Birth Outcomes and Infant Mortality by the Degree of Rural Isolation Among First Nations and Non-First Nations in Manitoba, Canada

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Abstract

Context—It is unknown whether rural isolation may affect birth outcomes and infant mortality differentially for Indigenous versus non-Indigenous populations. We assessed birth outcomes and infant mortality by the degree of rural isolation among First Nations (North American Indians) and non-First Nations populations in Manitoba, Canada, a setting with universal health insurance.

Methods—A geocoding-based birth cohort study of 25,143 First Nations and 125,729 non-First Nations live births to Manitoban residents, 1991–2000. Degree of rural isolation was defined by an indicator of urban influence (no, weak, moderate/strong) based on the percentage of the workforce commuting to urban areas.

Findings—Preterm birth and low birth weight rates were somewhat lower in all rural areas regardless of the degree of isolation as compared to urban areas for both First Nations and non-First Nations. Infant mortality rates were not significantly different across areas for First Nations (10.7, 9.9, 7.9, and 9.7 per 1,000 in rural areas with no, weak, moderate/strong urban influence, and urban areas, respectively), but rates were significantly lower in less isolated areas for non-First

Nations (7.4, 6.0, 5.6, and 4.6 per 1,000, respectively). Adjusted odds ratios showed similar patterns.

Conclusions—Living in less isolated areas was associated with lower infant mortality only among non-First Nations. First Nations infants do not seem to have similarly benefited from the better health care facilities in urban centers, suggesting a need to improve urban First Nations' infant care in meeting the challenges of increasing urban migration.

Keywords

birth outcomes; infant mortality; North American Indians; rural and urban; rural isolation

Birth outcomes are persistently worse among Aboriginal as compared to non-Aboriginal populations even in developed countries.— The underlying causes remain incompletely understood. Several studies indicate that the place of residence may affect the disparities in birth outcomes and infant mortality when comparing Aboriginal versus non-Aboriginal populations. Among North American Indians (the Canadian equivalent term “First Nations”) and Alaskan Natives compared to whites in the United States, greater disparities in infant mortality have been reported in some urban areas than in rural areas. In British Columbia, the disparity in infant mortality when comparing First Nations to non-First Nations declined less substantially and less consistently in urban versus rural areas. A recent Australian study found that the disparity in infant mortality when comparing Aboriginal versus non-Aboriginal populations was larger in remote rural areas. However, it is unknown whether the degree of rural isolation per se may affect birth outcomes and infant mortality differentially among Aboriginal versus non-Aboriginal populations. The question may be of particular importance due to the increasing migration of Aboriginal people to less isolated areas over recent decades.

Although many Aboriginal people have moved from rural to urban or near-urban areas, substantially higher proportions of the Aboriginal population remain living in rural and more isolated areas compared to the non-Aboriginal population. According to the 2001 census, 57% of the First Nations population of Canada lived in rural areas, compared to 20% of the non-Aboriginal population. We hypothesized that the degree of rural isolation may affect birth outcomes and infant mortality differentially among Aboriginal and non-Aboriginal populations, presumably because of the Aboriginal versus non-Aboriginal differences in access to and effective use of the better care facilities in urban centers, and the differences in socioeconomic conditions and other risk factors. The primary aim of this study was to evaluate whether the degree of rural isolation may differentially affect birth outcomes and infant mortality among First Nations and non-First Nations in Manitoba, Canada, a setting with universal health insurance.

Methods

Subjects and Design

We conducted a geocoding-based retrospective birth cohort study of all live births to residents of Manitoba from 1991 through 2000, using Statistics Canada's linked stillbirth, live birth, and infant death database. The validity of the Canadian linked vital data has been

well documented. A birth was considered a First Nations birth if the mother or father was self-identified as First Nations (“Registered Indians” via a self-identification checkbox and/or write-in of treaty number or band name) on live birth registrations (89% were classified based on the maternal identifier). We did not include stillbirths because there were no First Nations identifiers on stillbirth registrations in Manitoba. We excluded births (2%) with missing birth weight, gestational age, sex, or missing maternal residential locality (needed for geocoding), or with a gestational age <20 weeks or birth weight <500 g. Births at gestational age <20 weeks or birth weight <500 g were excluded because the registration of births at the borderline of viability varied substantially. The final study cohort consisted of 150,872 live births (25,143 First Nations, 125,729 non-First Nations). The observed total number of live births in Manitoba was consistent with that of other reports. Based on the 1996 census, the estimated number of First Nations live births was approximately 2,650/year, and our data may have captured over 95% of First Nations live births in Manitoba during the study period. Research ethics board approval was obtained from Sainte-Justine Hospital of the University of Montreal. The study was approved by the Assembly of Manitoba Chiefs—Health Information Research Governance Committee.

Geocoding Maternal Place of Residence

Using the postal code of the mother’s place of residence as reported on the birth registration, or the place-name-based locality code if the postal code was not present (<5%), we assigned each birth to the corresponding census subdivision (CSD) and census metropolitan area or census agglomeration, using a validated geocoding program developed by Statistics Canada. CSDs are municipalities or their equivalent (incorporated cities and towns, First Nations reserves, etc.). Census metropolitan area or census agglomerations are economic communities of 10,000 people or more, which include an urban core and adjacent areas (CSDs) with high commuting flows (>50%) into the urban core. All census metropolitan area or census agglomerations are defined as urban, while the residual areas are rural, according to Statistics Canada’s recommended definition. Within rural areas, the degree of rural isolation of a CSD was categorized by its urban influence as determined by the work force commuting flows into any urban area, based on the 1996-census place of work data. Four rural zones were defined by degree of urban influence: strong (a commuting flow of 30% or more of the total employed labor force living in the CSD working in any census metropolitan area or census agglomeration), moderate (a commuting flow of 5%–29%), weak (a commuting flow of more than 0% but less than 5%), and none (zero commuting flow). We combined the rural moderate and strong urban influence zones into a single subgroup because the total number of First Nations births was relatively small (1,899 births) in the combined category. Births in urban areas served as the reference group for comparisons. This Canadian census sub-division-based classification of rural areas by degree of rural isolation according to work force commuting flows is similar to but simpler than the US census tract-based rural-urban commuting areas classification. Because we did not have data on individual-level socioeconomic status, we created 2 small area-level neighborhood socioeconomic status indicators: neighborhood income and education quintiles at the enumeration area level (the smallest area unit for census data dissemination, 125–440 households), based on the 1996 census. However, we observed that the effect

estimates for the degree of rural isolation were unaffected by further adjusting for such neighborhood socioeconomic status indicators, and therefore they were not presented.

Maternal and Pregnancy Characteristics

Available maternal and pregnancy characteristics included maternal age (<20, 20–34, 35+ years), ethnicity (First Nations, non-First Nations), marital status (married, unmarried), parity (primiparous, multiparous), plurality (singleton, plural), infant sex (male, female), gestational age (in completed weeks), and birth weight (in grams).

Outcomes and Analyses

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), low birth weight (LBW, <2,500 g), high birth weight, >4,000 g, large-for-gestational-age birth (LGA, >90th percentile), neonatal death (died during 0–27 days of postnatal life), postneonatal death (28–364 days), and total infant death (0–364 days). Causes of infant death were investigated according to the classification of the International Collaborative Effort on Perinatal and Infant Mortality, based on International Classification of Diseases-9 codes for deaths in 1991–1999 or International Classification of Diseases-10 codes for deaths in 2000–2001. The cause categories included congenital conditions, immaturity-related conditions, asphyxia, sudden infant death syndrome, infection, external causes, other specific conditions, and remaining causes. The cause of infant death was assigned by the primary cause of death for each case. Analyses of the risk of sudden infant death syndrome were restricted to the postneonatal period because sudden infant death syndrome mostly spared the neonatal period.

Chi-square tests for differences in rates and Cochran-Armitage tests for trends were used to assess the differences and trends in outcome rates. Crude relative risks, and crude and adjusted odds ratios (ORs) with 95% confidence intervals (CIs) were computed to assess the associations. We assessed the adjusted ORs using both ordinary (single-level) and multilevel logistic regression analyses considering CSD-level cluster variations. The intracluster variations were observed to be very low and did not affect the effect estimates. We therefore present the adjusted ORs based on ordinary logistic regression analysis. All data management and analyses were carried out using SAS for Windows, Version 9.0 (SAS Institute, Cary, NC).

Results

There were relatively fewer primiparous but relatively more young (age <20 years) mothers in more isolated areas for both First Nations and non-First Nations (Table 1). First Nations mothers were much more likely to be less than 20 years of age than were non-First Nations mothers ($P < .0001$). The proportion of unmarried mothers was over 60% for First Nations in all areas, which was much higher than for non-First Nations (18%–31%) ($P < .0001$). For First Nations, unmarried mothers were relatively more frequent in urban areas, while for non-First Nations, unmarried mothers were relatively more frequent in rural areas with no urban influence. There were no significant differences in the proportions of male or multiple

births across areas (urban and rural regardless of the degree of urban influence) for either First Nations or non-First Nations.

Infant mortality was 9.8 per 1,000 live births among First Nations, much higher than that of 5.0 per 1,000 live births among non-First Nations (relative risk = 1.96 [95% CI, 1.69–2.27]). For both First Nations and non-First Nations, about 15%–20% lower rates of preterm, SGA, and LBW births were observed in any rural versus urban areas (Table 2). For non-First Nations, LGA and high-birth-weight birth rates were significantly higher in more isolated areas, while for First Nations those rates showed no significant trends across the 4 areas. There were no significant differences or trends in infant mortality among First Nations across the 4 areas: 10.7, 9.9, 7.9, and 9.5 per 1,000 in rural areas with no, weak, or moderate/strong urban influence, and urban areas, respectively. By contrast, infant mortality rates among non-First Nations were significantly lower in less isolated areas: 7.4, 6.0, 5.6, and 4.6 per 1,000 in rural areas with no, weak, or moderate/strong urban influence, and urban areas, respectively ($P < .01$ in tests for differences or trends). Lower rates of neonatal and postneonatal death in less isolated areas were observed only among non-First Nations.

For non-First Nations, all cause-specific risks of infant death (detailed results not shown) were not significantly different across the 4 areas, except that the risk of neonatal death due to asphyxia was significantly elevated in rural areas as a whole compared to urban areas (relative risk = 2.09 [95% CI, 1.13–3.85]). For First Nations, all cause-specific risks of infant death were not significantly different across the 4 areas.

The adjusted ORs indicated that the lower risks of preterm, SGA, or LBW birth in rural versus urban areas remained significant for both First Nations and non-First Nations after controlling for the observed maternal characteristics (Table 3). Compared to urban residence, greater rural isolation was associated with a higher risk of infant death for non-First Nations (adjusted OR = 1.57, 1.31, and 1.28 in rural areas of no, weak, and moderate/strong metropolitan influence, respectively). Across areas, all adjusted ORs for infant death were non-significant for First Nations.

Similar results were observed in the analyses of birth data of earlier years (1991–1995) and later years (1996–2000) during the study period, and therefore they were not presented.

Discussion

Main Findings

A novel finding from this study is that the degree of rural isolation may affect infant mortality differentially for First Nations versus non-First Nations. While living in less isolated areas was associated with lower rates of infant mortality among non-First Nations, such urban “advantages” were absent for First Nations. We also found that rural residence, regardless of the degree of rural isolation, was associated with somewhat lower risks of preterm, SGA, and LBW birth for both First Nations and non-First Nations.

Comparisons With Previous Studies and Interpretations of Findings

Most studies comparing birth outcomes between rural and urban areas have not made a distinction with regard to the degree of isolation. Studies of developing countries often have reported much worse birth outcomes in rural areas, while such differences were inconsistent in developed countries.— In contrast, our results suggest that there could be different directions to the effect of rural residence dependent on the birth outcomes of interest and the population group. Interestingly, rural residence, regardless of the degree of isolation, was associated with a modestly protective effect against preterm, SGA, or LBW birth. This observation is consistent with the findings from some recent studies. In addition, this study indicates that such a positive effect is present in both First Nations and non-First Nations populations. This is somewhat surprising because maternal smoking, an important risk factor of poor fetal growth, is more prevalent in rural areas. However, the urban advantage of a lower risk of infant death (even with more frequent preterm, SGA, or LBW birth) observed among non-First Nations was not observed among First Nations. We speculate that access to and effective use of the better health care facilities available in urban areas may be inadequate for First Nations women and children. To our knowledge, there were no significant changes in obstetrical and neonatological practices, policies, or interventions during the study period.

A number of studies have examined the degree of rural isolation and birth outcomes using various measures of rural isolation, and the findings have been inconsistent. No previous studies have examined whether the effects of rural isolation per se on birth outcomes may differ among Aboriginal and non-Aboriginal populations. Our results indicate that the degree of rural isolation may have some differential associations with the risks of adverse birth outcomes for First Nations and non-First Nations. Living in less isolated areas was clearly associated with lower infant mortality among non-First Nations, but not among First Nations (Table 2). First Nations infants do not seem to have similarly benefited from the better care and other facilities in urban centers as their non-First Nations counterparts. We speculate that this could be due to barriers in access to and effective use of the more advanced care facilities in urban centers for First Nations no matter where they live (eg, language barriers and the lack of facilities tailored to the cultural norms and needs of First Nations) and inadequate infant care promotion programs (eg, the lack of culturally relevant effective back-to-sleep campaigns for sudden infant death syndrome prevention). The results clearly suggest a strong need to improve First Nations' maternal and infant health care in meeting the challenges of urban migration.

Limitations

Our study is largely descriptive and could not address the causal mediators of the observed differences by urban versus rural residence and degree of rural isolation. We had no information on many potential confounders or effect mediators such as maternal education, income, occupation, smoking and alcohol use, access to and quality of perinatal care, and gestational complications. More studies are needed to understand these causal mediating risk factors. There could have been inaccuracies in recoding of gestational age in such large vital databases, which might have affected the rates of preterm, SGA, and LGA births. Also, we could not identify other Aboriginal population groups in Manitoba, including Métis and

Inuit. They were included in the “non-First Nations” group. However, Métis and Inuit together accounted for only 6% of the Manitoba population, according to the 2001 census. Therefore, such misclassifications would be unlikely to affect the differential patterns in infant mortality across areas observed among First Nations versus non-First Nations.

In conclusion, our study clearly indicates the need to improve the quality of maternal and infant care for First Nations living in increasingly urbanized communities, even in a setting with universal health insurance. It is unclear whether our findings could be applicable to Aboriginal populations in other regions and countries. More studies are needed to address such concerns.

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Table 1

Maternal Demographic and Pregnancy Characteristics in Rural Areas by Degree of Urban Influence and in Urban Areas, for First Nations and Non-First Nations Births to Manitoba Residents, Canada 1991–2000

Characteristics	Rural by Urban Influence *			Urban	P Value in Tests for Differences
	No	Weak	Moderate/Strong		
First Nations					
All births, N	5,507	8,623	1,899	9,114	
Male sex, %	51.2	51.2	49.5	51.3	.57
Multiple birth, %	1.7	2.0	1.5	1.9	.28
Primiparae, %	27.1	28.5	30.7	30.2	.0001
Unmarried, %	63.5	71.1	72.9	83.8	<.0001
Maternal age, %					.02
<20 y	25.6	24.8	23.0	23.3	
20–34 y	70.1	70.4	72.3	71.8	
35 y	4.3	4.7	4.7	4.9	
Non-First Nations					
All births, N	2,958	17,862	18,534	86,375	
Male sex, %	50.0	51.9	51.5	51.3	.1681
Multiple birth, %	2.2	2.2	2.3	2.4	.3343
Primiparae, %	31.8	35.9	38.4	46.0	<.0001
Unmarried, %	30.8	24.2	18.3	26.9	<.0001
Maternal age, %					<.0001
<20 y	10.9	8.8	6.4	7.0	
20–34 y	80.5	83.0	84.0	80.4	
35 y	8.6	8.3	9.7	12.6	

* Urban influence was determined according to work force commuting flows between rural areas and urban centers.

Table 2

Crude Rates of Birth Outcomes and Infant Mortality for First Nations and Non-First Nations in Urban Areas and in Rural Areas by Degree of Urban Influence, Manitoba 1991–2000

Outcome	Rural by Urban Influence [†]			P Values, Tests for Differences Trends [‡]		
	No	Weak	Moderate/Strong	Urban		
First Nations						
All live births, N	5,507	8,623	1,899	9,114		
Preterm birth, %	7.5	7.7	7.8	9.1	.001	.0002
SGA birth, %	7.0	7.2	7.3	8.7	.0003	<.0001
Low birth weight, %	4.7	4.5	5.0	6.0	<.0001	<.0001
High birth weight, %	18.8	20.2	21.9	18.9	.005	.69
LGA birth, %	18.1	18.3	19.7	17.1	.02	.06
Neonatal death, per 1,000	5.1	3.5	3.2	3.3	.32	.15
Postneonatal death, per 1,000	5.7	6.4	4.8	6.2	.82	.81
Infant death, per 1,000	10.7	9.9	7.9	9.5	.74	.48
Non-First Nations						
All live births, N	2,958	17,862	18,534	86,375		
Preterm birth, %	7.0	6.3	6.5	7.8	<.0001	<.0001
SGA birth, %	8.7	8.4	8.4	10.5	.0003	.0003
Low birth weight, %	5.4	5.1	4.9	5.9	<.0001	<.0001
High birth weight, %	18.8	17.3	15.6	13.1	<.0001	<.0001
LGA birth, %	15.0	12.9	12.2	10.6	<.0001	<.0001
Neonatal death, per 1,000	3.7	4.2	4.0	3.0	.02	.004
Postneonatal death, per 1,000	3.7	1.9	1.6	1.6	.05	.06
Infant death, per 1,000	7.4	6.0	5.6	4.6	.007	.0006

* $P < .05$.

[†] Urban influence was determined according to work force commuting flows between rural areas and urban centers.

[‡] Two-sided P values in chi-square tests for differences and Cochran-Armitage tests for trends across the 4 strata: rural no urban influence, rural weak urban influence, rural moderate/strong urban influence, and urban areas.

Table 3

Crude and Adjusted OR of Birth Outcomes and Infant Mortality for Rural Areas by Degree of Urban Influence as Compared to Urban Areas, for First Nations and Non-First Nations Births to Residents of Manitoba 1991–2000

	Rural, No Urban Influence Crude OR, Adjusted OR [†] (95% CI)	Rural, Weak Urban Influence Crude OR, Adjusted OR [†] (95% CI)	Rural, Moderate/Strong Urban Influence Crude OR, Adjusted OR [†] (95% CI)
First Nations			
Preterm birth	0.82, 0.81 (0.72, 0.92) *	0.83, 0.82 (0.74, 0.92) *	0.86, 0.88 (0.73, 1.06)
SGA birth	0.79, 0.84 (0.74, 0.95) *	0.82, 0.85 (0.76, 0.94) *	0.83, 0.86 (0.71, 1.03)
Low birth weight	0.78, 0.80 (0.68, 0.93) *	0.74, 0.73 (0.64, 0.84) *	0.82, 0.86 (0.68, 1.08)
High birth weight	0.99, 0.93 (0.85, 1.02)	1.08, 1.05 (0.97, 1.13)	1.20, 1.16 (1.03, 1.32) *
LGA birth	1.08, 1.00 (0.91, 1.09)	1.09, 1.05 (0.97, 1.13)	1.19, 1.15 (1.01, 1.30) *
Neonatal death	1.55, 1.60 (0.94, 2.72)	1.06, 1.05 (0.63, 1.77)	0.96, 0.99 (0.41, 2.39)
Postneonatal death	0.90, 1.00 (0.64, 1.56)	1.02, 1.09 (0.75, 1.59)	0.76, 0.81 (0.40, 1.64)
Infant death	1.12, 1.21 (0.86, 1.70)	1.03, 1.07 (0.79, 1.46)	1.21, 0.87 (0.50, 1.51)
Non-First Nations			
Preterm birth	0.89, 0.92 (0.79, 1.06)	0.80, 0.83 (0.78, 0.89) *	0.83, 0.86 (0.80, 0.92) *
SGA birth	0.81, 0.85 (0.75, 0.97) *	0.78, 0.82 (0.78, 0.87) *	0.79, 0.84 (0.79, 0.89) *
Low birth weight	0.92, 0.95 (0.80, 1.13)	0.87, 0.92 (0.85, 0.99) *	0.83, 0.88 (0.82, 0.95) *
High birth weight	1.54, 1.48 (1.35, 1.63) *	1.39, 1.34 (1.28, 1.40) *	1.23, 1.18 (1.12, 1.23) *
LGA birth	1.48, 1.40 (1.26, 1.55) *	1.25, 1.19 (1.14, 1.25) *	1.17, 1.12 (1.06, 1.17) *
Neonatal death	1.26, 1.28 (0.70, 2.34)	1.42, 1.44 (1.11, 1.87) *	1.35, 1.41 (1.09, 1.84) *
Postneonatal death	2.33, 2.03 (1.09, 3.76) *	1.16, 1.08 (0.73, 1.59)	1.01, 1.04 (0.69, 1.55)

* $P < .05$.

[†]The adjusted ORs were controlled for maternal age (<20, 20–34, 35+), marital status (married, not married), parity (primiparous or not), infant gender, plurality (singleton or multiple), using births to urban residents as the *reference* group.