups living in less remote communities. There is a greater need for improving maternal and infant health in more remote Aboriginal communities.

4.1 Introduction

Birth outcomes are fundamental to a population's health with long-term implications for the families and societies. Birth outcomes are much worse in indigenous versus non-indigenous populations even in developed countries like the U.S., Australia and Canada.¹⁻¹¹ However, Aboriginal birth outcomes remain a relatively quiescent research topic as reflected by the small number of publications and public funded research.¹² The Constitution Act (1982) recognizes three groups of Aboriginal peoples in Canada: First Nations (equivalent U.S. term "North American Indians"), Inuit and Métis. In Canada and in Quebec, little is known on health issues for Aboriginal peoples. Chronic and persistent lack of data and widespread information gaps frequently lead many policy makers and involved parties to resort to personal beliefs and anecdotal evidence in trying to understand and specificity of health issues, determinants and outcomes faced by First Nations, Inuit and Métis. Patchy, incomplete, and limited data is mainly due to the lack of an Aboriginal birth identifier on birth registrations in most provinces.⁶ Available data suggest that fetal and infant mortality are significantly elevated among Canadian First Nations and Inuit as compared to non-Aboriginal populations.^{6-8, 13}

The First Nations population in Canada numbered about 698,025 according to the latest 2006 Canadian Census³¹ and 40% of those individuals still live in reserve communities. A significant number of First Nations reserves are located in relatively remote areas. Little is known about the degree of community remoteness or isolation in relation to birth outcomes. Since poverty and lack of high-quality perinatal care services are often socioeconomic reality in remote area, we hypothesize that birth outcomes among First Nations may differ between lesser and more isolated areas, where the least remote areas may have better birth outcomes compared to the most isolated areas. The relationship between community remoteness and birth outcomes in First Nations communities is specifically examined in order to outline how birth outcomes vary by relative remoteness of FN communities. It is not known whether the degree of remoteness may affect various birth outcomes in these

First Nations communities. Aboriginal reserves in North American and Australia are most often located in relatively remote areas. Understanding the potential differential patterns in birth outcomes by community remoteness may provide essential information for developing targeted maternal and infant health promotion programs to reduce adverse birth outcomes in indigenous communities. There has been a lack of studies specifically examining the associations between the degree of remoteness and various birth outcomes in Aboriginal communities.

Health care is covered by universal health insurance program in Canada. The federal health agency - First Nations and Inuit Health Branch of Health Canada, plays a major role in the funding and maintenance of health care services to First Nations on reserve communities in partnerships with First Nations local governments. There is progression towards increasing self-governance of First Nations for health care services. To facilitate cost estimates, the Indian and Northern Affairs of Canada (INAC) has developed a scheme to classify all First Nations bands (reserves or communities) into four zones based on the degree of remoteness.¹⁴ Taking advantage of this practical remoteness measure, we assessed community remoteness in relation to birth outcomes in Quebec First Nations.

4.2 Methods

4.2a Subjects and design

This is a geocode linkage-based retrospective cohort study of all births to residents of First Nation's reserves in Quebec, 1991-2000. We used Statistics Canada's linked stillbirth, live birth and infant death data files. The validity of the Canadian linked vital data has been well documented.¹⁵ The study was approved by the research ethics board of Sainte-Justine hospital, a teaching hospital of the University of Montreal, as well as the First Nations of Quebec and Labrador Health and Social Services Commission.

4.2b Geocoding linkage identification of First Nations reserves

Births to residents of First Nation's reserves were identified through postal code linkage. The postal code indicated on the birth registration identified the maternal residential location. A list of postcodes for all 40 First Nation reserves (only one postcode for each reserve/band) in Quebec was obtained and verified by contacting a local person on each reserve. A total of 11,390 births were recorded to residents of the areas covered by those postal codes. In a preliminary analysis, we only considered births to First Nations language speaking individuals as births to on reserve First Nations residents, but found that the total number (n=4,088) was much lower than expected during the study period. We subsequently decided that the best estimates could be obtained by imputations based on the uniqueness of the postcode to a First Nation community. We imputed all births to residents of areas with postal codes unique to First Nations reserves²¹ as First Nations, because these reserves are relatively isolated from other communities and over 90% of the residents are First Nations. We obtained this information from First Nations individuals on working reserves. Moreover, such imputation is also justified by the fact that about 40% of First Nations individuals no longer speak their native tongue, according to the 2001 census. In areas with postal codes¹⁹ shared by a First Nation community and an adjacent non-First Nation community, we considered only births to women whose mother tongue was a First Nation language as 'On Reserve First Nations births'. Based on this algorithm, a total of 7,791 births were captured as 'On Reserve First Nations births' constituting the primary study cohort. In addition, we conducted sensitivity analyses to assess whether there were substantial changes in result patterns based on different definitions of 'On Reserve First Nations births'.

4.2c Community remoteness measure

We defined community remoteness according to the First Nations band classification manual developed by Indian and Northern Affairs of Canada (INAC). The classification was motivated by the need to create a reference for the "difficulty to deliver services" index which was used for the allocation of funds for social service programs on reserve.¹⁴ The

INAC classifications group all on reserve First Nations bands (communities, all rural) into four zones according to year-round access to roads and the distance from the nearest service center. Zone 1 is located within 50 km of the nearest service center with year-round road access. Zone 2 is between 50 and 350 km from the nearest service center with year-round road access. Zone 3 is over 350 km from the nearest service center with year-round road access. Zone 4 has no year-round access to a service center and, as a result, experiences higher costs and greater inconvenience with regard to transportation. The service center is the municipality where First Nations individuals have access to social services and supplies. Local health care centers are often located in these municipalities. The nearest community would have services which provide supplies, material and equipment for construction, office operation, a pool of skilled and semi-skilled labor and at least one financial institution such as a bank, trust company or credit union. Road Access includes surface transportation on year-round paved or graveled roads linking a First Nation community with the nearest service center. An INAC zone could therefore be described as a practical measure of the degree of remoteness of a community. Such INAC zone classification is only available for and applicable to on reserve First Nations communities. Variations in First Nations birth outcomes across these INAC zones have not yet been examined.

Available maternal and pregnancy characteristics included maternal age (<20, 20-29, 30-34, ≥35 years), education (<11 years, 11 years (high school graduation), ≥12 years (college or higher), marital status (single, common law unions, married), parity (primiparous, multiparous), plurality (singleton, plural), infant gender (male, female), gestational age (in completed weeks), and birth weight (in grams).

4.2d Outcomes and analyses

The birth rate is the number of live births per thousand populations. Birth outcomes examined included preterm birth (gestational age <37 completed weeks), small-for-gestational-age birth (SGA, <10th percentile, based on the Canadian fetal growth standard),¹⁶ low birth weight (LBW, <2500 g), high birth weight (HBW, >4000 g), large-for-

gestational-age birth (LGA, >90th percentile), stillbirth (fetal deaths ≥ 20 weeks), neonatal death (died during 0-27 days of postnatal life), perinatal death (stillbirth + neonatal death), postneonatal death (died during 28-364 days of postnatal life) and infant death (neonatal death + postneonatal death). Causes of infant death were investigated according to the classification of the International Collaborative Effort on Perinatal and Infant Mortality,¹⁷ based on the International Classification of Diseases (ICD)-9 codes for deaths in 1991-1999 or (ICD)-10 codes for deaths in 2000-2001. The causes of death included congenital anomalies, immaturity related conditions, asphyxia, sudden infant death syndrome (SIDS), infection, external causes, and other causes. Analysis of SIDS was restricted to the postneonatal period because SIDS mostly spared the neonatal period,¹⁸ and over 95% of the reported SIDS cases in our study were in the postneonatal period.

Chi-square tests for differences and Cochran-Armitage tests for trends were used to assess the differences and trends in outcome rates across the communities by remoteness (INAC zone). Crude and adjusted odds ratios with 95% confidence intervals (CIs) were calculated for assessing whether the associations could be explained by the differences in observed characteristics (maternal age, parity, education and marital status, plurality and infant sex). The least isolated INAC zone 1 served as the reference group. We assessed the adjusted ORs using both ordinary (single-level) and multilevel (community as a random effect variable) logistic regression models. Virtually identical adjusted ORs were obtained in the two sets of models due to very small intraclass correlations. We therefore reported the adjusted ORs from single-level analyses. All data management and analyses were carried out using Statistics Analysis System (SAS) for Windows, Version 9.0 (SAS Institute: Cary, North Carolina).

4.3 Results

There were significant differences in maternal characteristics across communities by remoteness, but the patterns were varied (Table 1). Women from the least remote INAC zone were mostly likely to be single, primiparous, but least likely to be a teenager (<20 y of

age). They were also most likely not to have completed high school. In all the other three (2,3,4) more remote zones, about one of every four births was to a teenage mother while the majority of those mothers had not completed high school.

Preterm birth rates were progressively lower, but infant mortality rates were progressively higher from the least remote to the most remote zones (Table 2, Figure 1). The higher infant mortality in more remote zones could be largely explained by the higher postneonatal mortality. Postneonatal mortality was particularly high in the more remote zone 3 (8.5 per 1000) and zone 4 (11.3 per 1000), where it was more than doubled the rate of neonatal mortality for both zones 3 and 4, 2.6/1000 and 5.6/1000 respectively. In contrast, the differences in neonatal versus postneonatal mortality were small in the less remote zone 1 and zone 2. Cause-specific infant mortality analyses demonstrates that postnatal SIDS was the only cause-specific infant death showing a statistically significantly higher rate in the most remote zone (4.7 per 1000, versus 1.7 per 1000 in the least remote zone), although cause-specific infant death due to other cause categories showing generally higher rates in more remote zones. Stillbirth, neonatal and perinatal death rates were all the highest in the most remote zone, but the differences across the four zones were not statistically significant. LBW and SGA birth rates were the highest in the least remote zone, while the differences among the other three more remote zones were small. Not unexpectedly, perinatal and infant mortality rates were significantly higher comparing preterm versus term infants, LBW versus normal birth weight (2500-3999 g) infants, or SGA versus birth weight appropriate for gestational age (10th -90th percentile) infants in the study cohort (risk ratios ranged from 3.6 to 16.6). LGA and HBW birth rates were >16% in all zones, and substantially higher in the middle two zones (2 and 3). Perinatal and infant mortality rates were not statistically significantly different comparing LGA versus birth weight appropriate for gestational age infants or HBW versus normal birth weight infants in the study cohort (risk ratios ranged from 0.7 to 1.1).

The ORs adjusting for maternal characteristics showed a similar pattern as the crude ORs for all outcomes examined (Table 3). Both crude and adjusted ORs indicated lower risks of preterm birth but higher risks of infant death in more remote zones. Crude and

adjusted ORs were very similar for preterm, SGA, LGA, LBW or HBW birth. All the adjusted ORs for infant death were slightly larger than the crude ORs compared zone 2, 3 and 4 to the least remote zone 1. There was a trend towards larger crude and adjusted ORs for infant death with increasing community remoteness ($p < 0.01$), although the adjusted OR for infant death was statistically significant only for the most remote zone 4. The risk of postnatal death after the adjustments remained almost tripled for infants from the most remote zone 4 (statistically significant), and almost doubled for infants from the remote zone 3 (not statistically significant).

We performed sensitivity analyses of our findings for births of only individuals speaking a First Nations language on reserves in areas covered with specific postal codes used for on reserve First Nations communities and all postal codes without imputations, we observed very similar result patterns. There were lower preterm birth rates but higher infant mortality rates in more remote communities. The ORs of infant death comparing the most remote versus the least remote zones declined modestly (from 2.5 to 1.9) when the analyses included all births in these areas.

4.4 Discussion

4.4a Major findings

Our study is the first report on variations in a range of birth outcomes including preterm birth, fetal and infant mortality by the degree of community remoteness in Aboriginal communities. We found that the more remote the First Nations communities, the lower the preterm birth rate, but the higher the infant mortality rate. However, other birth outcomes did not show a monotonous pattern. These results indicate a greater need for investments in more effective infant care promotion programs in more remote Aboriginal communities, and the need for more research into such variations in Indigenous communities in different countries and regions.

4.4b Comparisons with previous studies

Several studies have examined the association between the degree of remoteness and birth outcomes in the general population of some regions in developed countries.¹⁹⁻²⁴ Most studies reported that remoteness was associated with an elevated risk of adverse birth outcomes, while none or reverse associations were also observed in some studies.¹⁹⁻²⁴ It is unclear whether these differential results could be explained by the variable measures of remoteness, or the true differential associations in different regions due to different socioeconomic and health care context associated with remoteness. However, none of these studies focused on Indigenous communities, which are most often affected by remoteness.

A recent study in Western Australia observed somewhat higher Aboriginal infant mortality rates in “remote” versus “rural” areas during most periods in 1980-2001, although the study did not address all birth outcomes.³ In contrast, we observed a gradient in infant mortality and a reverse gradient in preterm birth by the degree of community remoteness in First Nations communities. There is a possibility that the lower preterm birth rates in more remote areas could be due to underreporting of extremely preterm births perhaps masked by undocumented transfers of high-risk pregnancies from those remote zones to southern part of Canada that may end in preterm delivery. If so, the true fetal and infant mortality rates in those more remote communities should be even higher, indicating an even greater need for more effective maternal and infant health promotion programs in more remote First Nations communities. Alternatively, there could be a true modest protective effect of lower preterm birth rates in more remote communities associated with more traditional life styles. If so, their higher infant mortality rates despite fewer high-risk births also indicate an even greater need for more investments in effective community-oriented infant care promotion programs in more remote communities. Limited or no access to road or the mere dependability on air transport for treatment of medical conditions may contribute to some of those infant deaths. More investments in local high-quality perinatal care facilities may be very helpful.

The observed high prevalence of macrosomic births (LGA or HBW) is consistent with previous findings of the high macrosomia prevalence in some Quebec First Nations Cree communities.^{25, 26} It is unknown whether macrosomia may be associated with fetal and infant death risks in Aboriginal populations. However, macrosomia was not associated with the risks of perinatal and infant death in our study cohort. The variations in macrosomia birth rates across the four zones were not monotonous, with the highest rates in the middle two zones. The causes and implications of such variations are unknown and warrant further investigations.

SIDS is a leading cause of infant death among Aboriginal infants in the U.S., Australia and Canada.^{3-7, 11, 27} however, no studies have examined the variations in SIDS by community remoteness in Aboriginal communities. We found that within the First Nations communities in Quebec, SIDS was substantially (3 times) more frequent in the most remote communities. This finding is unlikely explained by the differences in the ascertainment of SIDS, because that these comparisons are within on reserve communities with similar registration practices, and that unexplained deaths were required by law to be investigated by a legal coroner in Quebec. Our results indicate the need for more effective programs to promote “back-to-sleep” and maternal smoking cessation to reduce SIDS²⁸⁻³⁰ in remote communities.

4.4c Limitations

We had information on only a limited number of variables, but no information on many other potential effect mediators or confounders such as maternal smoking, alcohol use and gestational complications. More studies are needed to understand the causal mediators of the observed differences. Our findings are based on reserve First Nations communities in Quebec therefore we could not assume our findings are applicable to other regions without further investigations. Our findings do call for investigations of such variations in Aboriginal communities in other countries/regions.

In summary, our findings underline the stress and challenges remote Aboriginal communities face to reduce infant mortality especially postneonatal mortality. There is a greater need for more investments to improve maternal and infant health in more remote Aboriginal communities.

4.5 Reference List

1. Alessandri LM, Chambers HM, Blair EM, Read AW. Perinatal and postneonatal mortality among Indigenous and non-Indigenous infants born in Western Australia, 1980-1998. *Med.J.Aust.* 2001; 175:185-189.
2. Baldwin LM, Grossman DC, Casey S, Hollow W, Sugarman JR, Freeman WL *et al.* Perinatal and infant health among rural and urban American Indians/Alaska Natives. *Am.J.Public Health* 2002; 92:1491-1497.
3. Freemantle CJ, Read AW, de Klerk NH, McAullay D, Anderson IP, Stanley FJ. Patterns, trends, and increasing disparities in mortality for Aboriginal and non-Aboriginal infants born in Western Australia, 1980-2001: population database study. *Lancet* 2006; 367:1758-1766.
4. Grossman DC, Krieger JW, Sugarman JR, Forquera RA. Health status of urban American Indians and Alaska Natives. A population-based study. *JAMA* 1994; 271:845-850.
5. Grossman DC, Baldwin LM, Casey S, Nixon B, Hollow W, Hart LG. Disparities in infant health among American Indians and Alaska natives in US metropolitan areas. *Pediatrics* 2002; 109:627-633.
6. Luo ZC, Wilkins R, Platt RW, Kramer MS. Risks of adverse pregnancy outcomes among Inuit and North American Indian women in Quebec, 1985-97. *Paediatr.Perinat.Epidemiol.* 2004; 18:40-50.
7. Luo ZC, Kierans WJ, Wilkins R, Liston RM, Uh SH, Kramer MS. Infant mortality among First Nations versus non-First Nations in British Columbia: temporal trends in rural versus urban areas, 1981-2000. *Int.J.Epidemiol.* 2004; 33:1252-1259.
8. Macaulay A, Orr P, Macdonald S, Elliott L, Brown R, Durcan A *et al.* Mortality in the Kivalliq Region of Nunavut, 1987-1996. *Int.J.Circumpolar.Health* 2004; 63 Suppl 2:80-85.

9. Muggah E, Way D, Muirhead M, Baskerville B. Preterm delivery among Inuit women in the Baffin Region of the Canadian Arctic. *Int.J.Circumpolar.Health* 2004; 63 Suppl 2:242-247.
10. Nakamura RM, King R, Kimball EH, Oye RK, Helgerson SD. Excess infant mortality in an American Indian population, 1940 to 1990. *JAMA* 1991; 266:2244-2248.
11. Tomashek KM, Qin C, Hsia J, Iyasu S, Barfield WD, Flowers LM. Infant mortality trends and differences between American Indian/Alaska Native infants and white infants in the United States, 1989-1991 and 1998-2000. *Am.J.Public Health* 2006; 96:2222-2227.
12. Young TK. Review of research on Aboriginal populations in Canada: relevance to their health needs. *BMJ* 2003; 327:419-422.
13. Pageau, M., Ferland, M., and Dery, S. Our Children. Kuujjuaq, Nunavik Regional Board of Health and Social Services, Canada (ISBN 2-922764-04-4). 2003. Ref Type: Report
14. Therien M. Band Classification Manual. *Corporate Information Management Directorate, Information Management Branch.Ottawa: Indian and Northern Affairs Canada, May 2005* 2005.
15. Fair M, Cyr M, Allen AC, Wen SW, Guyon G, MacDonald RC. An assessment of the validity of a computer system for probabilistic record linkage of birth and infant death records in Canada. The Fetal and Infant Health Study Group. *Chronic.Dis.Can.* 2000; 21:8-13.
16. Kramer MS, Platt RW, Wen SW, Joseph KS, Allen A, Abrahamowicz M *et al.* A new and improved population-based Canadian reference for birth weight for gestational age. *Pediatrics* 2001; 108:E35.
17. Cole S, Hartford RB, Bergsjö P, McCarthy B. International collaborative effort (ICE) on birth weight, plurality, perinatal, and infant mortality. III: A method of grouping underlying causes of infant death to aid international comparisons. *Acta Obstet Gynecol Scand.* 1989; 68:113-117.

18. Guntheroth WG, Spiers PS. The triple risk hypotheses in sudden infant death syndrome. *Pediatrics* 2002; 110:e64.
19. Clarke LL, Coward RT. A multivariate assessment of the effects of residence on infant mortality. *J.Rural.Health* 1991; 7:246-265.
20. Hillemeier MM, Weisman CS, Chase GA, Dyer AM. Individual and community predictors of preterm birth and low birthweight along the rural-urban continuum in central Pennsylvania. *J.Rural.Health* 2007; 23:42-48.
21. Hulme PA, Blegen MA. Residential status and birth outcomes: is the rural/urban distinction adequate? *Public Health Nurs.* 1999; 16:176-181.
22. Roberts CL, Algert CS. The urban and rural divide for women giving birth in NSW, 1990-1997. *Aust.N.Z.J.Public Health* 2000; 24:291-297.
23. Robson S, Cameron CA, Roberts CL. Birth outcomes for teenage women in New South Wales, 1998-2003. *Aust.N.Z.J.Obstet Gynaecol.* 2006; 46:305-310.
24. Luo ZC, Wilkins R. Degree of rural isolation and birth outcomes. *Paediatr.Perinat.Epidemiol.* 2008; 22:341-349.
25. Armstrong IE, Robinson EJ, Gray-Donald K. Prevalence of low and high birthweight among the James Bay Cree of northern Quebec. *Can.J.Public Health* 1998; 89:419-420.
26. Rodrigues S, Robinson EJ, Kramer MS, Gray-Donald K. High rates of infant macrosomia: a comparison of a Canadian native and a non-native population. *J.Nutr.* 2000; 130:806-812.
27. Freemantle CJ, Read AW, de Klerk NH, McAullay D, Anderson IP, Stanley FJ. Sudden infant death syndrome and unascertainable deaths: trends and disparities among Aboriginal and non-Aboriginal infants born in Western Australia from 1980 to 2001 inclusive. *J.Paediatr.Child Health* 2006; 42:445-451.
28. American Academy of Pediatrics AAP Task Force on Infant Positioning and SIDS. Positioning and SIDS. *Pediatrics* 1992;1120-1126.

29. Dwyer T, Ponsonby AL, Newman NM, Gibbons LE. Prospective cohort study of prone sleeping position and sudden infant death syndrome. *Lancet* 1991; 337:1244-1247.

30. Fleming P, Blair PS. Sudden Infant Death Syndrome and parental smoking. *Early Hum.Dev.* 2007; 83:721-725.

31. Statistics Canada. *Aboriginal People Survey 2006*. Ottawa: Statistics Canada; 2009: Catalogue Number :89-637-XIE

Table 1. Maternal and birth characteristics among First Nations by community remoteness (INAC zone*) in Quebec, 1991-2000

Characteristics N (%)	INAC Zone*				P-value ** in tests for differences
	Least remote zone 1	2	3	Most remote zone 4	
N (all births)	3,051	1,765	1,896	1,079	
Infant gender					
% Male	51.2	50.8	51.9	51.2	0.91
Plurality					
% Multiple	2.1	2.0	2.1	1.3	0.39
Parity					
% Primiparous	36.1	30.2	30.2	29.5	<0.0001
Maternal age (y), %					<0.0001
<20	17.7	25.8	25.6	23.1	
20-29	56.8	56.0	57.4	56.4	
30-34	17.6	13.3	11.8	15.4	
≥35	8.0	4.9	5.2	5.1	
Marital status					<0.0001
Single	30.1	15.5	23.6	25.7	
Common law unions	46.1	39.4	30.2	34.1	
Married	23.8	45.1	46.2	40.2	
Maternal education					<0.0001
<High school	40.5	70.3	65.5	55.0	
High school	15.8	12.6	10.8	13.7	
≥College	43.7	17.1	23.7	31.3	

*INAC zone is an index of remoteness developed by the Indian and Northern Affairs Canada in order to classify First Nations bands (reserves) into four zones from the least remote zone 1 to the most remote Zone 4.

**Two-sided P values in Chi-square tests for differences across the four INAC zones.

Table 2. Crude rates of adverse birth outcomes among First Nations by community remoteness (INAC zone*) in Quebec, 1991-2000

Outcome	INAC Zone*				P-value in tests for**		
	All Zones	Least remote Zone 1	Zone 2	Zone 3	Most remote Zone 4	Differences	Trends
N (total births)	7,791	3,051	1,765	1,896	1,079		
Preterm birth, %	7.4	8.2	7.9	6.7	5.2	0.005	0.0006
SGA, %	4.6	6.3	3.1	3.4	4.3	<0.0001	<0.0001
LBW, %	4.1	5.0	3.2	4.3	2.9	0.003	0.009
HBW, %	24.8	17.6	31.4	29.9	25.0	<0.0001	<0.0001
LGA, %	24.5	16.5	31.6	29.9	26.3	<0.0001	<0.0001
Perinatal death, <i>per1,000</i>	8.9	7.2	11.3	7.4	12.0	0.27	0.31
Stillbirth, <i>per1000</i>	5.1	4.3	6.2	4.7	6.5	0.73	0.48
Neonatal death, <i>per1000</i>	3.7	3.0	5.1	2.6	5.6	0.39	0.46
Postneonatal death, <i>per1000</i>	6.0	4.0	3.4	8.5	11.3	0.01	0.003
Infant death, <i>per1000</i>	9.7	6.9	8.6	11.1	16.8	0.03	0.005

* INAC zone is an index of remoteness developed by the Indian and Northern Affairs Canada. All First Nations bands (reserves) are classified into four INAC zones from the least remote zone 1 to the most remote Zone 4.

**Two-sided P values in Chi-square tests for differences and Cochran-Armitage tests for trends across the four INAC zones.

Table 3: Crude and adjusted ORs of adverse birth outcomes among First Nations by community remoteness (INAC zone^{**}) in Quebec

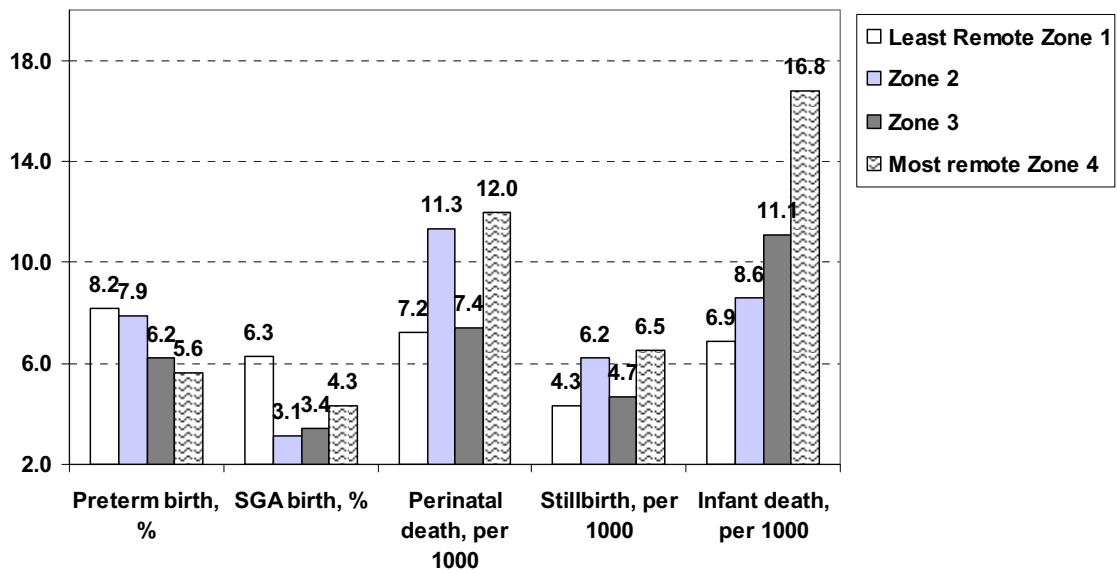
Outcome	INAC Zone 2		INAC Zone 3		INAC Zone 4	
	Crude OR	Adjusted OR [#]	Crude OR	Adjusted OR [#]	Crude OR	Adjusted OR [#]
	95% CI	95% CI	95% CI	95% CI	95% CI	95% CI
Preterm birth	0.96 (0.77, 1.19)	1.05 (0.83, 1.33)	0.80 (0.64, 0.99)*	0.81 (0.64, 1.04)	0.61 (0.45, 0.82)*	0.63 (0.46, 0.86)*
SGA birth	0.48 (0.35, 0.65)*	0.48 (0.34, 0.67)*	0.53 (0.40, 0.70)*	0.58 (0.43, 0.79)*	0.66 (0.48, 0.92)*	0.68 (0.48, 0.97)*
LBW birth	0.62 (0.46, 0.85)*	0.74 (0.53, 1.05)	0.86 (0.65, 1.13)	0.98 (0.72, 1.33)	0.56 (0.38, 0.84)*	0.62 (0.41, 0.94)*
HBW birth	2.14 (1.86, 2.45)*	2.01 (1.73, 2.34)*	1.99 (1.74, 2.28)*	1.85 (1.60, 2.14)*	1.56 (1.32, 1.84)*	1.48 (1.25, 1.77)*
LGA birth	2.35 (2.04, 2.70)*	2.10 (1.80, 2.44)*	2.17 (1.89, 2.48)*	1.95 (1.68, 2.27)*	1.81 (1.53, 2.13)*	1.69 (1.42, 2.01)*
Perinatal death	1.58 (0.86, 2.90)	1.74 (0.85, 3.58)	1.02 (0.52, 2.01)	0.96 (0.42, 2.17)	1.68 (0.84, 3.34)	2.07 (0.96, 4.43)
Stillbirth	1.47 (0.66, 3.28)	1.34 (0.50, 3.63)	1.11 (0.48, 2.61)	0.78 (0.25, 2.40)	1.53 (0.61, 3.83)	1.70 (0.60, 4.80)
Neonatal death	1.74 (0.69, 4.38)	2.36 (0.82, 6.80)	0.89 (0.30, 2.67)	1.25 (0.38, 4.14)	1.89 (0.67, 5.33)	2.66 (0.86, 8.18)
Postneonatal death	0.87 (0.32, 2.32)	0.90 (0.31, 2.58)	2.16 (1.02, 4.57)*	1.99 (0.85, 4.69)	2.86 (1.28, 6.39)*	2.86 (1.19, 6.87)*
Infant death	1.24 (0.64, 2.41)	1.43 (0.69, 2.97)	1.62 (0.88, 2.97)	1.72 (0.86, 3.42)	2.45 (1.30, 4.62)*	2.80 (1.40, 5.59)*

^{**}INAC zone is a degree of remoteness measure developed by the Indian and Northern Affairs Canada to classify First Nations bands (reserves) into four zones from the least remote zone 1 to the most remote zone 4. The least remote INAC zone 1 served as the reference in calculating the crude and adjusted ORs.

[#]The ORs adjusted for maternal age (<20, 20-29, 30-34, ≥35 years), education (<high school, high school, and some college or higher), marital status (single, common-law union, married), parity (primiparous, multiparous), plurality (singleton, multiple) and infant gender (boy, girl).

*P<0.05.

Figure 1. Birth outcomes of First Nations in four zones- Zone 1 is the least remote zone, and Zone 4 is the most remote zone-



Section V

Discussion

Conclusion

5.1 General Discussion

5.1a Impact of Remoteness on Birth outcomes

We found that remoteness did not affect all birth outcomes in the same manner. The more remote the First Nations communities, the lower the preterm, small for gestational age and low birth weight birth rates, but the higher the infant mortality rates. However, large for gestational age, high birth weight showed a varied pattern and did not follow the pattern of infant mortality or preterm birth. Stillbirth rate was higher in more remote zones but neither the difference nor the trend was significant across the zones. In INAC zone two and three, the rates of high birth weight and large for gestational age were remarkably higher compared to zone one - the least remote, and zone four - the most remote. Therefore, the rates of macrosomic birth had no monotonic associations with community remoteness in the study population. In this study, maternal characteristics specific to zones 2 and 3 were a higher number of teenage mothers with level of education below high school.

5.1b Comparison with other studies

Most Canadians and U.S. studies have compared birth outcomes in urban Aboriginals population areas to those living in rural areas, without a distinction as to the degree of rural isolation [12, 73]. Australian studies have compared birth outcomes of remote, rural and urban areas, but have not specifically examined the effects of community remoteness among Indigenous populations.[10, 93, 94] These studies produced mixed reports on the association of birth outcomes with rural living. We found that the more remote the First Nations communities, the lower the rate of small for gestational age birth. This contrasts with the findings of Australian studies in New South Wales for the periods of 1990-1997 and 1998-2003 where indigenous mothers in remote areas had higher odds of giving birth to small for gestational age babies, preterm birth and stillbirth.[93, 94] The reasons for such discrepancies are unknown. We speculate that this could be due to the differences in the measure of rural isolation, and in socioeconomic, cultural and health care delivery

factors associated with rural isolation in different countries. In our study, stillbirth rates are directly proportional to remoteness; women living in the most remote zone 4 had the highest stillbirth rate (although compared to other zones, it was not statistically significant). Our study is the first to report the difference of stillbirth rates by community remoteness among Indigenous communities.

In a study of Aboriginals in Western Australia, higher infant mortality rates in “remote” compared to “rural” areas were observed during most periods from 1980 to 2000. The relative risks of infant death ranged from 3 (1985-89) to 8.2 (1995-97) during those periods. An earlier American study on AI/AN population reported that the unadjusted odd ratio of postneonatal death was 1.23 for rural indigenous communities compared to urban communities.[73] Neither of the aforementioned studies correlated the degree of remoteness with birth outcomes among Indigenous women on reserve. In contrast, we observed an increasing risk gradient in infant mortality rates, and a reverse gradient in preterm birth rates in relation to increasing degree of community remoteness. Inadequate access to high-quality perinatal care may partly account for more fetal and early neonatal deaths in remote communities. Surprisingly, there was a low frequency of preterm birth in more remote communities, we speculate this may be due to undocumented transfers of high-risk pregnancies from those remote communities to southern part of Canada that may end in preterm delivery. If we assume this possibility, then the true fetal and infant mortality rates in those more remote communities would be even higher, indicating an even greater need for more effective maternal and infant health promotion programs as well as the need for local culturally accessible midwifery care program in remote First Nations communities. Alternatively, the remoteness of the community might offer a true modest protective effect against preterm birth due to better community and family support, and traditional life styles in these isolated traditional communities. Findings of this study confirm the persistent high risk of infant death among First Nations, especially in remote communities.

Birth weight is considered one of the most important predictors of infant mortality[95]. Diabetes could be a physiological component contributing to the high rate of HBW babies among First Nations. The prevalence of gestational and type 2 diabetes is reported

to be notably high among First Nations in Canada. We observed a high prevalence of macrosomic births (LGA or HBW) across all four zones, with the highest rates in the middle zones (2 and 3). The causes and implications of such variations in Aboriginal communities are unknown and warrant further investigation. The high prevalence of macrosomic birth is consistent with findings of previous Canadian studies.[29, 71]

We confirmed the relatively high infant mortality for First Nations infant in Quebec [6]. Historically, First Nations communities in Canada have poorer access to high-quality health care, generally poorer socioeconomic conditions such as higher unemployment rates, substandard housing, and high prevalence of both infectious and chronic diseases. These risk factors need to be addressed for improving First Nations birth outcomes. Among First Nations, the relatively higher infant mortality rates in more remote communities may be partly explained by their worse socioeconomic conditions, poorer access to high quality perinatal care, and poorer quality of postnatal infant care.

SIDS is a leading cause of infant death among Aboriginal infants in the U.S., Australia and Canada.[6, 9-12, 48, 86] To our knowledge, no studies have examined the correlation of SIDS with the degree of community remoteness, particularly in Aboriginal communities. We observed that within the First Nations communities in Quebec, SIDS was substantially (3 times) more frequent in the most remote communities. This finding is unlikely to be explained by differences in the ascertainment of SIDS, because these comparisons are within on-reserve communities with similar registration practices, and a legal coroner must investigate unexplained deaths in Quebec. Our results indicate the need for more effective programs to promote “back-to-sleep” and maternal smoking cessation to reduce SIDS [65, 96, 97] in remote communities

Most previous studies comparing birth outcomes in urban and rural areas have not been able to explain birth outcomes through a measure of remoteness. It is possible that the true differential associations in different regions may be the result of different socioeconomic and health care contexts associated with rural living and remoteness.

5.2 Limitation

Our study could not address the many potential effect mediators such as family socioeconomic status, maternal smoking, alcohol use, access to high quality perinatal care, and gestational complications especially diabetes. These risk factors may underline the generally poor birth outcomes among First Nations. Variations in these risk factors may also account for the differences in birth outcomes among First Nations communities. More studies are needed to understand the causal mediators of the observed birth outcome differences.

Second, First Nations communities are not exclusively inhabited by First Nations individuals so as a result, there might be at least some births that are non-First Nations. Our geocoding approach to identify births to residents of First Nations communities is subject to some misclassification bias. Some non-First Nations living on reserve might have been misclassified as First Nations. Also, some First Nations who lost their native mother tongue but lived in communities with postcodes non-unique to First Nations communities would have been excluded. However, these misclassifications would most likely bias towards underestimates of the poor birth outcomes among First Nations.

Third, our findings are based on Quebec on-reserve First Nations communities. Without further investigations, we cannot assume that these findings are applicable to other regions.

5.3 Conclusion

Our findings of high infant death rates despite the lower frequency of high-risk babies in the more remote First Nations communities indicate the unmet needs for improving infant health in those communities. A preterm birth is considered a high-risk delivery often requiring neonatal intensive care and hospitalization. Therefore it is more resource consuming for the health care system. There is a need for investment in local on reserve

or nearby midwifery, obstetric and paediatric facilities that will help First Nations mothers deliver in or near their home towns which may help to reduce infant mortality in remote on reserve communities. The high risk of infant death due to preventable causes such as sudden infant death syndrome and infection indicates substantial need for improving socioeconomic conditions, and more culturally sensitive infant health promotion programs in remote communities. Smoking in domicile and inappropriate covering of infants are thought to be common practices in Aboriginal communities. [38]. These practices are also thought to increase the risk of SIDS. Our data does not include information about these practices. A substantial number of First Nations mothers in our study were teenage single mothers with less than eleven years of education. All of the above-mentioned factors indicate a greater need for investment in more effective infant and prenatal care promotion programs designed for the particular cultural context in more remote Aboriginal communities. Meanwhile, culturally appropriate educational programmes preventing teenage pregnancy and counselling against smoking and substance use during pregnancy would be beneficial.

In summary, our findings underline the stresses and challenges that remote Aboriginal communities face in reducing infant mortality, particularly postneonatal mortality. This calls for more adequate and accessible services in high-quality perinatal and infant care and more culturally relevant infant health promotion programs in First Nations and other Aboriginal communities.

Section VI

Bibliography

Appendices

Bibliography

1. Indian and Northern Affairs of Canada, C.B. (2002) *Word First- An Evolving terminology Relating to Aboriginal Peoples in Canada*.
2. British Columbia Vital Statistics Agency, First Nation and Inuit Health Branch of Health Canada, *Analysis of Health Statistics for Status Indians in British Columbia, 1991-1999*. Vancouver: British Columbia Vital Statistics Agency. 2001: p. -.
3. First Nations and Inuit Health Branch, H.C., *A statistical profile on the health of First Nations in Canada*. 2000: p. -.
4. First Nations and Inuit Health Branch, H.C., *1998 Vital statistics of the Saskatchewan registered Indian population*. Ottawa: Health Canada. 2000: p. -.
5. Luo, Z.C., et al., *Infant mortality among First Nations versus non-First Nations in British Columbia: temporal trends in rural versus urban areas, 1981-2000*. Int J Epidemiol, 2004. **33**(6): p. 1252-9.
6. Luo, Z.C., et al., *Risks of adverse pregnancy outcomes among Inuit and North American Indian women in Quebec, 1985-97*. Paediatr.Perinat.Epidemiol., 2004/1. **18**(1): p. 40-50.
7. MacMillan, H.L., et al., *Aboriginal health*. CMAJ, 1996. **155**(11): p. 1569-78.
8. Tookenay, V.F., *Improving the health status of aboriginal people in Canada: new directions, new responsibilities*. CMAJ., 1996/12/1. **155**(11): p. 1581-1583.
9. Grossman, D.C., et al., *Health status of urban American Indians and Alaska Natives. A population-based study*. JAMA, 1994/3/16. **271**(11): p. 845-850.
10. Freemantle, C.J., et al., *Patterns, trends, and increasing disparities in mortality for Aboriginal and non-Aboriginal infants born in Western Australia, 1980-2001: population database study*. Lancet, 2006/5/27. **367**(9524): p. 1758-1766.
11. Freemantle, C.J., et al., *Sudden infant death syndrome and unascertainable deaths: trends and disparities among Aboriginal and non-Aboriginal infants born in Western Australia from 1980 to 2001 inclusive*. J.Paediatr.Child Health, 2006/7. **42**(7-8): p. 445-451.
12. Luo, Z.C., et al., *Infant mortality among First Nations versus non-First Nations in British Columbia: temporal trends in rural versus urban areas, 1981-2000*. Int.J.Epidemiol., 2004/12. **33**(6): p. 1252-1259.
13. Macaulay, A., et al., *Mortality in the Kivalliq Region of Nunavut, 1987-1996*. Int.J.Circumpolar.Health, 2004. **63 Suppl 2**: p. 80-85.
14. Pageau, M., M. Ferland, and S. Dery, *Our Children. Kuujjuaq, Nunavik Regional Board of Health and Social Services, Canada (ISBN 2-922764-04-4)*. 2003: p. -.
15. Godel, J.C., et al., *Smoking and caffeine and alcohol intake during pregnancy in a northern population: effect on fetal growth*. CMAJ., 1992/7/15. **147**(2): p. 181-188.

16. Hobart, C.W., *Socio-economic correlates of mortality and morbidity among Inuit infants*. circumpolar health: Proceeding of the 3rd International Symposium, Yellowknife, N.W.T., ed. R.J.a.I. Shephard, S. 1976.
17. Jenkins, A.L., et al., *An overview of factors influencing the health of Canadian Inuit infants*. Int.J.Circumpolar.Health, 2003/3. **62**(1): p. 17-39.
18. Clarke, L.L. and R.T. Coward, *A multivariate assessment of the effects of residence on infant mortality*. J.Rural.Health, 1991. **7**(3): p. 246-265.
19. Marc Therien, *Band Classification Manual*. Corporate Information Management Directorate, Information Management Branch Ottawa: Indian and Northern Affairs Canada, May 2005 2005.
20. Statistics Canada. *Aboriginal People Survey 2006*. Ottawa: Statistics Canada; 2009: Catalogue Number :89-637-XIE.
21. Statistics Canada. *Aboriginal Peoples in Canada in 2006: Inuit, Métis, and First Nations, 2006 Census*. Ottawa: Ministry of Industry; 2008. Catalogue number 7-558-XIE .
22. Luo, Z., Senécal S, Simonet F, Guimond E, Penney C, Wilkins R, *Birth Outcomes in the Inuit-Inhabited areas of Canada*. CMAJ, 2009.
23. Thomson, M., *Heavy birthweight in Native Indians of British Columbia*. Can J Public Health, 1990. **81**(6): p. 443-6.
24. Russell Wilkins, S.U., Phillippe Finès, Sacha Senécal, Éric Guimond and Rene Dion, *Life expectancy in the Inuit-inhabited areas of Canada, 1989 to 2003*. March 2008, Statistics Canada.
25. Frohlich, K.L., N. Ross, and C. Richmond, *Health disparities in Canada today: some evidence and a theoretical framework*. Health Policy, 2006. **79**(2-3): p. 132-43.
26. Hulme, P.A. and M.A. Blegen, *Residential status and birth outcomes: is the rural/urban distinction adequate?* Public Health Nurs., 1999/6. **16**(3): p. 176-181.
27. Enarson, D.A., *Tuberculosis in Aboriginals in Canada*. Int J Tuberc Lung Dis, 1998. **2**(9 Suppl 1): p. S16-22.
28. MacMillan, H.L., et al., *Aboriginal health*. CMAJ., 1996/12/1. **155**(11): p. 1569-1578.
29. Rodrigues, S., et al., *High rates of infant macrosomia: a comparison of a Canadian native and a non-native population*. J.Nutr., 2000/4. **130**(4): p. 806-812.
30. Brassard, P., E. Robinson, and C. Lavallee, *Prevalence of diabetes mellitus among the James Bay Cree of northern Quebec*. CMAJ, 1993. **149**(3): p. 303-7.
31. Pioro, M.P., R.F. Dyck, and D.C. Gillis, *Diabetes prevalence rates among First Nations adults on Saskatchewan reserves in 1990: comparison by tribal grouping, geography and with non-First Nations people*. Can J Public Health, 1996. **87**(5): p. 325-8.

32. Harris, S.B., et al., *The epidemiology of diabetes in pregnant Native Canadians. A risk profile.* Diabetes Care, 1997. **20**(9): p. 1422-5.
33. Dyck, R., et al., *A comparison of rates, risk factors, and outcomes of gestational diabetes between aboriginal and non-aboriginal women in the Saskatoon health district.* Diabetes Care, 2002. **25**(3): p. 487-93.
34. Belanger-Ducharme, F. and A. Tremblay, *Prevalence of obesity in Canada.* Obes Rev, 2005. **6**(3): p. 183-6.
35. Willows, N.D., M.S. Johnson, and G.D. Ball, *Prevalence estimates of overweight and obesity in Cree preschool children in northern Quebec according to international and US reference criteria.* Am J Public Health, 2007. **97**(2): p. 311-6.
36. Young, T.K. and G. Sevenhuysen, *Obesity in northern Canadian Indians: patterns, determinants, and consequences.* Am J Clin Nutr, 1989. **49**(5): p. 786-93.
37. Hanley AJ, H.S., Gittelsohn J, Wolever TM, Saksvig B, Zinman B., *Overweight among children and adolescents in a Native Canadian community: prevalence and associated factors.* Am J Clin Nutr, 2000 **71**(3): p. 693-700
38. Wilson, C.E., *Cree infant care practices and sudden infant death syndrome.* Can J Public Health, 2000. **91**(2): p. 133-6.
39. Luo, Z.C., et al., *Community characteristics and birth outcomes among Canadian aboriginal women. Funded by Canadian Institutes of Health Research (CIHR), Institute of Aboriginal Peoples' Health (IAPH), 2005.2-2008.1.* 2008: p. -.
40. Self, R.B., et al., *The prevalence of overweight adults living in a rural and remote community. The Bella Coola Valley.* Eat Weight Disord, 2005. **10**(2): p. 133-8.
41. Wenman, W.M., M.R. Joffres, and I.V. Tataryn, *A prospective cohort study of pregnancy risk factors and birth outcomes in Aboriginal women.* CMAJ., 2004/9/14. **171**(6): p. 585-589.
42. Thomson, M., *Heavy birthweight in Native Indians of British Columbia.* Can.J.Public Health, 1990/11. **81**(6): p. 443-446.
43. Munroe, M., et al., *Birth weight, length, head circumference and bilirubin level in Indian newborns in the Sioux Lookout Zone, northwestern Ontario.* Can.Med.Assoc.J., 1984/9/1. **131**(5): p. 453-456.
44. Luo, Z.C., et al., *Risks of adverse pregnancy outcomes among Inuit and North American Indian women in Quebec, 1985-97.* Paediatr Perinat Epidemiol, 2004. **18**(1): p. 40-50.
45. Seward, J.F. and F.J. Stanley, *Comparison of births to Aboriginal and Caucasian mothers in Western Australia.* Med J Aust, 1981. **2**(2): p. 80-4.

46. Stanley, F.J. and S. Mauger, *Birth-weight patterns in aboriginal and non-aboriginal singleton adolescent births in Western Australia, 1979-83*. Aust N Z J Obstet Gynaecol, 1986. **26**(1): p. 49-54.
47. Humphrey, M.D. and D.J. Holzheimer, *Differing influences on Aboriginal and non-Aboriginal neonatal phenotypes: a prospective study*. Med J Aust, 2001. **174**(10): p. 503-6.
48. Grossman, D.C., et al., *Disparities in infant health among American Indians and Alaska natives in US metropolitan areas*. Pediatrics, 2002/4. **109**(4): p. 627-633.
49. Castor ML, S.M., Taulii MM, Park AN, Lawson SA, Forquera RA., *A nationwide population-based study identifying health disparities between American Indians/Alaska Natives and the general populations living in select urban counties*. Am J Public Health, 2006 Aug. **96**(8):.
50. Goldenberg, R.L. and D.J. Rouse, *Prevention of premature birth*. N Engl J Med, 1998. **339**(5): p. 313-20.
51. Muggah, E., et al., *Preterm delivery among Inuit women in the Baffin Region of the Canadian Arctic*. Int.J.Circumpolar.Health, 2004. **63 Suppl 2**: p. 242-247.
52. Panaretto, K., et al., *Risk factors for preterm, low birth weight and small for gestational age birth in urban Aboriginal and Torres Strait Islander women in Townsville*. Aust N Z J Public Health, 2006. **30**(2): p. 163-70.
53. Coory, M., et al., *Post-neonatal mortality by rurality and Indigenous status in Queensland*. J Paediatr Child Health, 2006. **42**(7-8): p. 464-8.
54. Hogg R, T.N., *Fertility and mortality of Aboriginal living in Queensland Aboriginal Communities 1972-1990*. 1992, Canberra: Australian Government Publishing Services.
55. Mitchell, E.A., L. Hutchison, and A.W. Stewart, *The continuing decline in SIDS mortality*. Arch.Dis.Child, 2007/7. **92**(7): p. 625-626.
56. Stanton, C., et al., *Stillbirth rates: delivering estimates in 190 countries*. Lancet, 2006. **367**(9521): p. 1487-94.
57. Coory, M., *Gestational-age-specific stillbirth risk among Australian Aborigines*. Int J Epidemiol, 1998. **27**(1): p. 83-6.
58. Pearl, M., P. Braveman, and B. Abrams, *The relationship of neighborhood socioeconomic characteristics to birthweight among 5 ethnic groups in California*. Am.J.Public Health, 2001/11. **91**(11): p. 1808-1814.
59. Tomashek, K.M., et al., *Infant mortality trends and differences between American Indian/Alaska Native infants and white infants in the United States, 1989-1991 and 1998-2000*. Am.J.Public Health, 2006/12. **96**(12): p. 2222-2227.
60. Alessandri, L.M., et al., *Perinatal and postneonatal mortality among Indigenous and non-Indigenous infants born in Western Australia, 1980-1998*. Med.J.Aust., 2001/8/20. **175**(4): p. 185-189.

61. Alexander, G.R., M.S. Wingate, and S. Boulet, *Pregnancy Outcomes of American Indians: Contrasts Among Regions and with Other Ethnic Groups*. *Matern.Child Health J.*, 2007/10/25: p. -.
62. Panaretto, K.S., et al., *Sudden infant death syndrome risk factors in north Queensland: a survey of infant-care practices in Indigenous and non-Indigenous women*. *J Paediatr Child Health*, 2002. **38**(2): p. 129-34.
63. Leach, C.E., et al., *Epidemiology of SIDS and explained sudden infant deaths*. *CESDI SUDI Research Group*. *Pediatrics*, 1999. **104**(4): p. e43.
64. Peterson, D.R., G. vanBelle, and N.M. Chinn, *Sudden infant death syndrome and maternal age: etiologic implications*. *JAMA*, 1982. **247**(16): p. 2250-2.
65. Fleming, P. and P.S. Blair, *Sudden Infant Death Syndrome and parental smoking*. *Early Hum Dev*, 2007. **83**(11): p. 721-5.
66. Alessandri, L.M., et al., *Sudden infant death syndrome in Australian aboriginal and non-aboriginal infants: an analytical comparison*. *Paediatr Perinat Epidemiol*, 1996. **10**(3): p. 309-18.
67. Alessandri, L.M., et al., *Sudden infant death syndrome and infant mortality in aboriginal and non-aboriginal infants*. *J Paediatr Child Health*, 1994. **30**(3): p. 242-7.
68. Standfast, S.J., S. Jereb, and D.T. Janerich, *The epidemiology of sudden infant death in upstate New York: II: birth characteristics*. *Am J Public Health*, 1980. **70**(10): p. 1061-7.
69. Kramer, M.S., et al., *A new and improved population-based Canadian reference for birth weight for gestational age*. *Pediatrics*, 2001/8. **108**(2): p. E35-.
70. Michael S. Kramer, L.S., John Lydon and Lise Goulet, *Socio-economic disparities in pregnancy outcome: why do the poor fare so poorly?* *Paediatr Perinat Epidemiol*, 2000. **14**: p. 117.
71. Armstrong, I.E., E.J. Robinson, and K. Gray-Donald, *Prevalence of low and high birthweight among the James Bay Cree of northern Quebec*. *Can J Public Health*, 1998. **89**(6): p. 419-20.
72. Rhoades, E.R., et al., *Mortality of American Indian and Alaska native infants*. *Annu Rev Public Health*, 1992. **13**: p. 269-85.
73. Baldwin, L.M., et al., *Perinatal and infant health among rural and urban American Indians/Alaska Natives*. *Am.J.Public Health*, 2002/9. **92**(9): p. 1491-1497.
74. Day, P., P. Lancaster, and C.L. Szwarcwald, *Indigenous mothers and their babies Australia 1994-1996*. Sydney: Australian Institute of Health and Welfare, National Perinatal Statistics Unit (Perinatal Statistics Series No.8), AIHW Cat. No. PER. 9. 1999: p. -.
75. Nakamura, R.M., et al., *Excess infant mortality in an American Indian population, 1940 to 1990*. *JAMA*, 1991/10/23. **266**(16): p. 2244-2248.

76. Anonymous, *Decrease in infant mortality and sudden infant death syndrome among Northwest American Indians and Alaskan Natives--Pacific Northwest, 1985-1996*. MMWR Morb Mortal Wkly Rep, 1999. **48**: p. 181-184.
77. Canada. *Aboriginal People Survey*. Ottawa: Statistics Canada;1991<http://www.statcan.ca/english/sdds/3250.hml>.
78. Titmuss, A.T., E. Harris, and E.J. Comino, *The roles of socioeconomic status and Aboriginality in birth outcomes at an urban hospital*. Med J Aust, 2008. **189**(9): p. 495-8.
79. Chen, J., et al., *Maternal education and fetal and infant mortality in Quebec. Fetal and Infant Mortality Study Group of the Canadian Perinatal Surveillance System*. Health Rep, 1998. **10**(2): p. 53-64 (Eng); 57-70 (Fre).
80. Luo ZC, W.R., Kramer MS; Fetal and Infant Health Study Group of the Canadian Perinatal Surveillance System, *Effect of neighbourhood income and maternal education on birth outcomes: a population-based study*. CMAJ, 2006. **10**(174): p. 7.
81. Eades, S., et al., *Bibbulung Gnarneep ('solid kid'): causal pathways to poor birth outcomes in an urban Aboriginal birth cohort*. J Paediatr Child Health, 2008. **44**(6): p. 342-6.
82. Pickett, K.E., et al., *Neighborhood socioeconomic status, maternal race and preterm delivery: a case-control study*. Ann.Epidemiol., 2002/8. **12**(6): p. 410-418.
83. Szwarcwald, C.L., C.L. Andrade, and F.I. Bastos, *Income inequality, residential poverty clustering and infant mortality: a study in Rio de Janeiro, Brazil*. Soc.Sci.Med., 2002/12. **55**(12): p. 2083-2092.
84. O'Campo, P., et al., *Neighborhood risk factors for low birthweight in Baltimore: a multilevel analysis*. Am J Public Health, 1997. **87**(7): p. 1113-8.
85. Najman, J.M., et al., *Obstetrical outcomes of aboriginal pregnancies at a major urban hospital*. Aust J Public Health, 1994. **18**(2): p. 185-9.
86. Tomashek, K.M., et al., *Infant mortality trends and differences between American Indian/Alaska Native infants and white infants in the United States, 1989-1991 and 1998-2000*. Am J Public Health, 2006. **96**(12): p. 2222-7.
87. Kornelsen, J., S. Grzybowski, and S. Iglesias, *Is rural maternity care sustainable without general practitioner surgeons?* Can J Rural Med, 2006. **11**(3): p. 218-20.
88. Fair, M., et al., *An assessment of the validity of a computer system for probabilistic record linkage of birth and infant death records in Canada. The Fetal and Infant Health Study Group*. Chronic.Dis.Can., 2000. **21**(1): p. 8-13.
89. Hulme, P.A. and M.A. Blegen, *Residential status and birth outcomes: is the rural/urban distinction adequate?* Public Health Nurs, 1999. **16**(3): p. 176-81.
90. Cole, S., et al., *International collaborative effort (ICE) on birth weight, plurality, perinatal, and infant mortality. III: A method of grouping underlying causes of*

- infant death to aid international comparisons. Acta Obstet Gynecol Scand, 1989. 68(2): p. 113-7.*
91. Guntheroth, W.G. and P.S. Spiers, *The triple risk hypotheses in sudden infant death syndrome. Pediatrics, 2002/11. 110(5): p. e64-.*
 92. Hosseinpoor, A.R., et al., *Decomposing socioeconomic inequality in infant mortality in Iran. Int.J.Epidemiol., 2006/10. 35(5): p. 1211-1219.*
 93. Roberts, C.L. and C.S. Algert, *The urban and rural divide for women giving birth in NSW, 1990-1997. Aust.N.Z.J.Public Health, 2000/6. 24(3): p. 291-297.*
 94. Robson, S., C.A. Cameron, and C.L. Roberts, *Birth outcomes for teenage women in New South Wales, 1998-2003. Aust.N.Z.J.Obstet Gynaecol., 2006/8. 46(4): p. 305-310.*
 95. Medicine, I.o., *Institute of Medicine: Preventing Low Birthweight. Washington, DC: National Academy Press, 1985. 1985.*
 96. Pediatrics, A.A.o., *American Academy of Pediatrics AAP Task Force on Infant Positioning and SIDS. Positioning and SIDS. Pediatrics 1992;1120-1126. Pediatrics 1992;1120-1126.. 1992: p. 20.*
 97. Dwyer, T., et al., *Prospective cohort study of prone sleeping position and sudden infant death syndrome. Lancet, 1991. 337(8752): p. 1244-7.*

Appendix 1: Glossary

1.**Indians:** The term Indians refers to "First Nations" or "First Nations people". Indian peoples are one of three peoples (Indian, Inuit, Metis) recognized as Aboriginal in the Constitution Act, 1982. There are three categories of Indians in Canada: Status Indians, non-Status, and Treaty Indians.

2.**Status Indians** are people who are entitle to have their name on the included on the Indian register, an official list maintained by federal government. Status Indians are entitle to certain rights and benefits under the law.

3.**Non-Status Indians** are people that consider themselves Indians or members of First Nation but whom the government of Canada does not recognized as Indian under the Indian Act, either because they are unable to prove their status or have lost their status right.

4.**Treaty Indians** is a status Indian who belongs to First Nation that signed a treaty with the crown.

5.**First Nations:** A term that came into common usage in 1970 to replace the term "Indian". First Nations refers to Indian people in Canada both Status and non-Status.

6.**Métis:** The word "*Métis*" is French word for "mixed blood". The Canadian Constitution recognizes *Métis people* as one of the three Aboriginal peoples. Historically the term Métis refers to children of French Fur trader and Cree women in prairies, and of English and Scottish traders and Dene women in the North. Today the term is used broadly to describe people with mixed First Nations and European ancestry who identify themselves as *Métis*, distinct from Indian peoples, Inuit and non-Aboriginal people. (Many Canadians have mixed Aboriginal and non-Aboriginal ancestry but not all identify themselves as Métis.

7.**Inuit:** The word "Inuit" means "the people" in the Inuktitut, the Inuit language. The Inuit are Aboriginal people of Arctic Canada. Inuit primarily live in Northwest Territories, Nunavut, Northern part of Quebec and Labrador. Indian Act does not cover Inuit. "Inuk" is a singular form of Inuit and used if referring to one Inuit person

8. **Reserve:** A tract of land, the legal title to which is held by the Crown, set apart for the use and benefit of an Indian band. Some band has more than one reserve. Meanwhile, a "community" has been defined as a group of interacting people living in a common location, and is often used to refer to a group that is organized around common values and social cohesion within a shared geographical location, generally in social units larger than a household, and the term can also refer to the national community or global community. Many First Nations prefer the term of "First Nations Community" instead of reserve.

9. **Band:** A body of Indian for whose collective use and benefit lands have been set apart or money is held by the Crown, or declared by to be a band for the purposes of the Indian Act. Each band has its own governing band council. The member of a band usually shares common values, traditions and practices rooted in their ancestral heritage. Today, many band prefer to be known as First Nations(e.g. Batchewana band is called Batchewana First Nation)

10. **Birth Rate:** The birth rate is the number of live birth per 1,000 populations.

11. **Determinant:** is any factor, whether event, characteristic, or definable entity, that brings about change in disease outcomes or health condition. (source: Last J. A dictionary of epidemiology. New York: Oxford University Press:1983.

12. **Small for gestational age:** the baby's weight in the lowest 10% of babies born at that age.

13. **Large-for-gestational age:** the baby's weight in the highest 10% of babies born at that age.

14. **Low birth weight:** When baby's weight is less than 2500 g at birth.

15. **High birth weight:** Baby's weight more than 4000 g.

16. **Stillbirth:** If the baby was dead at birth (no signs of life).

17. **Neonatal death:** If a baby dies sometime in the first 27 days.

18. **Postneonatal death:** If the baby died sometime between 28 days and 1 year.

19. **Infant death:** if a baby who was born alive and died at any time up to 1 year old

Appendix III: Quebec First Nations Communities/Bands (total of 40) postal codes and INAC zone classification. The INAC (Indian and Northern Affairs of Canada) Zone classification is a summary indicator of community remoteness (Zone 1 the least remote, Zone 4 the most remote)

Quebec First Nations Bande	Bande	code postal	INAC	centre de service
Abénakis de Wôlinak	Wolinak	G0X1B0	1	Trois-Rivières
Algonquins of Barriere Lake	Barriere	J0W2C0	2	Val-d'Or
Atikamekw d'Opitciwan	Opitciwan	G0W3B0	3	La Tuque
Betsiamites	Betsiamites	G0H1B0	1	Baie-Comeau
Communauté anicinape de Kitcisakik	Kitcisakik	J9P7C6	2	Val-d'Or
Conseil de la Première Nation Abitibiwinni	Abitibiwinni	J9T3A3	1	Amos
Cree Nation of Chisasibi	Chisasibi	J0M1E0	3	Val-d'Or
Cree Nation of Mistissini	Mistissini	G0W1C0	2	Val-d'Or
Cree Nation of Wemindji	Wemindji	J0M1L0	3	Val-d'Or
Eagle Village First Nation - Kipawa	Kipawa	J0Z3R0	2	Ville-Marie
Eastmain	Eastmain	J0M1W0	3	Val-d'Or
Innu Takuaihan Uashat Mak Mani-Utenam	Utenam	G4R4k2	1	Sept-Îles
Kahnawake	Kahnawake	J0L1B0	1	Montréal
Kitigan Zibi Anishinabeg	Kitigan	J9E3C9	1	Maniwaki
La Nation Innu Matimekush-Lac John	Matimekush	G0G2T0	4	Sept-Îles
La Nation Micmac de Gespeg	Micmac	G4X6V2	1	Gaspé
Les Atikamekw de Manawan	Manawan	J0K1M0	2	Saint-Michel-des-
Les Innus de Ekuanitshit	Ekuanitshit	G0G1V0	2	Sept-Îles
Listuguj Mi'gmaq Government	Listuguj	G0C2R0	1	Campbellton, N.B.
Long Point First Nation	LongPoint	J0Z2J0	2	Ville-Marie
Micmacs of Gesgapegiag	Gesgapegiag	G0C1Y0	1	Maria/New Richmond
Mohawks of Kanesatake	Kanesatake	J0N1E0	1	Ville de Laval
Montagnais Essipit	Essipit	G0T1K0	1	Les Escoumins
Montagnais de Natashquan	Natashquan	G0G2E0	3	Sept-Îles
Montagnais de Pakua Shipi	Pakua	G0G2R0	4	Sept-Îles
Montagnais de Unamen Shipu	Unamen	G0G1M0	4	Sept-Îles
Montagnais du Lac St.-Jean	StJean	G0W2H0	1	Roberval
Naskapi of Quebec	Naskapi	G0G2Z0	4	Sept-Îles
Nation Anishnabe du Lac Simon	Anishnabe	J0Y3M0	1	Val-d'Or
Nation Huronne Wendat	Huronne	G0A4V0	1	Québec
Cree Nation of Nemaska	Nemaska	J0Y3B0	3	Val-d'Or
Odanak	Odanak	J0G1H0	1	Sorel
Première Nation Malecite de Viger	Malecite	G0L1G0	1	Rivière-du-Loup
Première nation de Whapmagoostui	Whapmagoostui	J0M1G0	4	Val-d'Or
Timiskaming First Nation	Timiskaming	J0Z3B0	1	Ville-Marie
The Crees of the Waskaganish First Nation	Waskaganish	J0M1R0	4	Val-d'Or
Waswanipi	Waswanipi	J0Y3C0	2	Val-d'Or
Conseil des Atikamekw de Wemotaci	Wemotaci	G0X3R0	2	La Tuque
Wolf Lake	WolfLake	J0Z3R0	2	Ville-Marie
Oujé-Bougoumou (Cree)	Ouje	G0X3C0	1	Chibougamau