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Provincial variations in birth outcomes according to maternal country of birth, 2000 to 2016

by Janelle Boram Lee, Aynsle Hinds and Marcelo L. Urquia

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Provincial variations in birth outcomes according to maternal country of birth, 2000 to 2016

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Abstract

Background: International migration is the main source of population growth in Canada. Research on the birth outcomes of immigrants has largely been based on Canadian provincial data, raising concerns about whether the findings can be generalized between provinces or between the provinces and Canada. Provincial time trends and variations in birth outcomes are described according to the 20 top maternal birthplaces.

Data and methods: Statistics Canada's Vital Statistics–Birth Database (2000 to 2016) was used to extract 5,831,580 records on live births for analyses. Rates of preterm birth (PTB, referring to births at 22 to 36 gestation weeks) and mean birth weight (at 39 to 40 gestation weeks) were compared across provinces between immigrant mothers, according to the top 20 maternal birthplaces, and Canadian-born mothers.

Results: The proportion of births to immigrant mothers rose overall from 23.7% in 2000 to 30.7% in 2016, but rose unevenly across the provinces. Increases were modest in British Columbia and Ontario; twofold in Alberta, Manitoba and Quebec; and fourfold in Saskatchewan. Compared with PTB rates among Canadian-born mothers, PTB rates were lower among various Asian, African and Western immigrant groups and higher among those from Bangladesh, the Philippines and the Caribbean. Lower birth weights were seen for most source countries, except the United States. These differences were uniform across the provinces, with a few exceptions.

Interpretation: There were large provincial variations in the proportion of births to immigrant mothers. However, disparities in birth outcomes did not substantially vary across provinces for most immigrant maternal birthplaces, suggesting some degree of generalizability for provincial birth data.

Keywords: Canada, perinatal, foreign-born, immigrants, preterm birth, birth weight

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In Canada, information on birth outcomes is routinely collected at the provincial and national levels through birth registrations¹ and hospital records.² These data are useful to understand perinatal health at the population level³ and its variations according to key sociodemographic characteristics, such as immigration status. Immigration is the main source of population growth in Canada; together, immigrants and second-generation individuals are projected to account for 1 out of 2 people by 2036.⁴ Studies on differences in perinatal outcomes between immigrant groups and non-immigrants have provided conflicting results, mainly because of the heterogeneity of study populations, data sources and analytic approaches.⁵ The perinatal health of infants born in Canada to immigrant mothers has primarily been studied using linked population-based provincial databases,^{6–8} and, more recently, using national data.^{9,10} Based on the level of geography results are presented at, there are concerns about the generalizability of results from province to province, from a particular province to the national level, and from the national level to the provincial level. For a single immigrant group, differences in birth outcomes may exist between Canadian provinces because of selection factors (e.g., provincial immigration programs and language), different post-migration experiences, or a combination of the two. Little is known about whether observed associations between maternal birthplace and birth outcomes are consistent across provinces.

Statistics Canada's Vital Statistics–Birth Database was used to advance knowledge on provincial variations in birth out-

comes. This large and comprehensive population-based dataset allowed for province-specific comparisons of the disparities between the top 20 immigrant groups and the Canadian-born group that are not affected by differing time periods, sampling schemes and variable definitions. The study objectives were to describe recent provincial trends in the proportion of births to immigrant mothers and to determine whether disparities in birth outcomes according to immigrant maternal birthplace vary across the provinces.

Methods

Data source and cohort definition

Managed by Statistics Canada, the Vital Statistics–Birth Database includes birth registration records provided by the provincial and territorial vital statistics registrars. The study population included all singleton live births from January 1, 2000, to December 31, 2016. Multiple births, births missing birth type and stillbirths were excluded. Also excluded were births where the sex was unknown, the maternal age was 50 years or older, the gestational age was less than 22 weeks or more than 45 weeks, the infant was lighter than 500 grams or heavier than 6,000 grams, and the maternal birthplace could not be determined. Because of their small numbers, live births from the territories (i.e., Yukon, the Northwest Territories and Nunavut) and of Canadian-born mothers in the United States were excluded.

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Variable definitions

Perinatal outcomes included preterm birth (PTB), defined as a gestational age from 22 to 36 completed weeks, and mean birth weight at term (39 to 40 gestation weeks). Birth weight and gestational age are the two most studied newborn variables in population-based perinatal research. PTB is a dichotomous adverse outcome and an important indicator for perinatal surveillance in Canada³ since it is associated with infant mortality,

morbidity and chronic conditions later in life.^{11,12} Variations in PTB by finely disaggregated immigrant maternal birthplace have been reported for Ontario,^{13,14} but it is unclear whether these findings can be generalized to other provinces. Unlike with PTB, individual differences in birth weight at term do not necessarily reflect an adverse outcome. However, mean birth weight is sensitive to environmental influences on the normal fetal growth among population groups.¹⁵ Birth weight has the advantage of being measured with high precision and reliability in most settings and therefore represents a suitable outcome to investigate variations among well-defined population subgroups across geographic areas. Although term gestation is usually defined as 37 to 41 weeks, analyses are restricted to full-term gestations (39 to 40 weeks) to further reduce the influence of potential misclassification of gestational age and pathological processes that may occur among early term (37 to 38 weeks) and late term (41 weeks) births.¹⁶⁻¹⁸

The Vital Statistics–Birth Database contains information on maternal country of birth if the mother was born outside Canada, or province of birth if the mother was born in Canada; no information on race or ethnicity is available. Maternal birthplace is therefore conceptualized here as a contextual characteristic reflecting early life and environmental exposures in the source countries, and, in many cases, English or French as a second language. The United Nations classification of world regions¹⁹ was adapted to group births according to maternal countries or regions of birth, when appropriate. Countries represented by more than 10 cases of PTB in every province were considered a sole group (e.g., China, India, Pakistan, Bangladesh, the Philippines, Viet Nam, the United States and the United Kingdom). Countries with lower counts were amalgamated with other countries into geographically homogeneous regions to meet the former criterion. Finally, countries that could not be assigned a region were categorized as “rest of the world.” See Appendix A for the complete classification of countries.

Statistical analysis

The proportion of births to immigrant mothers was calculated by province and calendar year, then plotted. PTB rates and mean birth weight were obtained for each maternal birthplace overall and within each province. Risk ratios were then calculated for PTB using log-binomial models, and mean differences were calculated for birth weight using linear models. Generalized estimating equations with an exchangeable correlation structure accounted for the dependency of observations within provinces in the overall Canadian model. Canadian-born mothers were the reference group for the measures of association, which were minimally adjusted for the infant’s year of birth, the infant’s sex, and maternal age groups (11 to 19 years, 20 to 24 years, 25 to 29 years, 30 to 34 years, 35 to 39 years and 40 to 49 years). In sensitivity analyses, Ontario births were subdivided into three periods, characterized by the presence of birth registration fees. Among vulnerable sub-populations, such as single mothers, these fees lead to the under-registration of live births and the potential underestimation of PTB rates.^{3,20} These periods are defined as follows: fees in all municipalities (2000 to 2006), fees progressively eliminated (2007 to 2009) and fees completely eliminated (2010 to 2016). Counts were rounded to the nearest multiple of five. All analyses were conducted using SAS 9.4 (SAS Institute, Cary, North Carolina) at the research data centre located at the University of Manitoba in Winnipeg, Manitoba, Canada.

Results

During the 17-year period from 2000 to 2016, there were 6,158,520 live births in Canada. Among those, 326,940 (5.3%) birth records were excluded because they met one or more of the following exclusion criteria: stillborn and unknown stillborn status ($n = 14,525$); multiple births and unknown or missing data on multiple births ($n = 193,530$); mother’s age older than 49 years ($n = 2,620$); unknown infant sex ($n = 165$); gestational age less than 22 weeks or more

What is already known on this subject?

- Studies on differences in perinatal outcomes between immigrant groups and non-immigrants provide conflicting results because of the heterogeneity of study populations and methodological approaches.
- Little is known about the comparability of birth outcomes of immigrants across Canadian provinces.

What does this study add?

- A single national dataset was used to compare provincial temporal trends and disparities in birth outcomes according to maternal birthplace, thereby overcoming problems associated with the heterogeneity of data sources and methodological approaches.
- The proportion of births to immigrants reached 30% in 2016 for the first time in Canada, but occurred unevenly across the provinces.
- Disparities in PTB rates between immigrant and non-immigrant groups were moderate, with some variations between provinces. However, disparities in birth weight were large and had a similar direction and magnitude across provinces for most immigrant groups.
- Deviations from the national pattern may reflect province-specific immigration dynamics.

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than 45 weeks ($n = 3,465$); missing gestational age ($n = 8,755$); infant birth weight less than 500 grams or more than 6,000 grams ($n = 6,955$); missing birth weight ($n = 4,980$); unknown or missing mother's place of birth ($n = 87,275$); infant born in the United States ($n = 330$); and infant born in Yukon, the Northwest Territories or Nunavut ($n = 26,195$, of whom 6.8% were born to immigrant mothers). The final cohort included 5,831,580 live births.

In the study cohort, Canadian-born mothers had 4,268,745 (73.2%) live births and immigrant mothers had 1,562,835 (26.8%) (Table 1). Ontario had the largest proportion of births to immigrant mothers (36.0%), followed by British Columbia (33.9%). Atlantic Canada was the only region with a proportion of births to immigrant mothers below 10%.

Overall, the proportion of live births to immigrant mothers increased steadily over the study period, from 23.7% in 2000 to 30.6% in 2016 (Figure 1). Over this period, provinces with higher shares

of immigrants showed a slight increase, from 34.1% to 37.0% in Ontario and from 33.8% to 36.6% in British Columbia. In Alberta, Manitoba, Quebec and Atlantic Canada, the proportion doubled from 2000 to 2016 (18.9% to 34.6% in Alberta, 13.3% to 26.4% in Manitoba, 12.5% to 22.3% in Quebec, and 4.6% to 8.5% in Atlantic Canada). Saskatchewan experienced a nearly fourfold increase, from 5.4% in 2000 to 19.9% in 2016.

Table 2 describes the associations between maternal birthplace and PTB. When immigrant mothers from the 20 immigrant groups were compared with Canadian-born mothers at the national level, PTB rates were lower for 10 groups (i.e., China, the rest of Eastern Asia, the rest of Southern Asia, Western and Central Asia, Northern Africa, Central America, the United States, Eastern Europe, the United Kingdom and the rest of Western Europe), higher for 7 groups (India, Bangladesh, the Philippines, Viet Nam, the rest of Southeastern Asia, the Caribbean and the rest of the world), and non-significantly different for the

remaining 3 groups (Pakistan, Sub-Saharan Africa and South America).

Disparities observed at the national level were also observed across most provinces, but did not always achieve statistical significance given the small effect sizes and small population sizes in some provinces. A few deviations from the general pattern must be noted. First, the PTB rate among Central American mothers was slightly lower than the rate among Canadian-born mothers overall, driven by Manitoba (adjusted risk ratio [ARR]: 0.71; 95% confidence interval [CI]: 0.62, 0.81) and Ontario (ARR: 0.88; 95% CI: 0.84, 0.93), but it was higher in Quebec (ARR: 1.13; 95% CI: 1.04, 1.23). Second, the PTB rates among mothers from India and Pakistan did not differ from the rate among Canadian-born mothers across most provinces, except Alberta and Quebec, where their PTB rates were higher. The PTB rate among South American mothers was higher only in Ontario (ARR: 1.15; 95% CI: 1.11, 1.20).

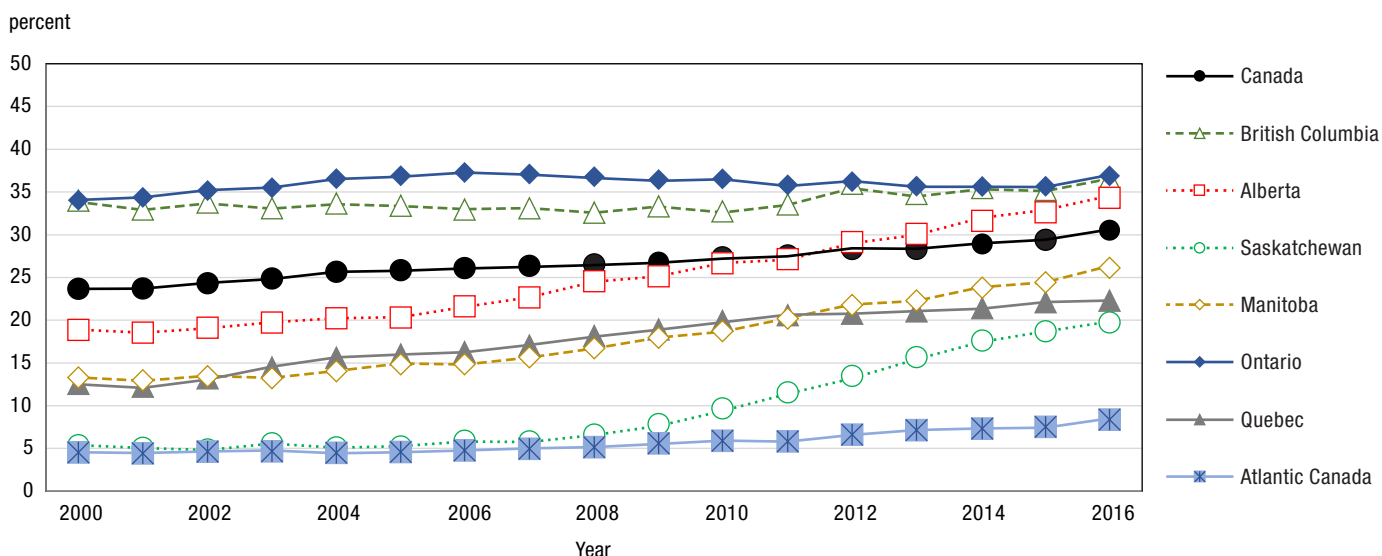
Table 1
Number and percentage of singleton births by maternal country of birth and infant's province of birth, Canada, 2000 to 2016

Mother's birthplace	Infant's province of birth															
	Canada		British Columbia		Alberta		Saskatchewan		Manitoba		Ontario		Quebec		Atlantic Canada	
	Live births	%	Live births	%	Live births	%	Live births	%	Live births	%	Live births	%	Live births	%	Live births	%
Canada	4,268,745	73.2	462,355	66.1	579,025	74.5	202,935	90.0	211,510	81.8	1,436,855	64.0	1,037,375	82.0	338,690	94.3
Outside Canada, overall	1,562,835	26.8	236,780	33.9	198,660	25.5	22,630	10.0	47,090	18.2	808,850	36.0	228,475	18.0	20,350	5.7
China	141,720	2.4	37,620	5.4	12,815	1.6	1,775	0.8	2,255	0.9	74,380	3.3	11,325	0.9	1,550	0.4
Rest of Eastern Asia	64,115	1.1	25,945	3.7	7,480	1.0	560	0.2	815	0.3	26,365	1.2	2,395	0.2	560	0.2
India	169,385	2.9	44,525	6.4	21,950	2.8	1,835	0.8	4,465	1.7	91,695	4.1	4,180	0.3	735	0.2
Pakistan	69,955	1.2	3,520	0.5	9,230	1.2	1,670	0.7	825	0.3	50,070	2.2	4,270	0.3	370	0.1
Bangladesh	16,020	0.3	705	0.1	1,260	0.2	455	0.2	215	0.1	10,265	0.5	2,930	0.2	190	0.1
Rest of Southern Asia	85,035	1.5	7,445	1.1	5,345	0.7	430	0.2	815	0.3	62,935	2.8	7,605	0.6	460	0.1
Philippines	117,955	2.0	22,920	3.3	25,280	3.3	4,210	1.9	9,435	3.6	49,300	2.2	5,755	0.5	1,055	0.3
Viet Nam	47,425	0.8	8,900	1.3	7,850	1.0	600	0.3	1,085	0.4	24,195	1.1	4,575	0.4	220	0.1
Rest of Southeastern Asia	24,045	0.4	5,295	0.8	3,735	0.5	435	0.2	765	0.3	10,570	0.5	3,005	0.2	245	0.1
Western and Central Asia	97,680	1.7	5,910	0.8	11,705	1.5	1,060	0.5	2,555	1.0	55,765	2.5	18,095	1.4	2,585	0.7
Northern Africa	78,450	1.3	1,835	0.3	7,260	0.9	680	0.3	1,050	0.4	15,940	0.7	50,810	4.0	880	0.2
Sub-Saharan Africa	115,125	2.0	7,445	1.1	21,150	2.7	2,055	0.9	4,220	1.6	57,960	2.6	20,940	1.7	1,355	0.4
Caribbean	80,995	1.4	1,480	0.2	2,815	0.4	215	0.1	605	0.2	49,985	2.2	25,505	2.0	395	0.1
Central America	63,685	1.1	6,550	0.9	11,880	1.5	770	0.3	4,705	1.8	30,030	1.3	9,180	0.7	570	0.2
South America	69,880	1.2	4,750	0.7	7,520	1.0	560	0.2	2,745	1.1	41,155	1.8	12,600	1.0	545	0.2
United States	61,710	1.1	11,850	1.7	9,895	1.3	1,790	0.8	2,460	1.0	25,615	1.1	6,340	0.5	3,760	1.0
Eastern Europe	95,355	1.6	10,715	1.5	10,130	1.3	1,330	0.6	3,590	1.4	53,620	2.4	15,140	1.2	835	0.2
United Kingdom	46,745	0.8	10,510	1.5	7,530	1.0	710	0.3	1,230	0.5	23,735	1.1	1,625	0.1	1,405	0.4
Rest of Western Europe	102,255	1.8	11,940	1.7	10,700	1.4	1,265	0.6	3,080	1.2	51,680	2.3	21,305	1.7	2,280	0.6
Rest of the world [†]	15,300	0.3	6,925	1.0	3,130	0.4	225	0.1	180	0.1	3,595	0.2	890	0.1	360	0.1

[†] Rest of the world includes countries and regions with less than 10 preterm birth cases, as well as countries that could not be classified into the above groupings.

Source: Statistics Canada, Vital Statistics—Birth Database, 2000 to 2016.

Figure 1
Proportion of singleton live births to immigrant mothers by province, Canada, 2000 to 2016



Source: Statistics Canada, Vital Statistics—Birth Database, 2000 to 2016.

Sensitivity analyses restricted to Ontario revealed low variability in overall PTB rates by period affected by birth registration fees: 5.9% from 2000 to 2006 (fees in all municipalities), 6.2% from 2007 to 2009 (fees in some municipalities), and 6.0% from 2010 to 2016 (no fees). In Ontario, disparities in PTB by maternal birthplace remained virtually unchanged in sensitivity analyses excluding birth years from 2000 to 2006 (data not shown).

Results for mean birth weight differences were more consistent in direction and across geographic areas (Table 3). Overall, mean birth weights among infants born to mothers from all immigrant groups were lower than among infants born to Canadian-born mothers (ranging from -294 to -25 grams), except among those born to immigrant mothers from the United States, who had lower birth weights only in Ontario (adjusted mean differences [AMD]: -13; 95% CI: -20, -6). This association was observed for 13 of the 19 immigrant groups with infants with lower birth weights at the national level (i.e., China, the rest of Eastern Asia, India, Pakistan, Bangladesh, the rest of Southern Asia, the Philippines, Viet Nam, the rest of Southeastern Asia, Western and Central

Asia, Sub-Saharan Africa, the Caribbean and South America) in all seven province groups. Infants born to mothers from Northern Africa and the United Kingdom showed lower mean birth weights in six provinces, and infants born to mothers from Central America, Eastern Europe, the rest of Western Europe and the rest of the world had lower mean birth weights in five provinces. Despite the general consistency of results, there were a few deviations from the general pattern. Infants born to mothers from Northern Africa and Eastern Europe had higher birth weights than those of Canadian-born mothers in Quebec (AMD: 28; 95% CI: 23, 32; and 11; 95% CI: 3, 20, respectively). Infants born to mothers from Central America had higher birth weights only in Atlantic Canada (AMD: 58; 95% CI: 10, 106).

Discussion

In a standardized national population-based dataset, the proportion of births to immigrant mothers increased in recent years, surpassing the 30% mark for the first time in 2016. However, increases were uneven across the provinces. The greatest increases occurred in the Prairie provinces, most notably

in Saskatchewan. In contrast, historically high-immigration provinces such as Ontario and British Columbia experienced marginal increases in the proportion of live births to immigrant mothers, possibly reflecting a ceiling effect. Findings also suggest that the comparability of disparities in birth outcomes between immigrant groups and the Canadian-born group across provinces is outcome-specific. Compared with PTB rates among Canadian-born mothers, PTB rates among immigrants were only significantly higher across all provinces for mothers from the Philippines, and lower for those from the United States and China, with mixed results for the remaining source countries. In contrast, for mean birth weight, most immigrant groups had consistently lighter infants than the Canadian-born group across provinces, which suggests a high degree of generalizability of maternal birthplace-specific birth weight data across Canada.

Regions with historical low levels of immigration, such as the Prairies, have seen a dramatic increase in their share of births to immigrant mothers in recent years and are becoming more diverse. In 2000, less than 20% of births were to immigrant mothers in five out of the

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Table 2
Associations between maternal birthplace and preterm birth by infant's province of birth, 2000 to 2016 (N = 5,831,580)

Mother's birthplace	Infant's province of birth											
	Canada			British Columbia			Alberta			Saskatchewan		
	PTB %	95% LCI	95% UCI	PTB %	95% LCI	95% UCI	PTB %	95% LCI	95% UCI	PTB %	95% LCI	95% UCI
Canada [†]	6.16	6.13	6.18	5.90	5.83	5.97	6.81	6.75	6.88	5.99	5.89	6.09
	ARR	95% LCI	95% UCI	ARR	95% LCI	95% UCI	ARR	95% LCI	95% UCI	ARR	95% LCI	95% UCI
China	0.73*	0.71	0.75	0.80*	0.76	0.84	0.78*	0.72	0.84	0.69*	0.55	0.87
Rest of Eastern Asia	0.80*	0.77	0.83	0.79*	0.75	0.84	0.83*	0.75	0.92	0.90	0.63	1.29
India	1.03*	1.01	1.05	1.00	0.95	1.04	1.14*	1.09	1.20	0.91	0.74	1.11
Pakistan	1.02	0.99	1.05	0.88	0.75	1.02	1.13*	1.05	1.22	1.12	0.93	1.35
Bangladesh	1.32*	1.25	1.40	1.82*	1.42	2.32	1.67*	1.40	2.00	1.09	0.76	1.58
Rest of Southern Asia	0.96*	0.93	0.99	0.89*	0.81	0.99	0.89	0.80	1.00	1.23	0.86	1.76
Philippines	1.45*	1.42	1.48	1.40*	1.33	1.47	1.51*	1.45	1.57	1.41*	1.26	1.57
Viet Nam	1.06*	1.02	1.10	1.11*	1.02	1.21	1.14*	1.05	1.24	0.83	0.58	1.19
Rest of Southeastern Asia	1.15*	1.09	1.21	1.06	0.94	1.18	1.30*	1.16	1.46	1.45*	1.04	2.02
Western and Central Asia	0.79*	0.77	0.81	0.81*	0.72	0.91	0.84*	0.77	0.90	0.92	0.70	1.19
Northern Africa	0.69*	0.67	0.72	0.79*	0.63	0.98	0.82*	0.74	0.91	0.83	0.59	1.16
Sub-Saharan Africa	0.98	0.95	1.00	0.93	0.84	1.03	0.95	0.90	1.01	0.87	0.72	1.05
Caribbean	1.39*	1.35	1.42	1.12	0.91	1.37	1.42*	1.25	1.61	0.98	0.56	1.71
Central America	0.93*	0.90	0.96	1.01	0.91	1.12	0.93	0.87	1.00	1.13	0.85	1.49
South America	1.03	1.00	1.06	0.87*	0.77	0.99	0.94	0.85	1.03	0.81	0.56	1.18
United States	0.82*	0.80	0.85	0.80*	0.74	0.87	0.79*	0.73	0.87	0.78*	0.63	0.97
Eastern Europe	0.81*	0.79	0.84	0.72*	0.66	0.79	0.85*	0.78	0.93	0.88	0.70	1.12
United Kingdom	0.91*	0.88	0.95	0.88*	0.81	0.96	0.93	0.84	1.02	0.63*	0.44	0.92
Rest of Western Europe	0.78*	0.75	0.80	0.77*	0.71	0.84	0.83*	0.77	0.90	0.76*	0.58	0.98
Rest of the world [‡]	1.18*	1.11	1.25	1.31*	1.19	1.43	1.18*	1.03	1.34	0.94	0.54	1.65

Mother's birthplace	Manitoba			Ontario			Quebec			Atlantic Canada		
	PTB %	95% LCI	95% UCI	PTB %	95% LCI	95% UCI	PTB %	95% LCI	95% UCI	PTB %	95% LCI	95% UCI
		ARR	95% LCI	95% UCI	ARR	95% LCI	95% UCI	ARR	95% LCI	95% UCI	ARR	95% LCI
Canada [†]	6.99	6.88	7.10	6.01	5.97	6.04	5.96	5.91	6.00	6.22	6.14	6.30
China	0.64*	0.53	0.78	0.71*	0.68	0.73	0.72*	0.66	0.79	0.88	0.71	1.09
Rest of Eastern Asia	0.71*	0.52	0.96	0.83*	0.78	0.87	0.88	0.74	1.06	0.63*	0.42	0.96
India	1.00	0.89	1.12	1.03	1.00	1.06	1.24*	1.11	1.40	1.14	0.86	1.51
Pakistan	0.94	0.72	1.23	1.00	0.96	1.04	1.21*	1.08	1.36	0.77	0.48	1.23
Bangladesh	0.96	0.57	1.63	1.25*	1.16	1.35	1.47*	1.29	1.68	1.10	0.63	1.94
Rest of Southern Asia	0.80	0.60	1.07	0.99	0.96	1.03	1.07	0.97	1.17	0.64	0.40	1.01
Philippines	1.32*	1.23	1.42	1.42*	1.37	1.47	1.36*	1.23	1.49	1.40*	1.13	1.74
Viet Nam	1.00	0.79	1.25	1.01	0.96	1.06	1.10	0.98	1.24	1.51	0.95	2.39
Rest of Southeastern Asia	0.94	0.71	1.24	1.12*	1.04	1.21	1.23*	1.07	1.42	1.24	0.78	1.98
Western and Central Asia	0.57*	0.47	0.69	0.80*	0.77	0.84	0.76*	0.71	0.82	0.87	0.73	1.03
Northern Africa	0.70*	0.53	0.92	0.71*	0.66	0.77	0.70*	0.67	0.73	0.76	0.56	1.03
Sub-Saharan Africa	0.94	0.83	1.06	0.99	0.95	1.02	1.00	0.95	1.07	1.05	0.85	1.31
Caribbean	1.26	0.95	1.66	1.42*	1.37	1.46	1.48*	1.41	1.55	1.04	0.70	1.55
Central America	0.71*	0.62	0.81	0.88*	0.84	0.93	1.13*	1.04	1.23	0.70	0.47	1.04
South America	0.69*	0.58	0.82	1.15*	1.11	1.20	0.92*	0.85	0.99	0.98	0.69	1.39
United States	0.74*	0.62	0.88	0.86*	0.81	0.91	0.84*	0.75	0.94	0.83*	0.72	0.96
Eastern Europe	0.67*	0.58	0.78	0.83*	0.80	0.87	0.87*	0.80	0.93	0.95	0.71	1.26
United Kingdom	0.59*	0.45	0.78	0.97	0.92	1.03	0.69*	0.54	0.88	0.81	0.64	1.02
Rest of Western Europe	0.74*	0.64	0.87	0.81*	0.78	0.85	0.70*	0.66	0.75	0.89	0.74	1.06
Rest of the world [‡]	0.50	0.24	1.07	1.03	0.90	1.18	0.96	0.72	1.28	1.66*	1.18	2.35

* significantly different from reference category (p < 0.05)

[†] Reference category for ARR is mothers born in Canada

[‡] Rest of the world includes countries and regions with less than 10 preterm birth cases, as well as countries that could not be classified into the above groupings.

PTB = preterm birth

ARR = adjusted relative risk

LCI = lower confidence interval

UCI = upper confidence interval

Notes: Adjusted for infant's birth year, infant's sex and mother's age (11 to 19 years, 20 to 24 years, 25 to 29 years, 30 to 34 years, 35 to 39 years and 40 to 49 years).

Source: Statistics Canada, Vital Statistics—Birth Database, 2000 to 2016.

Table 3

Associations between maternal birthplace and birth weight at term (39 to 40 weeks) by infant's province of birth, 2000 to 2016
(N = 3,234,165)

Mother's birthplace	Infant's province of birth											
	Canada			British Columbia			Alberta			Saskatchewan		
	mean BW	95% LCI	95% UCI	mean BW	95% LCI	95% UCI	mean BW	95% LCI	95% UCI	mean BW	95% LCI	95% UCI
Canada [†]	3,509	3,509	3,510	3,527	3,526	3,528	3,488	3,487	3,489	3,549	3,547	3,552
	AMD	95% LCI	95% UCI	AMD	95% LCI	95% UCI	AMD	95% LCI	95% UCI	AMD	95% LCI	95% UCI
China	-133*	-136	-130	-161*	-167	-156	-146*	-155	-136	-148*	-175	-121
Rest of Eastern Asia	-209*	-214	-205	-235*	-242	-228	-212*	-225	-199	-190*	-239	-141
India	-206*	-209	-203	-184*	-190	-179	-214*	-222	-206	-268*	-296	-240
Pakistan	-203*	-207	-198	-187*	-206	-168	-216*	-228	-204	-271*	-300	-242
Bangladesh	-294*	-303	-284	-308*	-352	-263	-316*	-350	-282	-372*	-428	-316
Rest of Southern Asia	-136*	-140	-132	-127*	-140	-114	-141*	-157	-126	-135*	-191	-79
Philippines	-202*	-206	-199	-212*	-220	-204	-203*	-210	-195	-249*	-269	-230
Viet Nam	-225*	-230	-219	-248*	-260	-237	-245*	-258	-232	-323*	-369	-277
Rest of South Eastern Asia	-178*	-185	-170	-179*	-194	-163	-197*	-216	-178	-152*	-208	-97
Western and Central Asia	-98*	-102	-94	-129*	-143	-114	-103*	-113	-92	-160*	-196	-124
Northern Africa	-47*	-51	-43	-83*	-109	-56	-130*	-143	-117	-125*	-169	-81
Sub-Saharan Africa	-92*	-96	-89	-109*	-122	-96	-88*	-96	-80	-132*	-159	-106
Caribbean	-127*	-132	-123	-96*	-126	-67	-122*	-144	-100	-163*	-241	-85
Central America	-35*	-40	-31	-92*	-106	-78	-25*	-36	-14	-136*	-179	-94
South America	-97*	-102	-93	-79*	-95	-63	-45*	-58	-32	-110*	-158	-61
United States	4	0	9	5	-6	15	9	-3	20	3	-24	30
Eastern Europe	-26*	-30	-22	-40*	-51	-29	-48*	-59	-37	-48*	-79	-17
United Kingdom	-25*	-31	-20	-35*	-46	-24	-17*	-30	-4	-62*	-107	-17
Rest of Western Europe	-25*	-29	-22	-21*	-31	-11	0	-11	10	-44*	-77	-11
Rest of the world [‡]	-87*	-97	-78	-145*	-159	-131	-93*	-114	-72	-39	-120	42

Mother's birthplace	Manitoba			Ontario			Quebec			Atlantic Canada		
	mean BW	95% LCI	95% UCI	mean BW	95% LCI	95% UCI	mean BW	95% LCI	95% UCI	mean BW	95% LCI	95% UCI
Canada [†]	3,553	3,551	3,556	3,506	3,505	3,507	3,490	3,489	3,491	3,557	3,555	3,559
	AMD	95% LCI	95% UCI	AMD	95% LCI	95% UCI	AMD	95% LCI	95% UCI	AMD	95% LCI	95% UCI
China	-182*	-207	-157	-147*	-151	-143	-55*	-65	-45	-151*	-180	-123
Rest of Eastern Asia	-201*	-242	-161	-224*	-230	-217	-157*	-179	-136	-201*	-249	-153
India	-256*	-274	-237	-236*	-240	-232	-181*	-198	-164	-241*	-283	-198
Pakistan	-269*	-311	-227	-214*	-219	-208	-123*	-139	-106	-233*	-293	-173
Bangladesh	-366*	-455	-278	-306*	-318	-294	-228*	-248	-208	-314*	-402	-225
Rest of Southern Asia	-205*	-247	-164	-154*	-159	-150	-67*	-79	-54	-221*	-273	-169
Philippines	-255*	-268	-242	-211*	-216	-205	-147*	-162	-133	-192*	-229	-155
Viet Nam	-268*	-304	-232	-228*	-236	-221	-165*	-181	-149	-219*	-295	-144
Rest of South Eastern Asia	-220*	-264	-176	-189*	-201	-178	-156*	-176	-135	-140*	-213	-68
Western and Central Asia	-32*	-55	-9	-112*	-116	-107	-37*	-45	-29	-198*	-220	-175
Northern Africa	-132*	-170	-95	-107*	-116	-98	28*	23	32	-83*	-121	-45
Sub-Saharan Africa	-117*	-136	-99	-108*	-113	-103	-33*	-41	-25	-67*	-100	-35
Caribbean	-154*	-203	-105	-149*	-154	-143	-65*	-72	-58	-99*	-160	-39
Central America	-1	-18	16	-37*	-44	-30	-36*	-48	-25	58*	10	106
South America	-59*	-82	-36	-139*	-144	-133	-15*	-25	-6	-134*	-183	-85
United States	8	-15	32	-13*	-20	-6	-1	-14	13	-14	-32	5
Eastern Europe	9	-10	29	-37*	-42	-32	11*	3	20	-66*	-106	-27
United Kingdom	-44*	-78	-9	-43*	-50	-35	-29*	-56	-3	-14	-45	17
Rest of Western Europe	-38*	-59	-16	-26*	-31	-21	-38*	-45	-30	-22	-46	3
Rest of the world [‡]	-118*	-212	-23	-40*	-59	-21	-61*	-97	-25	-29	-92	33

* significantly different from reference category (p < 0.05)

[†] Reference category for AMDs is mothers born in Canada

[‡] Rest of the world includes countries and regions with less than 10 preterm birth cases, as well as countries that could not be classified into the above groupings.

BW = birth weight

AMD = adjusted mean difference (expressed in grams; adjusted for infant's year of birth and sex)

LCI = lower confidence interval

UCI = upper confidence interval

Notes: Adjusted for infant's birth year, infant's sex and mother's age (11 to 19 years, 20 to 24 years, 25 to 29 years, 30 to 34 years, 35 to 39 years and 40 to 49 years).

Source: Statistics Canada, Vital Statistics—Birth Database, 2000 to 2016.

seven geographic areas, whereas by 2016, only Atlantic Canada was still below 20%. Increasing immigration trends are present among the whole population. The number of legal immigrants increased from 5.4 million in 2001 (18% of Canada's population) to 7.5 million in 2016 (21.9% of Canada's population).^{21,22} These demographic trends have implications for the delivery of perinatal health care, child care and early childhood education. Such services may need to respond to the needs of an unprecedented number of children whose parents were not born in Canada, many of whom may not have been exposed to English or French at home. This is particularly important in provinces where high immigration is a new phenomenon.

Associations for PTB were similar in direction to those reported by Park, Urquia and Ray based on Ontario data, especially for immigrants from the Philippines, Bangladesh and some Caribbean countries.¹⁴ However, the relatively low consistency in PTB rates across provinces may be because of a number of factors. First, factors affecting PTB rates or reporting of gestational age may not have been uniform across provinces. For example, under-registration of live births in Ontario during the 2000s disproportionately affected births to single mothers and births resulting in infant deaths, which are associated with higher PTB rates.^{3,20} It is unknown how this may have affected different immigrant groups. Second, PTB rates do not exhibit large variability between demographic groups, with risk ratios generally staying below 2.^{9,14} In this study, the PTB rate among infants born to Canadian-born mothers was in the middle of the continuum of risk according to maternal birthplace, making disparities small to moderate in either direction. Some estimates of effects may not reach statistical significance in provinces with fewer infants born to immigrant mothers. Third, provincial differences may be affected by characteristics of the Canadian-born population, immigrant groups, or both. For example, the proportion of Indigenous residents varies across

provinces, with the highest proportion living in Manitoba, after the territories.²³ Since Indigenous mothers experience preterm delivery more frequently than non-Indigenous mothers,²⁴ the baseline PTB rate among Canadian-born mothers in Manitoba may be affected. At 7.0%, Manitoba has the highest PTB rate of the Canadian provinces, and therefore the PTB rates among immigrant groups are lower in comparison. Push and pull factors such as language, established ethnic communities, refugee waves, labour market and provincial immigration policies (e.g., provincial nominee programs) may also shape differential patterns of settlement for certain immigrant groups to be attracted to certain provinces.^{9,25,26} For instance, the risk of PTB among Central American mothers may be higher in Quebec and lower in Manitoba and Ontario because presumably less healthy immigrants were attracted to Quebec and disproportionately admitted as refugees (1.9% in Manitoba, 18.1% in Ontario and 32.3% in Quebec of those admitted from 2011 to 2016).²⁷ Likewise, compared with Canadian-born mothers with similar baseline PTB rates in British Columbia, Ontario and Quebec (~6%), South American mothers were at higher risk of PTB in Ontario but at lower risk in British Columbia and Quebec. Ontario results did not change after excluding years potentially affected by under-registration of births. These contrasting patterns may be driven by various factors, such as a different composition of source countries within the region in each province. Immigrants from Guyana, who were at increased risk of PTB,¹⁴ accounted for 38% of births to South Americans in Ontario but only 2% of those in Quebec and 4% of those in British Columbia. Cohort effects²⁸ may also influence differences between provinces. For example, 54% of all South American immigrants to Ontario from 1980 to 2016 arrived before 2001, compared with 30% of those in Quebec and 38% of those in British Columbia.²⁷ This means that many South American immigrants in Ontario are part of an earlier cohort and have been in Canada longer

than their counterparts in other provinces. Because time since immigration has been associated with increases in PTB among Latin American immigrants in Ontario,⁹ cohort effects are plausible.

In contrast, results for birth weight were much more consistent across geographic areas and robust against the potential sources of variability noted above. Restricting mean birth weight to a favourable gestation period (weeks 39 and 40) likely helped reduce confounding by gestational age. Exceptions to the general pattern likely reflect particular dynamics that affect specific immigrant subgroups. For example, 65% of all births to Northern African mothers occurred in Quebec, the only province where infants born to Northern African mothers had higher birth weights than those of the Canadian-born mothers. It is possible that this exception is related to self-selection, with healthier immigrants settling in Quebec based on French language affinity and established ethnic communities. Francophone Northern African mothers who settle in English-speaking provinces may differ in social support and other birth weight determinants. Likewise, Caribbean immigrants who settle in Quebec are predominantly Haitian,²⁹ and those who settle in Ontario are predominantly Jamaican.¹³ Although infants born to Caribbean-born mothers were lighter than infants born to Canadian-born mothers in all provinces, the difference was smallest in Quebec. A systematic overview found that the birth weights of infants born to immigrant mothers in Canada were higher than those of infants born to mothers who did not migrate and gave birth in their home countries.³⁰ This suggests that selection factors, health care differences and living conditions could have contributed to higher birth weights associated with migration to Canada. Despite this phenomenon, lower birth weights for most immigrant groups were consistently observed in the data.

This study has unique strengths. The use of a single national dataset to compare provincial temporal trends and disparities in birth outcomes by maternal birthplace

overcomes problems associated with the heterogeneity of data sources and methodological approaches, including variable definitions, comparison groups and study periods. The large sample size also allowed the top 20 immigrant groups to be examined for Canada and across the provinces.

There are several limitations to this study as well. Birth registrations do not contain Indigenous identifiers. The Canadian-born reference groups may include varying proportions of Indigenous populations, which may have contributed to higher rates of PTB among Canadian-born mothers in some provinces, thereby affecting the comparability of differences across provinces. The exclusion of the territories may have somewhat buffered the impact of Indigenous people on the results since the highest proportions of Indigenous people living in Canada are found in the territories. However, this impact would be small given the low numbers of births in the territories. Birth registrations also lack information on refugee status and the year mothers immigrated to Canada, which may account for differing exposure

to the Canadian social environment and cohort effects.³¹ PTB, along with other perinatal health indicators, is known to deteriorate with time since migration to Canada,³² particularly among immigrants living in deprived neighborhoods.³¹ The data contained information on paternal birthplace, but this was not used since it was incomplete. As information on parental race or ethnicity is not available, results apply only to births to first-generation immigrant mothers. The Vital Statistics–Birth Database does not contain information on the methods used to determine gestational age and whether these methods differ by province. Under-registration of live births in Ontario may have contributed to overall lower-than-expected PTB rates before 2007, but excluding this period did not noticeably affect associations between maternal birthplace and PTB in Ontario.

Conclusions

For the first time in modern Canadian history, births to immigrant mothers surpassed 30% of all births in 2016. The share of births to immigrants reached more than 20% in most provinces.

Differences in birth outcomes between various immigrant groups and the Canadian-born group were consistently observed across provinces for mean birth weight, but less consistently for PTB. Birth weight and gestational age are the two most studied perinatal variables available in birth registration data. These findings can be used to guide the interpretation of results and claims of generalizability of immigration-related birth outcomes at different levels of Canadian geography in future studies.

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