RESEARCH

Disparities in infant hospitalizations in Indigenous and non-Indigenous populations in Quebec, Canada

Hua He MD MSc, Lin Xiao MS, Jill Elaine Torrie MSc, Nathalie Auger MD MSc, Nancy Gros-Louis McHugh MSc, Hamado Zoungrana MSc, Zhong-Cheng Luo MD PhD

Cite as: *CMAJ* 2017 May 29;189:E739-46. doi: 10.1503/cmaj.160900

ABSTRACT

BACKGROUND: Infant mortality is higher in Indigenous than non-Indigenous populations, but comparable data on infant morbidity are lacking in Canada. We evaluated disparities in infant morbidities experienced by Indigenous populations in Canada.

METHODS: We used linked population-based birth and health administrative data from Quebec, Canada, to compare hospitalization rates, an indicator of severe morbidity, in First Nations, Inuit and non-Indigenous singleton infants (< 1 year) born between 1996 and 2010.

RESULTS: Our cohort included 19 770 First Nations, 3930 Inuit and 225 380 non-Indigenous infants. Compared with non-Indigenous infants, all-cause hospitalization rates were higher in First Nations infants (unadjusted risk ratio [RR] 2.05, 95% confidence interval [CI] 1.99–2.11; fully adjusted RR 1.43, 95% CI 1.37–1.50) and in Inuit infants (unadjusted RR 1.96, 95% CI 1.87–2.05; fully adjusted RR 1.37, 95% CI 1.24–1.52). Higher risks of hospitalization (accounting for multiple comparisons) were observed for First Nations infants in 12 of 16 disease categories and for Inuit infants in 7 of 16 disease categories. Maternal characteristics (age, education, marital status, parity, rural residence and Northern residence) partly explained the risk elevations, but maternal chronic illnesses and gestational complications had negligible influence overall. Acute bronchiolitis (risk difference v. non-Indigenous infants, First Nations 37.0 per 1000, Inuit 39.6 per 1000) and pneumonia (risk difference v. non-Indigenous infants, First Nations 41.2 per 1000, Inuit 61.3 per 1000) were the 2 leading causes of excess hospitalizations in Indigenous infants.

INTERPRETATION: First Nations and Inuit infants had substantially elevated burdens of hospitalizations as a result of diseases of multiple systems. The findings identify substantial unmet needs in disease prevention and medical care for Indigenous infants.

Indigenous infants are at substantially higher risk of mortality than their non-Indigenous counterparts, even in developed countries such as Australia, the United States and Canada.[1–7] Infant mortality is merely a tip of the iceberg of infant morbidity. The high infant mortality rates suggest high risk of severe infant morbidities in Indigenous populations. Knowledge of these morbidities is essential for developing intervention measures to reduce infant health inequalities. Population-based studies in the US and Australia have shown substantially higher rates of hospital admissions (an indicator of severe infant morbidities) in Indigenous than in non-Indigenous infants.[8–14] Likewise, we would expect substantial disparities in Indigenous versus non-Indigenous infant hospitalizations in Canada. Indigenous infants in Canada often live in communities with poor access to high-quality care, and in communities and families with poor socioeconomic conditions that are strongly predictive of poor infant health.[15] However, there is a lack of population-based data on infant morbidities or hospitalizations in Indigenous populations in Canada, and a lack of data on all-cause hospitalizations for Indigenous infants in most countries.

Through population-based linkage of birth-infant hospitalization records, in the present study we sought to assess disparities in infant hospitalizations in First Nations, Inuit and non-Indigenous infants in Quebec, Canada. We also endeavoured to explore the factors that may explain these disparities.

Methods

Study design and population

This was a population-based retrospective birth cohort study, using a linked birth database for singleton births in Quebec, Canada, 1996–2010.[7] The research protocol was approved by the Institut de la statistique du Québec, the Commission for Access to Information

in Quebec, the Commission for Access to Information of Indigenous Affairs and Northern Development Canada, and 3 major Indigenous community health organizations in Quebec: the Cree Board of Health and Social Services of James Bay, the First Nations of Quebec and Labrador Health and Social Services Commission, and the Nunavik Regional Board of Health and Social Services. To respect participant confidentiality, the numbers of study subjects are reported to the nearest 10. Numbers < 10 are not reportable.

Table 1: Indigenous status, maternal, pregnancy and infant characteristics in the study birth cohort, Quebec 1996–2010*

Characteristic	First Nations (*n* = 19 770)	Inuit (*n* = 3930)	Non-Indigenous (*n* = 225 380)
Maternal age, mean ± SD, yr	25.1 ± 6.2	24.1 ± 6.0	28.8 ± 5.2
< 20	21.9	27.1	3.3
20–34	69.5	67.1	82.6
≥ 35	8.6	5.8	14.1
Primiparous, %	40.8	36.4	46.6
Marital status, %			
Married	21.7	14.8	40.6
Common-law union	51.8	50.6	51.4
Single/divorced/widowed	26.5	34.6	8.1
Maternal education			
Mean ± SD, yr	11.1 ± 3.1	10.3 ± 2.6	13.9 ± 3.1
< High school	41.6	50.7	10.3
High school (11 yr)	22.2	25.8	15.2
College (12–13 yr)	15.0	13.7	16.1
University (14+ yr)	21.2	9.8	58.3
Rural residence, %	84.6	96.9	22.3
Northern residence, %	34.5	97.2	1.6
Maternal major chronic diseases, %			
Pre-existing diabetes	3.9	1.4	1.1
Pre-existing hypertension	1.3	1.5	0.7
Heart disease	0.6	0.6	0.4
Renal disease	4.0	8.6	2.7
Genitourinary infections	3.9	8.5	2.5
Gestational complications, %			
Gestational diabetes	10.8	3.6	4.9
Gestational hypertension	8.0	8.4	4.3
Preeclampsia	3.5	4.7	1.5
Anemia	22.2	16.9	12.6
Infant characteristics			
Sex, male	51.8	53.0	51.3
Gestational age, mean ± SD	38.8 ± 1.8	38.3 ± 2.2	38.9 ± 1.8
Median, wk	39.0	39.0	39.0
Preterm birth (< 37 wk)	6.9	11.3	6.3
Birth weight, mean ± SD	3603.4 ± 604.9	3369.8 ± 596.4	3376.5 ± 539.6
Median (g)	3611.0	3410.0	3395.0
Birth weight for gestational age, %			
SGA (< 10th)	4.0	5.2	8.7
LGA (> 90th)	25.0	13.9	9.1

Note: LGA = large for gestational age, SD = standard deviation, SGA = small for gestational age.
*Data presented are % or mean ± SD.

Indigenous births were identified based on 3 sources of information: mother tongue, community of residence (according to residential postal code/municipality name) and Indian Registration System membership status of both parents (a positive in any Indigenous identifier was considered Indigenous).[7] The original birth cohort included 20 190 First Nations, 4260 Inuit and 229 960 non-Indigenous singleton births in Quebec, 1996–2010. The present study included all infants (19 770 First Nations, 3930 Inuit and 225 380 non-Indigenous) whose medical insurance number (and, thus, hospitalization records) could be identified through probabilistic record linkage by mother's first name, last name, date of birth and residential postal code; father's first name, last name and date of birth; and infant's sex, first name, last name and date of birth.

Pregnancy complications and infant hospitalizations (in the first 365 days of life after birth) were based on hospital discharge records in the Maintenance et exploitation des données pour l'étude de la clientèle hospitalière database maintained at the Régie de l'assurance maladie du Québec (RAMQ). In Quebec, universal medical insurance is available. Every resident is assigned a unique lifetime medical insurance (RAMQ) number. The RAMQ number was used to link delivery discharge records to the mothers with hospitalization records for the infants. The linkage to hospitalization records was successful for 19 770 First Nations (97.9%), 3930 Inuit (92.3%) and 225 380 non-Indigenous (98.0%) infants. Therefore, the final study cohort comprised 249 080 infants.

Pregnancy complications and causes of infant hospitalizations were coded by the International Classification of Diseases (ICD)-9 Clinical Modification codes for records in the years 1996–2005, and ICD-10 codes for records in the years 2006–2010. The causes of infant hospitalizations were classified by ICD chapter.

Outcomes

The primary outcomes were infant hospitalizations during the first year (365 d) of life after birth. We tabulated hospitalizations

Table 2: Infant hospitalization rates (per 1000)* in First Nations, Inuit and non-Indigenous infants, Quebec 1996–2011

Cause of infant hospitalizations	First Nations	Inuit	Non-Indigenous	First Nations v. non-Indigenous			Inuit v. non-Indigenous		
				RD	RR (95% CI)	*p*	RD	RR (95% CI)	*p*
N (total = 249 080)	19 770	3930	225 380						
Any hospitalization	329.8	315.7	160.5	169.3	2.05 (1.99–2.11)	< 0.0001	155.5	1.96 (1.87–2.05)	< 0.0001
Hospitalization as a result of:									
Infections	77.2	67.5	37.0	40.2	2.09 (1.98–2.20)	< 0.0001	30.5	1.82 (1.62–2.05)	< 0.0001
Injuries/accidents	9.6	10.7	0.6.4	3.2	1.51 (1.30–1.75)	< 0.0001	4.3	1.68 (1.24–2.28)	0.0008
Congenital anomalies	16.8	16.3	11.0	5.8	1.52 (1.36–1.70)	< 0.0001	5.3	1.47 (1.15–1.89)	0.002
Perinatal-originated conditions	9.7	10.4	7.6	2.1	1.27 (1.09–1.47)	0.002	2.8	1.37 (1.01–1.87)	0.045
Respiratory system	124.8	129.1	47.2	77.6	2.64 (2.54–2.76)	< 0.0001	81.9	2.74 (2.52–2.97)	< 0.0001
Digestive system	23.0	17.3	13.3	9.7	1.74 (1.57–1.91)	< 0.0001	4.0	1.30 (1.03–1.66)	0.03
Nervous system	17.7	19.6	9.9	7.8	1.79 (1.60–2.00)	< 0.0001	9.7	1.98 (1.58–2.48)	< 0.0001
Genitourinary system	12.5	6.9	7.7	4.8	1.62 (1.42–1.85)	< 0.0001	-0.8	0.89 (0.61–1.30)	0.54
Musculoskeletal system	1.3	-	0.5	0.8	2.35 (1.53–3.62)	0.0001	-	-	-
Circulatory system	1.3	-	0.7	0.6	1.71 (1.12–2.60)	< 0.0001	-	-	-
Endocrine system	3.5	4.3	1.3	2.2	2.83 (2.18–3.67)	< 0.0001	3.0	3.46 (2.12–5.64)	< 0.0001
Skin and subcutaneous tissue	8.7	6.9	1.4	7.3	6.13 (5.09–7.37)	< 0.0001	5.5	4.84 (3.27–7.16)	< 0.0001
Blood	1.3	-	0.9	0.4	1.39 (0.93–2.09)	0.11	-	-	-
Mental neurodevelopmental disorders	0.4	-	0.3	0.1	1.38 (0.66–2.88)	0.39	-	-	-
Neoplasms	0.8	-	1.0	–0.2	0.74 (0.44–1.25)	0.26	-	-	-
Undefined symptoms	21.0	27.0	14.3	6.7	1.47 (1.33–1.62)	< 0.0001	12.7	1.88 (1.55–2.28)	< 0.0001

Note: CI = confidence interval, ICD = International Classification of Diseases, RD = risk difference, RR = risk ratio, - = not reportable (number of events < 10).
*Hospitalization rates presented are the numbers per 1000 infants who were hospitalized during the first year (365 d) of life after birth. Multiple admissions for different causes were treated as separate events, but multiple admissions for the same cause as one event. The denominator included all live-born infants. Bonferroni-adjusted 2-tailed *p* values < 0.0015 were considered statistically significant, considering 34 primary comparisons of interest (overall and 16 ICD chapter cause–specific infant hospitalization rates comparing First Nations and Inuit to non-Indigenous groups, total = 34 primary comparisons).

due to all-cause and each specific ICD chapter morbidity category. We also explored the top 10 specific infant morbidities to show the leading specific diseases for hospitalization to guide prevention strategies. Multiple admissions for different causes were treated as separate events, but multiple admissions for the same cause as one event.

Statistical analysis

We calculated crude rates of outcomes, and crude risk ratios (RRs) with 95% confidence intervals (CIs) to illustrate the relative disparities. Risk differences were calculated to illustrate the absolute disparities. Log-binomial models were fitted to estimate the adjusted RRs with 95% CIs of outcomes accounting for cluster effects (multiple infants of the same mother) in generalized estimating equations.[16] We adjusted for available risk factors and potential confounders and examined the changes in the RRs to assess whether maternal characteristics (age, marital status, parity, education, rural residence, and Northern residence based on postal code [in Canada, the North is characterized by poor socioeconomic conditions, remoteness and substantial barriers in access to high-quality health care][17,18]), major chronic illnesses (pregestational diabetes, pre-existing hypertension, heart disease, renal disease, genitourinary infections), and gestational complications (gestational diabetes, gestational hypertension and preeclampsia, and anemia) may explain the risk disparities in infant hospitalizations comparing First Nations and Inuit to non-Indigenous infants. We did not adjust for gestational age and birth weight, so as to avoid collider bias.[19,20] All data analyses were carried out using SAS, Version 9.2. Two-tailed p values < 0.0015 were considered statistically significant, considering 34 primary comparisons of interest (overall and 16 ICD chapter cause–specific infant hospitalization rates comparing First Nations and Inuit to non-Indigenous groups, total = 34 primary comparisons, Bonferroni-adjusted p value cut-off = 0.05/34 = 0.0015).

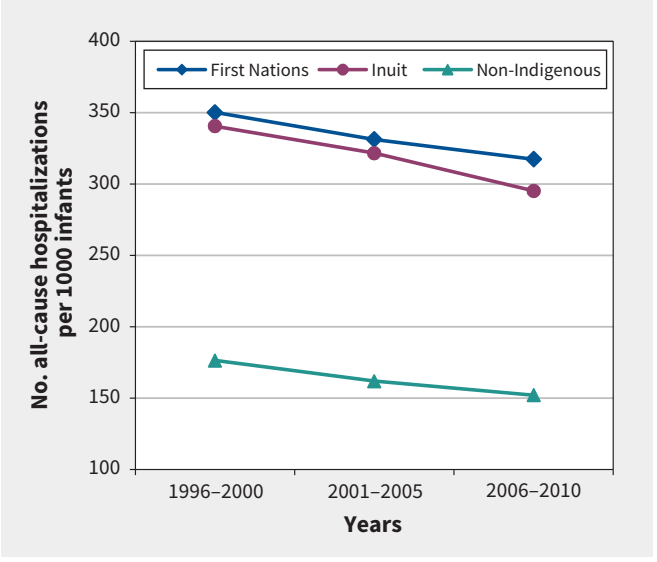

Figure 1: Trends in all-cause infant hospitalization rates in First Nations, Inuit and non-Indigenous infants in Quebec, 1996–2000, 2001–2005 and 2006–2010. $p < 0.001$ in tests for trends in hospitalization rates over time in all 3 groups. The risk ratios (RRs, 95% confidence interval) comparing First Nations versus non-Indigenous infants were 1.98 (1.91–2.05), 2.05 (1.99–2.11) and 2.09 (2.03–2.15) in 1996–2000, 2001–2005 and 2006–2010, respectively; the corresponding numbers comparing Inuit versus non-Indigenous infants were 1.93 (1.85–2.01), 1.99 (1.90–2.04) and 1.94 (1.88–2.00), respectively (Breslow–Day test for homogeneity of RRs across year period strata: $p > 0.3$ in both comparisons).

Ethics approval

The study was approved by the research ethics board of Sainte-Justine Hospital Research Centre.

Results

Table 1 presents the characteristics of First Nations, Inuit and non-Indigenous births in the study cohort. First Nations and Inuit mothers were much younger. The proportion of mothers younger than 20 years was > 6 times higher in First Nations (21.9%) and Inuit (27.1%) than in non-Indigenous (3.3%) groups. First Nations and Inuit mothers were > 3 times more likely to be living alone, but less likely to be primiparous than non-Indigenous mothers. Average education levels were much lower in First Nations and Inuit than in non-Indigenous mothers. More than 40% of First Nations or Inuit mothers had not completed high school, versus about 10% in non-Indigenous mothers. Compared with non-Indigenous mothers, First Nations and Inuit mothers had substantially higher rates of major chronic illnesses (pre-existing hypertension, pre-existing diabetes, renal disease and genitourinary infections) and gestational complications (anemia, gestational diabetes, gestational hypertension and preeclampsia). First Nations and Inuit mothers were less likely to deliver a small-for-gestational-age (SGA; birth weight < 10th percentile, according to the Canadian sex- and gestational age–specific birth weight standards[21]) infant (3.8% and 5.4% v. 8.6%), but more likely to deliver a preterm (6.9% and 11.3% v. 6.3%) or large-for-gestational age (LGA; birth weight > 90th percentile) infant (25.0% and 13.9% v. 9.10%), respectively, than non-Indigenous mothers.

All-cause infant hospitalization rates were substantially higher in both First Nations (329.8 per 1000) and Inuit (315.7 per 1000) versus non-Indigenous (160.5 per 1000) infants; the RRs were 2.05 (95% CI 1.99–2.11) and 1.96 (1.87–2.05), respectively (all $p < 0.0001$) (Table 2). Infant hospitalization rates trended lower in all 3 groups, but the relative disparities persisted and did not diminish over time (Figure 1).

Compared with non-Indigenous infants, First Nations and Inuit infants were at higher risks of hospitalization as a result of infections (RR 2.09 and 1.82, respectively), injuries/accidents (1.51 and 1.68), congenital anomalies (1.52 and 1.47) and diseases of respiratory (2.64 and 2.74), digestive (1.74 and 1.30), nervous (1.79 and 1.98) and endocrine (2.83 and 3.46) systems, skin and subcutaneous tissue (6.13 and 4.84) and undefined symptoms (1.47 and 1.88) ($p < 0.0001$ in most comparisons). First Nations infants were also at higher risks of hospitalization resulting from diseases of musculoskeletal (RR 2.35), circulatory (RR 1.71) and genitourinary (RR 1.62) systems (Table 2). Infections and respiratory system diseases were the top 2 major morbidity categories in all 3 study groups. The absolute risk differences were much larger for infant hospitalizations resulting from infections

and respiratory system disorders than other morbidity categories. Comparing First Nations and Inuit versus non-Indigenous infants, there were 70–80 more hospitalizations per 1000 infants for respiratory system disorders, and 30–40 more hospitalizations per 1000 infants for infections.

Tables 3 and 4 present the stepwise adjusted RRs of infant hospitalization comparing First Nations or Inuit to non-Indigenous infants. Compared with the crude RRs in Table 2, there were only small changes (< 10%) in the RRs of most outcomes adjusted for mother-level cluster effects only. Further adjustment for maternal characteristics (age, education, marital status, parity and rural residence) decreased the RRs substantially for all-cause infant hospitalization, from 1.97 to 1.46 for First Nations infants, and from 1.89 to 1.40 for Inuit infants. Similarly, the adjustment for maternal characteristics attenuated the Indigenous versus non-Indigenous risk disparities in infant hospitalizations due to most causes. However, the RRs for infant hospitalization due to all-cause and most specific morbidity categories comparing First Nations or Inuit to non-Indigenous infants showed few (< 10%) additional changes when further adjustments were made for maternal chronic illnesses (pre-existing hypertension, pre-existing diabetes, heart disease, renal disorders and genitourinary infections) or gestational complications (gestational diabetes, gestational hypertension and preeclampsia, anemia). There were virtually no changes in all the RRs when further adjustment was made for infant sex and mode of delivery (data not shown).

The top 10 most frequent specific diseases leading to infant hospitalizations are presented in Table 5. The top 2 major specific diseases contributing to the excess infant hospitalizations in First Nations and Inuit versus non-Indigenous infants were acute bronchiolitis (64.6 and 67.2 v. 27.6 per 1000) and pneumonia (47.9 and 68.0 v. 6.7 per 1000), respectively. The absolute risk differences showed that there were about 36 to 61 more hospitalizations per 1000 infants for acute bronchiolitis or pneumonia for First Nations or Inuit infants than non-Indigenous infants. In contrast, the absolute risk differences for hospitalization due to any other specific disease were much smaller.

Interpretation

We found that First Nations and Inuit infants suffered a substantially elevated risk of hospitalization as a result of diseases of multiple systems. The higher hospitalization rates could be partly due to the higher underlying severe morbidity rates, and partly to inadequate medical care of less severe diseases (e.g., delays in diagnosis or treatment) progressing to more severe diseases requiring hospitalization.

The leading causes of the excess infant hospitalizations in First Nations and Inuit infants were infectious and respiratory system diseases, for the most part (Table 5). The excess risks of these diseases may be related to infant immunization and the quality of the living environment, and thus may be largely preventable, suggesting the need to improve infant immunization programs, promote

Table 3: Adjusted rate ratios* of infant hospitalization comparing First Nations versus non-Indigenous infants in Quebec

Reason for infant hospitalization	Model 1† RR (95% CI)	Model 2‡ RR (95% CI)	Model 3§ RR (95% CI)	Model 4¶ RR (95% CI)
Any cause	1.97 (1.87–2.08)	1.46 (1.40–1.52)	1.45 (1.39–1.52)	1.43 (1.37–1.50)
Infections	2.14 (2.01–2.28)	1.73 (1.60–1.86)	1.72 (1.59–1.85)	1.66 (1.54–1.78)
Injuries/accidents	1.50 (1.30–1.73)	1.18 (1.01–1.40)	1.23 (1.02–1.48)	1.16 (0.97–1.39)
Congenital anomalies	1.68 (1.48–1.92)	1.37(1.16–1.61)	1.36 (1.16–1.60)	1.35 (1.15–1.59)
Perinatal-originated conditions	1.40 (1.18–1.66)	0.98 (0.79–1.23)	0.98 (0.78–1.21)	0.95 (0.75–1.19)
Respiratory system	2.68 (2.58–2.83)	2.09 (1.98–2.20)	1.98 (1.86–2.09)	1.91 (1.80–2.03)
Digestive system	2.00 (1.81–2.22)	1.51 (1.33–1.72)	1.50 (1.32–1.71)	1.49 (1.31–1.69)
Nervous system	2.31 (2.16–2.46)	1.69 (1.55–1.83)	1.64 (1.43–1.88)	1.64 (1.43–1.89)
Genitourinary system	1.84 (1.58–2.13)	1.77 (1.47–2.14)	1.76 (1.46–2.12)	1.75 (1.45–2.11)
Musculoskeletal system	2.25 (1.33–3.81)	1.44 (0.66–3.16)	1.42 (0.65–3.12)	1.34 (0.60–2.98)
Circulatory system	1.95 (1.47–2.59)	1.54 (1.08–2.19)	1.53 (1.07–2.17)	1.50 (0.86–2.61)
Endocrine system	2.33 (2.08–2.61)	1.54 (1.33–1.78)	1.54 (1.33–1.79)	1.49 (1.29–1.73)
Skin and subcutaneous tissue	5.11 (4.56–5.72)	3.06 (2.64–3.57)	3.05 (2.62–3.55)	3.00 (2.58–3.49)
Blood	1.38 (0.93–2.07)	1.07 (0.67–1.68)	0.99 (0.63–1.56)	0.96 (0.57–1.60)
Mental/neurodevelopmental disorders	1.37 (0.66–2.84)	1.36 (0.62–2.97)	1.24 (0.51–3.00)	1.20 (0.50–2.95)
Neoplasms	0.75 (0.45–1.26)	0.86 (0.48–1.56)	0.95 (0.53–1.75)	0.91 (0.50–1.71)
Undefined symptoms	1.48 (1.33–1.66)	1.15 (1.03–1.30)	1.13 (1.01–1.27)	1.10 (0.95–1.27)

Note: CI = confidence interval, RR = rate ratio.
*RRs were calculated from log-binomial models accounting for mother-level cluster effects (multiple infants of the same mother).
†Model 1: RRs adjusted for cluster effects (multiple infants of the same mother) only.
‡Model 2: Model 1 further adjusted for maternal characteristics (age, education, marital status, parity, rural residence and Northern residence).
§Model 3: Model 2 further adjusted for maternal chronic illnesses (hypertension, diabetes, heart disease, renal disorders, genitourinary infections).
¶Model 4: Model 3 further adjusted for gestational complications (anemia, gestational diabetes, gestational hypertension and preeclampsia).

Table 4: Adjusted rate ratios* of infant hospitalization comparing Inuit versus non-Indigenous infants in Quebec

Reason for infant hospitalization	Model 1† RR (95% CI)	Model 2‡ RR (95% CI)	Model 3§ RR (95% CI)	Model 4¶ RR (95% CI)
Any cause	1.89 (1.74–2.07)	1.40 (1.26–1.55)	1.38 (1.24–1.53)	1.37 (1.24–1.52)
Infections	1.89 (1.60–2.23)	1.35 (1.15–1.60)	1.32 (1.10–1.57)	1.31 (1.10–1.57)
Injuries/accidents	1.68 (1.24–2.29)	1.41 (1.00–1.91)	1.40 (0.96–2.07)	1.36 (0.86–2.15)
Congenital anomalies	1.48 (1.15–1.90)	1.42 (1.04–2.03)	1.41 (1.02–1.94)	1.40 (1.01–1.95)
Perinatal-originated conditions	1.38 (1.01–1.89)	1.09 (0.79–1.50)	0.95 (0.61–1.48)	0.92 (0.58–1.45)
Respiratory system	2.97 (2.70–3.28)	1.78 (1.60–1.99)	1.82 (1.60–2.07)	1.82 (1.59–2.08)
Digestive system	1.31(1.03–1.68)	0.91 (0.69–1.20)	1.03 (0.75–1.40)	1.01 (0.73–1.39)
Nervous system	1.99 (1.58–2.50)	1.50 (1.15–1.93)	1.62 (1.18–2.22)	1.64 (1.20–2.25)
Genitourinary system	0.87 (0.47–1.62)	0.72 (0.48–1.08)	0.66 (0.33–1.32)	0.61 (0.32–1.16)
Musculoskeletal system	–	–	–	–
Circulatory system	–	–	–	–
Endocrine system	2.93 (2.43–3.52)	2.49 (1.49–4.16)	2.55 (1.52–4.28)	2.61 (1.50–4.53)
Skin and subcutaneous tissue	4.83 (3.23–7.22)	3.13 (2.01–4.90)	2.87 (1.59–5.21)	2.86 (1.57–5.23)
Blood	–	–	–	–
Mental/neurodevelopmental disorders	–	–	–	–
Neoplasms	–	–	-	-
Undefined symptoms	1.90 (1.56–2.30)	1.27 (1.03–1.58)	1.36 (1.05–1.75)	1.36 (1.02–1.80)

Note: CI = confidence interval, RR = risk ratio, - = unreportable (number of events < 10 for Inuit).
*RRs were calculated from log-binomial models accounting for mother-level cluster effects (multiple infants of the same mother).
†Model 1: RRs adjusted for mother-level cluster effects only.
‡Model 2: RRs adjusted for maternal characteristics (age, education, marital status, parity, rural residence and Northern residence).
§Model 3: Model 2 further adjusted for maternal chronic illnesses (chronic hypertension, diabetes, heart disease, renal disorders, genitourinary infections).
¶Model 4: Model 3 further adjusted for gestational complications (anemia, gestational diabetes, gestational hypertension and preeclampsia).

Table 5: Top 10 major morbidities for infant hospitalizations (per 1000)* in First Nations–Inuit and non-Indigenous infants — Quebec 1996–2011

Reason for infant hospitalization (%)*	First Nations	Inuit	Non-Indigenous	First Nation v. non-Indigenous		Inuit v. non-Indigenous	
				RD	RR (95% CI)	RD	RR (95% CI)
Acute bronchiolitis	64.6	67.2	27.6	37.0	2.34 (2.21–2.48)	39.6	2.44 (2.16–2.75)
Pneumonia	47.9	68.0	6.7	41.2	7.18 (6.63–7.78)	61.3	10.19 (8.98–11.57)
Otitis media	12.8	12.0	7.3	5.5	1.75 (1.54–2.00)	4.7	1.63 (1.22–2.18)
Fever unspecified	10.7	12.5	5.5	5.2	1.95 (1.69–2.26)	7.0	2.27 (1.71–3.02)
Urinary tract diseases	11.0	8.1	6.9	4.1	1.58 (1.38–1.82)	1.2	1.18 (0.83–1.67)
Upper respiratory disorders	14.7	8.7	9.0	5.7	1.63 (1.45–1.85)	–0.3	0.96 (0.69–1.35)
Enteritis	13.1	4.6	4.3	8.8	3.03 (2.64–3.47)	0.3	1.06 (0.67–1.69)
Viremia	4.0	3.1	2.8	1.2	1.47 (1.17–1.86)	0.3	1.11 (0.63–1.96)
Kidney disease	7.0	–	3.6	3.4	1.94 (1.62–2.32)	–	–
Intestinal infections	11.3	4.1	5.7	5.6	1.99 (1.73–2.29)	–1.6	0.72 (0.44–1.17)

Note: CI = confidence interval, RD = risk difference, RR = risk ratio, - = unreportable (number of events < 10 for Inuit).
*Hospitalization rates presented are the numbers per 1000 infants who were hospitalized at least once during the first year (365 d) of life. Multiple admissions for different causes were treated as separate events, but multiple admissions for the same cause as 1 event. Unadjusted risk differences and risk ratios are shown.

breastfeeding and no smoking in the child's living environment, and improve living conditions in Indigenous communities.

The factors that may explain the excess risks of hospitalization in First Nations and Inuit infants are not yet fully understood. Maternal characteristics could partly explain these risk differences. Unmeasured risk factors, especially maternal smoking and alcohol use, may also contribute. It is known that smoking and alcohol use are much more frequent among Indigenous populations.[22,23] The adverse effects of alcohol and tobacco on the developing fetus are well known.[24–26] Smoking and alcohol use may result in more unhealthy fetuses, contributing to elevated risks of multiple infant morbidities in First Nations and Inuit infants. Another unmeasured risk factor is the quality of perinatal care. Indeed, a recent study found poorer quality of obstetric care in First Nations versus other pregnant women in British Columbia.[27] Poor housing conditions, financial and food insecurity, and stress might be contributing factors.

Unexpectedly, pregnancy complications could not explain the excess infant hospitalizations in Indigenous populations. Although all major pregnancy complications were much more common in First Nations and Inuit women, the overall effects of adjusting for these pregnancy complications hardly diminished the hospitalization risk disparities between First Nations and Inuit versus non-Indigenous infants (Table 3, Table 4).

Our and other studies have consistently reported worse birth outcomes and higher perinatal and infant mortality rates in First Nations and Inuit versus non-Indigenous populations in Canada.[4–7] The present study further shows that First Nations and Inuit peoples may bear a disproportionately greater burden of severe infant morbidities than non-Indigenous populations in Quebec, as shown by the much higher infant hospitalization rates. We are aware of only 2 previous studies on Canadian Indigenous infant hospitalizations, both with important limitations.[28,29] A study in 2007 reported higher rates of infant hospitalization due to pneumonia in Indigenous versus non-Indigenous communities in the Northern Peninsula of Newfoundland based on place of residence only to identify Indigenous infants.[28] A small cohort study (First Nations infants, $n = 99$) reported 4 times greater risk of hospitalization in First Nations than in non-Indigenous infants in southern Ontario.[29]

Strengths and limitations

The main strength is the population-based large birth cohort with linked data on infant hospitalizations. One limitation is that misclassifications of Indigenous status might have occurred. In Quebec, Indigenous peoples numbered about 142 000 in the 2011 census, accounting for only about 2.1% of the total provincial population. In this study, we could identify First Nations and Inuit infants, but not Métis infants since no identifiers were available. Métis infants would have been classified as "non-Indigenous." However, this limitation should not have affected the comparisons, because the number of Métis infants in the "non-Indigenous" group is very small (Métis accounted for about 0.5% of the total Quebec population in the 2011 census). Inuit infants were slightly less likely to be linked to hospital records, possibly due to some home births in low-risk pregnancies. Such unlinked Inuit infants might thus be at lower risk for hospitalization, leading to somewhat overestimated risk for Inuit infants overall.

Another limitation is our inability to determine whether the decision to hospitalize an infant was influenced by factors other than the infant's clinical conditions. However, hospital care might have been more accessible to non-Indigenous infants. Thus, the observed disparities might underestimate the true disparities in severe morbidities between Indigenous and non-Indigenous infants.

The study was based on infant hospitalization data in the province of Quebec. There is a need for studies in other provinces to understand the generalizability of the findings and depict the national picture of Indigenous versus non-Indigenous risk disparities in Canada. We suspect that similar risk patterns may be observed in other provinces with similar social and health care contexts.

Conclusion

First Nations and Inuit infants suffered a substantially heavier burden of hospitalizations resulting from diseases of multiple systems in Quebec. Preventable morbidities accounted for the major excess risks. The findings identify substantial unmet needs in Indigenous infant disease prevention and medical care. There is an urgent need for interventions to reduce Indigenous versus non-Indigenous infant health inequalities.

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Competing interests: None declared.

This article has been peer reviewed.

Affiliations: Ministry of Education-Shanghai Key Laboratory of Children's Environmental Health (He, Luo), Xinhua Hospital, Shanghai Jiao-Tong University School of Medicine, Shanghai, China; Department of Obstetrics and Gynecology (He, Xiao, Luo), Sainte-Justine Hospital, University of Montreal, Montréal, Que.; Public Health Department (Xiao, Torrie), Cree Board of Health and Social Services of James Bay, Mistissini, Que.; University of Montreal Hospital Research Centre (Auger), University of Montreal, Montréal, Que.; Research Division, First Nations of Quebec and Labrador Health and Social Service Commission (Gros-Louis McHugh), Wendake, Que.; Nunavik Regional Board of Health and Social Services (Zoungrana), Kuujjuaq, Que.

Contributors: Nathalie Auger and Zhong-Cheng Luo conceived the study. All authors contributed to refining the analytic framework and data interpretation. Lin Xiao and Zhong-Cheng Luo conducted the data analyses. Hua He conducted the literature review and drafted the manuscript. All authors contributed to revising the article critically for important intellectual content, and approved the version to be published.

Funding: This work was supported by a research grant from the Canadian Institutes of Health Research (CIHR grant number MOP 106521). Hua He was partly supported by a research grant from the National Natural Science Foundation of China (NSFC grant number 81571451). Lin Xiao was partly supported by the Cree Board of Health and Social Services of James Bay.

Acknowledgements: The authors are indebted to Indigenous and Northern Affairs Canada for providing the Indian Registration System membership database, and to the Régie de l'assurance maladie du Québec (RAMQ) for providing the Maintenance et exploitation des données pour l'étude de la clientèle hospitalière (MED-ECHO) database for data linkage in this project. The authors are grateful to the Institut de la statistique du Québec (ISQ) for providing access to the linked research data, and to Isabelle Leroux and Jimmy Baulne from the ISQ for assistance in the creation of the linked research database.

Accepted: Feb. 21, 2017

Correspondence to: Zhong-Cheng Luo, zc_luo@yahoo.com