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Infant mortality among First Nations versus non-First Nations in British Columbia: temporal trends in rural versus urban areas, 1981–2000

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Background Increasingly more First Nations (FN) people have moved from rural to urban areas. It is unknown how disparities in infant mortality among FN versus non-FN women have changed over time in urban versus rural areas.

Methods We conducted a birth cohort-based study of all 877 925 live births (56 771 FN and 821 154 non-FN) registered in British Columbia, 1981–2000. Main outcomes included rates, risk differences, and relative risks of neonatal, postneonatal, and overall infant death.

Results Both neonatal and postneonatal mortality rates for FN infants showed a steady decline in rural areas but a rise-and-fall pattern in urban areas. Relative risks for overall infant death among FN versus non-FN infants declined steadily from 2.75 (95% CI: 2.04, 3.72) to 1.87 (95% CI: 1.24, 2.81) in rural areas from 1981–1984 to 1997–2000, but rose from 1.59 (95% CI: 1.27, 1.99) (1981–1984) to 2.80 (2.33–3.37) (1989–92) and then fell to 1.89 (1.44–2.49) (1997–2000) in urban areas. Risk differences for neonatal death among FN versus non-FN infants declined substantially over time in rural but *not* urban areas. The disparities in neonatal death among FN versus non-FN were largely explained by differences in preterm birth, while the disparities in postneonatal death were not explained by observed maternal and pregnancy characteristics.

Conclusions Reductions in disparities in infant mortality among FN versus non-FN women have been less substantial and consistent over time in urban versus rural areas of British Columbia, suggesting the need for greater attention to FN maternal and infant health in urban areas.

Keywords Urban, rural, North American Indians, First Nations, birth outcomes, infant mortality

Searching for new opportunities, young First Nations (FN) people (often referred to as North American Indians) have been moving from rural to urban areas in recent decades, with an increasing proportion of FN births in urban areas.[1–3] In the US, approximately 56% of the FN population now lives in urban areas, in contrast to their predominant rural residency in the past.[2] In Canada, as many as 40% of the FN population have moved off-reserve over the last three decades, mostly into large urban communities.[3]

Little is known about birth outcomes among FN versus non-FN in urban areas. Available literature on this issue is scarce[2,4–6] and is totally absent for Canadian urban FN. Similar or even greater disparities in infant mortality among FN versus whites have been observed in US urban versus rural areas, perhaps due to inadequate access to health care resources for FN in urban areas.[2,4,6] We are unaware of any population-based studies of temporal trends in disparities in birth outcomes among FN versus non-FN women in rural versus urban areas.

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Disadvantaged socioeconomic status is an important risk factor for poor FN birth outcomes.[1–3] Canadian FN are approximately 80% less likely to possess a university degree, and twice as likely to be unemployed, than other Canadians.[7] We hypothesized that disparities in infant mortality among Canadian FN versus non-FN have diminished over time in both rural and urban areas with the universal health insurance system in place since the 1970s,[1] and therefore affordable access to health care irrespective of socioeconomic status. Our study aimed to test this hypothesis among FN women in British Columbia who gave birth between 1981 and 2000.

Materials and Methods

Subjects

We conducted a birth cohort-based study of all 881 651 live births (gestational age ⩾20 weeks) registered in British Columbia, Canada, from 1981 to 2000, using the linked birth/infant death database of the British Columbia Vital Statistics Agency.[8] 'First Nations' (FN) is the current preferred term for North American Indians in Canada. FN is one part of the broad group of aboriginal peoples (First Nations, Inuit, Metis) in Canada. However, virtually all aboriginal people in British Columbia are FN. FN births were identified by a flag in the linked data set. The major source for this data flag was the British Columbia Vital Statistics Agency's statistical database of information extracted from the registration of births. Additional sources were the Indian Status Verification File of the First Nations and Inuit Health Branch, Health Canada, originating from the Department of Indian Affairs and Northern Development, and the Status Indian Entitlement files from the British Columbia Medical Services Plan.[8,9] A birth was considered a FN birth if the mother and/or infant was identified as FN in any of the three sources.[9] Stillbirths were not included in analyses because the variable used to allocate rural versus urban was often missing on stillbirth records, particularly in earlier years of the study period.

Definition of rural versus urban

We used Statistics Canada's recommended definition of 'rural': residing in a rural area or a small town of <10 000 people in community size,[10] based on the 1996 Canadian Census population figures for each Census Metropolitan Area or Census Agglomeration (CMACA, 25 valid codes for British Columbia). The CMACA codes were obtained through postal code linkage based on the mother's place of residence at the time of birth for births in the years 1985–2000,[11] and through standard geographical code linkage for births in the years 1981–1984 (postal codes were absent on the machine-readable files of birth registrations for this period). The standard five-digit geographical code represents a well-defined geographical area and can be mapped to a CMACA. Urban community size was categorized into three strata (10 000–99 999, 100 000–499 999, and ⩾500 000) to further account for differences in access to and quality of health care.

Of the 881 651 live births recorded, 337 (0.6%) of the 57 108 FN births and 3389 (0.4%) of the 824 543 non-FN births, rural versus urban residence could not be determined owing to missing, incomplete, or incorrect postal codes and/or standard geographical codes, leaving 877 925 live births (56 771 FN and 821 154 non-FN) for the rural versus urban comparisons.

Neighbourhood income quintiles

A small area-based neighbourhood income quintile (NIQ) variable was created to reflect the socioeconomic status of the neighbourhoods in which the mothers lived.[12] The quintiles were derived from household size-adjusted average family income of an enumeration area (EA) relative to other EA within the same CMACA, using the Canadian census data from the closest census year (1986, 1991, or 1996). The EA is the smallest census geographical unit and typically contains 125 to 440 dwellings in Canada.[13] The household size-adjusted income per person equivalent (IPPE) of each EA was calculated,[13] and EA within the same CMACA were ranked into five quintiles from Q1 (richest) to Q5 (poorest) according to IPPE. The EA and thus the quintile values were assigned to each birth through postal code linkage based on the mother's place of residence at the time of birth.[11] NIQ were unavailable for births in the years 1981–1984, owing to the absence of postal codes on birth registrations for those years.

Distance to the nearest hospital with obstetricians

A list of all hospitals with obstetricians in British Columbia and the neighbouring province of Alberta was obtained by one contributing author (RML). Distance to the nearest hospital with obstetricians was calculated for each birth based on the mother's residential postal codes at the time of birth and the postal codes of the hospital,[14] and was therefore unavailable for births before 1985. Distance to the nearest hospital with obstetricians was used as a measure of remoteness of the mother to perinatal care, which can influence neonatal mortality. Almost all these hospitals with obstetricians also have paediatric support. Exploratory analyses suggested a higher risk of neonatal mortality for distance >50 km. The distance variable was therefore dichotomized into two strata (⩽50 km versus >50 km) to account for differences in access to obstetric care.

Maternal and pregnancy characteristics

Several important maternal and pregnancy characteristics are recorded in the British Columbia Vital Statistics Agency's linked birth and infant death data files. The variables examined included infant sex (boy versus girl), parity (primiparous versus multiparous), plurality (singleton versus multiple), gestational age (in completed weeks), birthweight (g), maternal age (<10, 20–34, ⩾35 years), marital status (married versus unmarried), abortion history (yes versus no), maternal illness (presence versus absence of any of the following conditions during pregnancy: diabetes, abnormal glucose tolerance, epilepsy, hypertension, pre-eclampsia, eclampsia, anaemia, thyroid dysfunction, or renal or liver disorders), and mode of delivery (spontaneous versus instrumental, the latter including cesarean section, forceps, and vacuum extraction).

Outcome measures and statistical analyses

The principal outcomes under study were neonatal (0–27 days), postneonatal (28–364 days), and overall infant death (0–364 days). Gestational age-specific neonatal and postneonatal mortality and rates of preterm birth (<37 completed weeks of gestation), small-for-gestational-age (SGA, below the 10th percentile, based on a recent Canadian standard),[15] and large-for-gestational-age (LGA, above the 10th percentile) were also examined to assess the extent to which differences in gestational duration or fetal growth might account for differences in infant mortality. Risk differences (RD) and relative risks (RR) with 95% CI were calculated for neonatal, postneonatal, and overall infant death among FN versus non-FN infants. Non-FN infants were not further subdivided, since the differences in outcomes among non-FN infants of different ethnic groups were much smaller. Aggregated results over 4-year intervals were calculated to obtain more stable estimates for assessing trends over time. Causes of infant death were investigated using the classification of the International Collaborative Effort on Perinatal and Infant Mortality.[16] We examined causes of infant death due to congenital anomalies, asphyxia, sudden infant death syndrome (SIDS), infection, and external causes.

Logistic regression analysis was used to estimate the adjusted odds ratios (OR) of neonatal, postneonatal, and overall infant death among FN versus non-FN infants after controlling for infant sex, parity, plurality, maternal age, marital status, abortion history, mode of delivery, pregnancy complications, community size (in urban areas), and (from 1985–1988 onwards) neighbourhood income quintile and distance to the nearest hospital with obstetricians. Multicollinearity among covariates was checked (by removing a collinear variable), and no significant effects on parameter estimates were observed. We also examined multilevel logistic regression models (CMACA and EA defined area-levels) using SAS GLMM800 macro,[17] but the adjusted OR for all outcomes were virtually identical and are therefore not presented. All data analyses were carried out using SAS, Version 8.2.[17]

Results

Large differences in maternal and pregnancy characteristics were observed among FN versus non-FN mothers in both rural and urban areas (Table 1). FN mothers were much more likely to be unmarried or adolescent, to live in a poor neighbourhood or >50 km in distance to the nearest hospital with obstetricians, or to have a previous history of abortion, and were less likely to be primiparous, or to have a multiple birth, or an instrumental delivery. The observed maternal complication rates were slightly higher among FN versus non-FN mothers in rural areas but were lower in urban areas.

Infant mortality over the study period was more than twice as high among FN versus non-FN in both rural and urban areas (Table 2). Postneonatal mortality rates were 3.6-fold higher among FN versus non-FN infants in both rural and urban areas. Differences in gestational age-specific neonatal morality rates among FN versus non-FN infants were small and non-significant, while postneonatal mortality rates were consistently substantially higher among FN versus non-FN infants in both rural and urban areas (detailed results available upon request). The RR for postneonatal death among FN versus non-FN were consistently elevated at all gestational ages: 1.67 (95% CI: 1.02, 2.72), 2.10 (95% CI: 1.32, 3.37), 2.82 (95% CI: 2.17, 3.66), 3.86 (95% CI: 3.41, 4.37), and 2.97 (95% CI: 1.54, 5.70) for infants born at gestational ages of 20–27, 28–32 33–36, 37–41, and ⩾42 weeks, respectively.

Rates of neonatal death due to congenital anomalies among FN versus non-FN infants were not significantly different in either rural or urban areas; RR were 0.87 (95% CI: 0.53, 1.43) and 1.17 (95% CI: 0.88, 1.56), respectively. Much higher risks of postneonatal death due to SIDS, infection, and external causes were observed among FN versus non-FN infants in both rural and urban areas. SIDS was the major cause of the excess postneonatal mortality among FN versus non-FN infants and accounted for approximately 50% of postneonatal deaths and one-third of overall infant deaths among FN infants in both rural and urban areas.

Bivariate analyses suggested that higher risks of infant mortality were associated with rural residence, living in poor neighbourhoods, distance >50 km from the nearest hospitals with obstetricians, infant male sex, multiple birth, primiparity, maternal age <20 or ⩾35 years, unmarried status, abortion history, presence of maternal complications, and instrumental delivery.

Similar RR of adverse outcomes among FN versus non-FN births were observed across neighbourhood income quintiles. For example, the RR among urban FN versus non-FN infants were 2.24 (95% CI: 1.89, 2.64) for infant death and 4.80 (95% CI: 3.60, 6.40) for SIDS in the poorest neighbourhood income quintile, versus 2.54 (95% CI: 1.79, 3.62) and 5.07 (95% CI: 2.41, 10.66), respectively, in the richest neighbourhood income quintile. The Mantel-Haenszel RR controlling for neighbourhood income quintiles were therefore similar to the crude RR.

Infant mortality rates among FN live births declined steadily from 20.7 to 7.5 per 1000 live births from 1981–1984 to 1997–2000 in rural areas, but surprisingly rose from 13.4 to

Table 1 Maternal and pregnancy characteristics among First Nations (FN) versus non-FN mothers in rural versus urban areas of British Columbia, 1981–2000

	Rural		Urban	
Characteristic	FN	Non-FN	FN	Non-FN
n (877 925)	20 412	108 678	36 359	712 476
Living in the poorest neighbourhoods, %	32.2	18.3**	40.3	22.3**
Distance to the nearest hospital with obstetricians				
Median, in km	96.7	60.4**	3.5	4.0**
Distance >50 km, %	79.4	54.8**	5.1	3.0**
Mother's age, years, mean/SD	24.2/5.6	27.3/5.3**	24.7/5.7	28.3/5.2**
<20 years, %	21.9	6.5**	19.5	4.4**
⩾35 years, %	5.3	9.6**	5.8	12.2**
Unmarried mothers, %	63.9	23.4**	57.6	18.4**
Primiparous, %	35.6	39.5**	38.3	45.2**
Multiple birth, %	1.7	1.9*	1.8	2.2**
Abortion history, %	30.8	29.3*	34.7	29.9**
Maternal illness,[a] %	3.3	3.1*	3.2	3.7**
Instrumental delivery,[b] %	22.3	29.7**	24.7	34.4**

[a] Presence of any of the following conditions during pregnancy: diabetes, abnormal glucose tolerance, epilepsy, hypertension, pre-eclampsia, eclampsia, anaemia, thyroid dysfunction, or renal or liver disorders.

[b] Instrumental deliveries include cesarean section, forceps, and vacuum extraction.

*$P < 0.05$; **$P < 0.01$; Chi-square tests were used for differences in proportion; t-tests were used for differences in means; Wilcoxon rank tests were used for differences in medians.

Table 2 Outcomes among First Nations (FN) versus non-FN live births in rural versus urban areas of British Columbia, 1981–2000

	Rural			Urban		
Outcomes	FN (1)	Non-FN (2)	(1) versus (2) RR[a] (95% CI)	FN (3)	Non-FN (4)	(3) versus(4) RR (95% CI)
n (877 925)	20 412	108,678		36 359	712 476	
GA[b] weeks, mean/SD	38.9/2.2	39.5/1.9*		38.5/2.2	39.3/2.0*	
Birthweight, g, mean	3462.6	3444.7*		3445.7	3415.3*	
SD	611.9	557.8		614.7	575.3	
Preterm birth, %	9.2	5.0	1.84 (1.75, 1.94)	9.9	6.3	1.57 (1.52, 1.63)
SGA,[c] %	7.7	10.3	0.75 (0.71, 0.79)	7.4	10.2	0.72 (0.69, 0.75)
LGA,[d] %	15.6	9.8	1.59 (1.53, 1.65)	15.5	10.0	1.54 (1.50, 1.58)
Infant mortality[e]	13.8	6.1	2.27 (1.97, 2.60)	12.7	6.1	2.08 (1.89, 2.29)
Neonatal mortality[e]	5.6	3.8	1.48 (1.20, 1.82)	5.4	4.1	1.32 (1.14, 1.53)
Postneonatal mortality[f]	8.2	2.3	3.61 (2.97, 4.40)	7.4	2.0	3.62 (3.18, 4.13)

[a] Relative risk.
[b] Gestational age.
[c] Small-for-gestational-age.
[d] LGA = large-for-gestational-age.
[e] Per 1000 live births.
[f] Per 1000 neonatal survivors.
* T-tests for differences in GA and birthweight between FN versus non-FN infants were all significant at $P < 0.01$.

16.7 per 1000 live births from 1981–1984 to 1989–1992 before falling thereafter to 7.1 per 1000 live births in 1997–2000 in urban areas (Figure 1). Both neonatal and postneonatal mortality rates among FN births showed a steady decline over time in rural areas, versus bumpy rise-and-fall pattern in urban areas (Figure 2). The lower neonatal and postneonatal mortality rates among urban versus rural FN infants in earlier periods disappeared in more recent periods. Postneonatal SIDS rates among FN neonatal survivors showed a rise-and-fall pattern over time in both rural and urban areas (Figure 3).

Crude RR for overall infant death among FN versus non-FN births declined consistently over time in rural areas, but rose from 1981–1984 to 1989–1992 and fell thereafter in urban areas (Table 3). Crude RD for neonatal death declined substantially from 3.9 to 0.7 per 1000 live births in rural areas, but was exceptionally low in 1981–1984 and showed no apparent changes from 1985–1988 to 1997–2000 in urban areas. Crude RD for postneonatal death among FN versus non-FN infants declined steadily in rural areas versus a rise-and-fall pattern in urban areas.

The adjusted OR of neonatal, postneonatal death were smaller than the crude RR (which were identical to the crude OR) after controlling for sex, parity, plurality, maternal age, marital status, abortion history, mode of delivery, maternal illness, community size, neighbourhood income quintile, and distance to the nearest hospital with obstetricians in both rural and urban areas (Table 3). The reduction in risks after adjustment was greater for postneonatal mortality. The adjusted OR with or without controlling for maternal illness or mode of delivery were virtually identical (results not shown). When further controlled for gestational age, all adjusted OR for neonatal death became non-significant and even changed direction during most time periods in both rural and urban

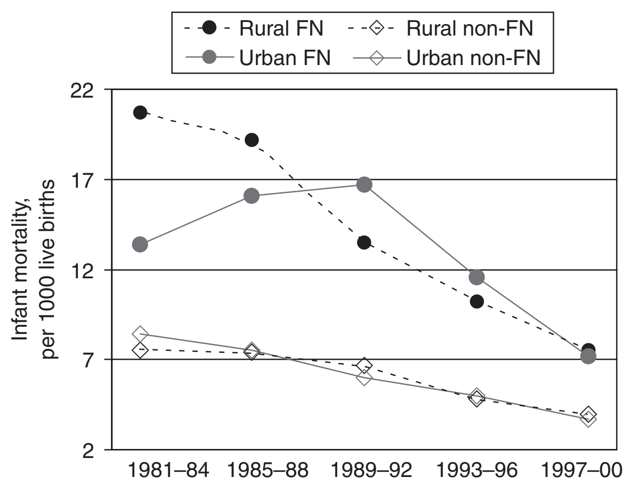

Figure 1 Infant mortality among First Nations (FN, dots) versus non-FN (diamonds) infants in rural (dashed lines) versus urban (solid lines) areas of British Columbia, 1981–1984 through 1997–2000

areas. The adjusted OR for postneonatal death remained large and significant for most time periods.

FN infants had shorter gestations but heavier birthweights, and were at higher risk of preterm birth and LGA, but at lower risk of SGA, than non-FN infants in both rural and urban areas (Table 2). However, preterm, postterm, SGA, and LGA FN infants were not at higher RR of neonatal or postneonatal death versus comparable non-FN infants; for example, the RR for neonatal death in urban FN versus non-FN were 0.86 (95% CI: 0.73, 1.02) among preterm versus 1.29 (95% CI: 0.97, 1.73) among term births, and were 1.40 (95% CI: 1.17, 1.67) among AGA, 1.21 (95% CI: 0.82, 1.81) among SGA, and 1.35 (95%

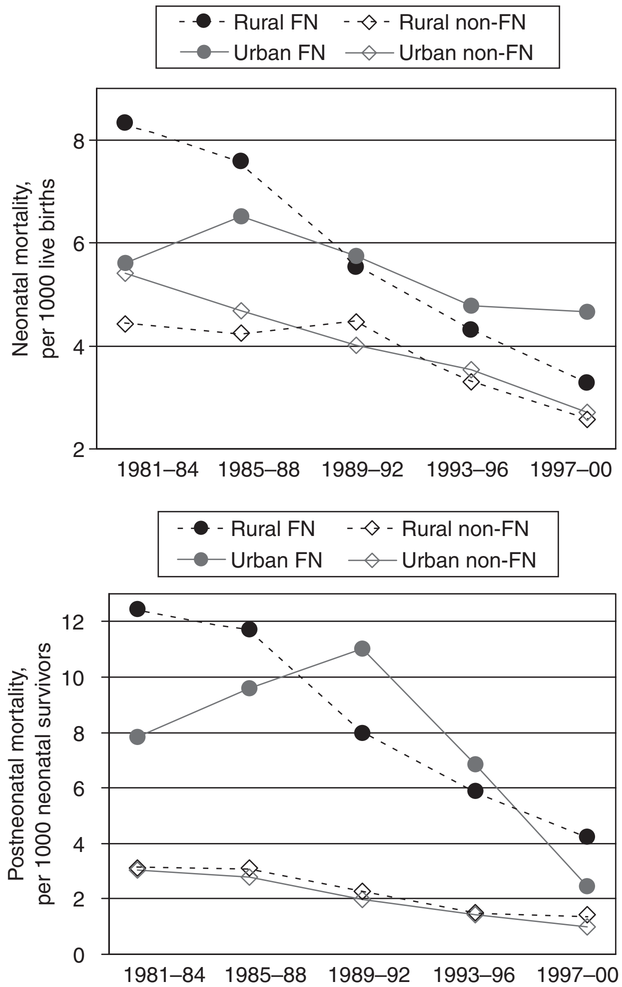

Figure 2 Neonatal and postneonatal mortality among First Nations (FN, dots) versus non-FN (diamonds) infants in rural (dashed lines) versus urban (solid lines) areas of British Columbia, 1981–1984 through 1997–2000

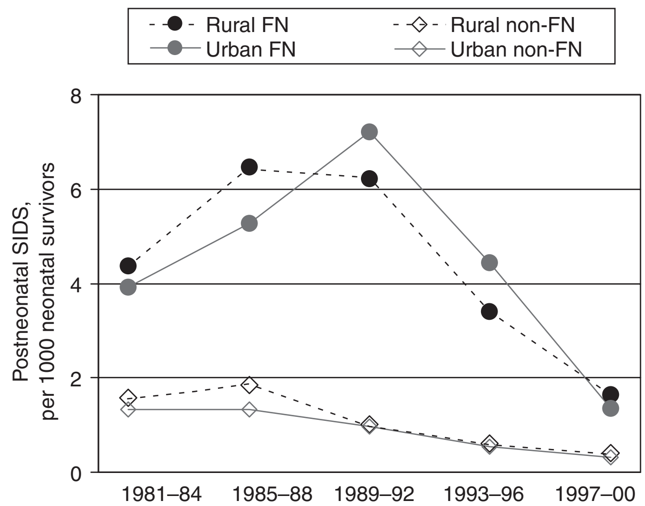

Figure 3 Incidence of postneonatal SIDS among First Nations (FN, dots) versus non-FN (diamonds) infants in rural (dashed lines) versus urban (solid lines) areas of British Columbia, 1981–1984 through 1997–2000

CI: 0.92, 1.99) among LGA births, respectively. The RR for neonatal death among FN versus non-FN became non-significant when adjusting for preterm birth but were virtually unchanged when adjusting for SGA or LGA birth using the Mantel-Haenszel method. The RR for postneonatal death were virtually unchanged when adjusting for preterm, SGA, or LGA birth in both rural and urban areas.

Higher RR of neonatal death among FN versus non-FN infants were observed for instrumental delivery in both rural and urban areas. In rural areas, the RR of neonatal death among FN versus non-FN infants were 1.90 (95% CI: 1.39, 2.59) for instrumental delivery versus 1.31 (95% CI: 0.98, 1.72) for spontaneous delivery; in urban areas, the corresponding RR were 1.50 (95% CI: 1.20, 1.87) for instrumental delivery versus 1.38 (95% CI: 1.14, 1.67) for spontaneous delivery.

Discussion

Our study provides the first population-based assessment of temporal trends in infant mortality among FN versus non-FN in rural versus urban areas. The patterns in rural areas confirm our hypothesis of narrowing disparities among FN versus non-FN, while the patterns in urban areas are less consistent. The reduction in disparities in infant mortality among FN versus non-FN has been less substantial and consistent in urban versus rural areas of British Columbia over the last two decades, despite a universal health insurance system. In fact, the lower neonatal, postneonatal, and overall infant mortality rates among urban versus rural FN infants in earlier periods disappeared in more recent periods.

The differential patterns observed in urban versus rural areas remain after adjustment for multiple factors (including gestational age) and therefore cannot be explained by these factors. The inconsistent reduction in disparities in postneonatal mortality among urban FN versus non-FN suggest a greater need for attention to FN infant health in urban areas.

Our study confirms the persistent excess risks of infant mortality among FN.[1–4,18–20] In addition, similar RR of infant mortality among FN versus non-FN were observed in both poor and rich neighbourhoods, suggesting that the observed disparities were independent of neighborhood socioeconomic status. FN may be of lower socioeconomic status within the same neighborhood income quintile or alternatively, may not benefit from living in richer neighbourhoods. Most of the excess infant mortality among FN versus non-FN was due to higher postneonatal mortality in both rural and urban areas, particularly for death due to preventable causes (SIDS, infection, and external causes), suggesting the need for improved socioeconomic and living conditions.[7]

The higher preterm birth and LGA but lower SGA rates among Canadian FN are consistent with previous reports.[7,8,20] The differences we observed in neonatal mortality among FN versus non-FN were largely be attributable to the differences in preterm birth, while the higher postneonatal mortality could not be accounted for by these differences. The absence of differences in gestational age-specific neonatal mortality suggests that preterm FN newborns have adequate referral and

Table 3 Crude risk differences (RD, per 1000), relative risks (RR), and adjusted odds ratios (OR) for neonatal, postneonatal, and overall infant death among First Nations (FN) versus non-FN infants in rural versus urban areas of British Columbia, 1981–1984 through 1997–2000

	Rural, FN versus non-FN				**Urban, FN versus non-FN**			
	Crude		Adjusted	Adjusted	Crude		Adjusted	Adjusted
	RD	RR (95% CI)	OR[a] (95% CI)	R[b] (95% CI)	RD	RR (95% CI)	OR[a] (95% CI)	OR[b] (95% CI)
Neonatal death								
1981–1984	3.9	1.88 (1.20, 2.96)	1.61 (0.92, 2.79)	1.71 (0.90, 3.25)	0.2	1.03 (0.73, 1.46)	1.07 (0.74, 1.56)	0.79 (0.51, 1.21)
1985–1988	3.3	1.79 (1.20, 2.65)	1.63 (1.01, 2.64)	0.93 (0.51, 1.70)	1.8	1.39 (1.02, 1.91)	1.21 (0.85, 1.73)	1.12 (0.74, 1.71)
1989–1992	1.1	1.24 (0.80, 1.91)	1.16 (0.70, 1.92)	0.97 (0.53, 1.77)	1.7	1.43 (1.06, 1.95)	0.99 (0.70, 1.41)	0.81 (0.53, 1.24)
1993–1996	1.0	1.30 (0.79, 2.15)	0.99 (0.55, 1.78)	0.74 (0.37, 1.50)	1.2	1.35 (0.98, 1.87)	1.07 (0.74, 1.54)	0.75 (0.49, 1.18)
1997–2000	0.7	1.28 (0.71, 2.30)	1.04 (0.54, 2.02)	0.71 (0.32, 1.59)	1.8	1.69 (1.20, 2.36)	1.53 (1.04, 2.25)	1.15 (0.72, 1.82)
Postneonatal death								
1981–1984	9.4	4.01 (2.64, 6.10)	3.45 (2.06, 5.79)	3.40 (2.02, 5.74)	4.8	2.59 (1.91, 3.50)	1.93 (1.38, 2.70)	1.73 (1.23, 2.43)
1985–1988	8.6	3.78 (2.64, 5.42)	3.03 (1.92, 4.77)	2.84 (1.80, 4.50)	6.8	3.45 (2.63, 4.53)	1.77 (1.29, 2.43)	1.70 (1.23, 2.34)
1989–1992	5.7	3.54 (2.33, 5.39)	2.46 (1.45, 4.19)	2.31 (1,35, 3.95)	9.1	5.63 (4.42, 7.17)	3.33 (2.49, 4.16)	3.10 (2.34, 4.16)
1993–1996	4.4	3.93 (2.37, 6.52)	1.90 (0.97, 3.71)	1.58 (0.78, 3.17)	5.4	4.83 (3.61, 6.47)	2.44 (1.71, 3.47)	2.25 (1.58, 3.22)
1997–2000	2.8	2.94 (1.64, 5.29)	2.23 (1.08, 4.59)	1.92 (0.92, 4.03)	1.5	2.46 (1.54, 3.93)	1.78 (1.03, 3.07)	1.60 (0.93, 2.77)
Infant death								
1981–1984	13.2	2.75 (2.04, 3.72)	2.38 (1.63, 3.46)	2.55 (1.70, 3.88)	5.0	1.59 (1.27, 1.99)	1.45 (1.13, 1.86)	1.26 (0.96, 1.65)
1985–1988	11.8	2.60 (2.01, 3.38)	2.25 (1.62, 3.13)	1.85 (1.27, 2.68)	8.6	2.14 (1.75, 2.63)	1.53 (1.21, 1.94)	1.53 (1.17, 1.98)
1989–1992	6.8	2.01 (1.50, 2.70)	1.65 (1.15, 2.18)	1.55 (1.03, 2.33)	10.8	2.80 (2.33, 3.37)	1.87 (1.51, 2.32)	1.95 (1.53, 2.50)
1993–1996	5.4	2.12 (1.50, 3.00)	1.30 (0.84, 2.01)	1.07 (0.65, 1.78)	6.6	2.35 (1.90, 2.90)	1.59 (1.24, 2.04)	1.45 (1.08, 1.92)
1997–2000	3.5	1.87 (1.24, 2.81)	1.44 (0.89, 2.33)	1.22 (0.71, 2.11)	3.3	1.89 (1.44, 2.49)	1.61 (1.18, 2.21)	1.32 (0.92, 1.91)

[a] Odds ratio controlled for infant sex, parity, plurality, maternal age, marital status, abortion history, mode of delivery, pregnancy complications, community size (in urban areas), and (from 1985–1988 onwards) neighbourhood income quintile and distance to the nearest hospital with obstetricians.

[b] OR further controlled for gestational age.

access to neonatal intensive care and that the modest excess crude neonatal mortality among FN infants is attributable to higher proportions of births at lower gestational ages.

The higher RR of neonatal death associated with instrumental delivery suggest that access to and quality of neonatal care may be poorer for FN. This is partly reflected by the higher proportions of FN mothers living in areas with distance >50 km to the nearest hospital with obstetricians in both rural and urban areas. An alternative explanation may be that high-risk instrumental deliveries are relatively more frequent among FN women, perhaps because the threshold for cesarean, forceps, or vacuum delivery is lower among non-FN women, i.e. more use in low-risk settings.

SIDS remains the leading cause of the excess postneonatal mortality among FN versus non-FN infants in both rural and urban areas. SIDS nearly completely accounted for the rise in infant mortality among urban FN between 1981–1984 and 1989–1992; changes in other causes of death were much smaller. The higher SIDS rates among FN versus non-FN infants in British Columbia are unlikely to be due to the differences in ascertainment of causes of infant death.[21] The persistent high prevalence of smoking among FN (around 60%) may partly account for these disparities.[3,7] We are unaware of any reports of smoking prevalence specific to urban FN. The dramatic fall in SIDS among both FN and non-FN infants from 1989–1992 to 1997–2000 is encouraging, and is probably at least partly attributable to the 'back-to-sleep' campaign.[22,23] The prevalence of prone sleep position among Canadian FN infants has not been reported. Persistent large disparities in SIDS remain among FN versus non-FN infants, however, suggesting the need to promote smoking cessation and supine sleep position among FN mothers and families in both rural and urban areas.

Infant mortality among FN infants in British Columbia in both rural (10.2 per 1000) and urban areas (11.6 per 1000) in 1993–1996 were much higher than those reported among FN infants in the US Pacific Northwest (7.7 per 1000) in the same period.[24] The latest figures we could find for infant mortality among US rural versus urban FN infants were 11.7 versus 11.0 per 1000 live births in 1989–1991,[2] much lower than the corresponding rates of 13.5 versus 16.7 per 1000 live births observed in British Columbia for 1989–1992. However, infant mortality rates among non-FN infants in British Columbia were consistently substantially lower than the US national rates. It is surprising that urban FN infants fared much worse in British Columbia than in the US within comparable time periods, given the presence of a universal health insurance system in Canada.[1] A potential explanation is that FN in the US may be better assimilated in urban areas, but no studies have been reported to confirm this possibility. Cultural disruptions and dislocation from more traditional lifestyles may present new challenges and therefore be associated with higher risks of adverse birth outcomes. For example, it has been shown that foreign-born ethnic women had better pregnancy outcomes than US-born Mexican, Black, or Chinese women.[25]

Misclassification of ethnicity is a potential problem in studies of FN birth outcomes.[26] Because of the multiple sources of the FN status flag in our study, however, the identification of FN status has been both comprehensive and consistent over time.[8] Common to most Canadian population-based studies of birth outcomes using linked vital records, we did not have information on maternal education, occupation or income, smoking, alcohol or drug use, or use of prenatal care. Differentials in these and other unobserved behaviours may explain the remaining disparities not accounted for by observed maternal and pregnancy characteristics. For example, smoking and alcohol and drug use are more common among FN.[3,7,27]

The observed findings in British Columbia may be not generalizable to other regions, since each jurisdiction may have its own unique history and socioeconomic context. Nonetheless, relocation of aboriginal people from rural to urban areas is a general trend in many countries. We would expect even greater disparities in settings with less social welfare benefits and no universal health insurance coverage. Yet the smaller reported urban disparities in the US from the limited literature are puzzling, suggest that factors other than health care systems and social welfare benefits, such as acculturation may also play an important role. More culturally oriented maternal and infant health promotion programmes may be helpful and should be investigated.

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KEY MESSAGE

- Reductions in disparities in infant mortality among First Nations versus non-First Nations have been less substantial and consistent in urban versus rural areas of British Columbia over the last two decades, despite the Canadian universal health insurance system.

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