

Birth and postnatal outcomes among infants of immigrant parents of different admission categories and parents born in Canada: a population-based retrospective study

Seungmi Yang PhD, Gabriel D. Shapiro PhD, Edward Ng PhD, Bilkis Vissandjée PhD, Zoua M. Vang PhD

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Abstract

Background: Most studies of disparities in birth and postnatal outcomes by parental birthplace combine all immigrants into a single group. We sought to evaluate heterogeneity among immigrants in Canada by comparing birth and postnatal outcomes across different immigration categories.

Methods: We conducted a population-based retrospective study using Statistics Canada data on live births and stillbirths (1993–2017) and infant deaths (1993–2018), linked to parental immigration data (1960–2017). We classified birthing parents as born in Canada, economic-class immigrants, family-class immigrants, or refugees, and evaluated differences in preterm births,

small-for-gestational-age (SGA) and large-for-gestational-age (LGA) births, stillbirths, and infant deaths among singleton births by group.

Results: Among 7 980 650 births, 1 715 050 (21.5%) were to immigrants, including 632 760 (36.9%) in the economic class, 853 540 (49.8%) in the family class, and 228 740 (13.4%) refugees. Compared with infants of Canadian-born birthing parents, infants of each of the 3 immigrant groups had higher risk of preterm birth, SGA birth, and stillbirth, but lower risk of LGA birth and neonatal death. Compared with infants of economic-class immigrants, infants of refugees had higher risk of early preterm birth (0.9% v. 0.8%,

adjusted risk ratio [RR] 1.08, 95% confidence interval [CI] 1.01–1.15) and LGA birth (9.2% v. 7.5%, adjusted RR 1.12, 95% CI 1.10–1.15), but lower risk of SGA birth (10.2% v. 11.0%, adjusted RR 0.92, 95% CI 0.90–0.94), while infants of family-class immigrants had higher risk of SGA birth (12.2% v. 11.0%, adjusted RR 1.01, 95% CI 1.00–1.02). Risk of stillbirth, neonatal death, and overall infant death did not differ significantly among immigrant groups.

Interpretation: Heterogeneity exists in outcomes of infants born to immigrants to Canada across immigration categories. These results highlight the importance of disaggregating immigrant populations in studies of health disparities.

Nearly 1 in 4 (23%) people in Canada are immigrants and this number is projected to reach 1 in 3 within 20 years.¹ Immigrant populations are not homogeneous, and their lived experiences before immigration, underlying reasons for immigration, and resettlement experiences after immigration vary.² These differences, in turn, contribute to variations in subsequent post-migration health outcomes.^{3–5} The healthy immigrant effect — the health advantage of immigrants owing to health selection that decreases over time after immigration — has often been provided as an explanation for favourable outcomes among immigrants. However, the healthy immigrant effect is not universal, and results vary across countries, immigrant characteristics, and outcomes.^{6–10}

Perinatal health outcomes have shown differences by immigration status in various countries, including Canada.^{8,11–14} However, most previous studies have combined all immigrants into a single group, masking heterogeneity within the foreign-born population,^{15,16} or have focused on refugees versus non-refugee immigrants.^{17–19} A small number of studies have also shown variations in perinatal health outcomes by refugee status and by migration route (i.e., direct migration from their country of origin v. via a transit country).^{20,21}

Disaggregating immigrants is thus important to better understand health variations. Immigrants to Canada are mostly admitted in 1 of 3 immigration categories, namely the economic class for those selected based on their potential to contribute to Canada's

economy (e.g., skills and abilities), the family class for reunification with a family member who is a Canadian citizen or permanent resident, and the refugee class. Resettlement experiences among immigrants would thus vary across these immigration pathways.

We therefore aimed to evaluate differences in adverse birth and postnatal outcomes among infants born to immigrants by immigration admission category, compared with those of Canadian-born parents, accounting for sociodemographic characteristics, to potentially aid health care providers and policy-makers in improving service organization for diverse immigrant communities. We also sought to compare differences in outcomes within the immigrant population, accounting for characteristics at landing, to further explore potential heterogeneity among foreign-born people in Canada.

Methods

Study population

We used data from the Migrant Maternal and Infant Morbidity and Mortality (MMIMM) study, which includes live births and stillbirths from Jan. 1, 1993, to Dec. 31, 2017, and infant deaths from Jan. 1, 1993, to Dec. 31, 2018, from Canadian Vital Statistics databases, linked with the Longitudinal Immigration Database (IMDB),²² which contains immigration records from Jan. 1, 1960, to Dec. 31, 2017. Data were linked according to information on birthing parents, identified from vital statistics records using probabilistic linkage^{23,24} in the Social Data Linkage Area at Statistics Canada in its secure central depository, the Derived Record Depository.²⁵ Canadian Vital Statistics data captures all births and deaths from all 10 provinces and 3 territories. Details of data sources are in Appendix 1, available at www.cmaj.ca/lookup/doi/10.1503/cmaj.230878/tab-related-content. Linkage rates to the Derived Record Depository were 95.9% for live births, 81.1% for stillbirths, 82% for infant deaths, and 96.2% for immigration files in the MMIMM.²³ We excluded births for which the birthing parent's immigration category was not available (e.g., immigrants who arrived before 1980, temporary residents) and non-singleton births (because of different underlying mechanisms of adverse outcomes, compared with singleton births,^{26–28} and the small number of outcomes when stratified by immigration category).

Measures

We determined immigration categories using the admission records in the IMDB. We classified birthing parents without an immigration record as born in Canada, confirmed by the country of birth listed on their birth records.

Non-fatal outcomes derived from live birth records included preterm birth (< 37 wk gestation), early preterm birth (< 32 wk gestation), and moderate-to-late preterm birth (32–36 wk gestation), as well as small-for-gestational-age (SGA) birth and large-for-gestational-age (LGA) birth (defined as birth weight below the 10th and above the 90th percentile, respectively, of sex- and gestational age-specific thresholds based on the Canadian reference²⁹). Data on stillbirth (registered for births at ≥ 20 wk gestation or birth weight ≥ 500 g, except in Quebec, where only the

birth weight criterion applies) and infant death (overall death in first year, neonatal death [< 28 d], and post-neonatal death [28–364 d]) were from vital statistics stillbirths and deaths records, respectively. Because stillbirths were under-reported in our data set for the province of Ontario in 1998 and 1999 (< 20 stillbirths each v. > 310 stillbirths in every other year), analyses for stillbirth excluded Ontario births from these years. We also evaluated stillbirth at 25 weeks' gestation or later to better capture spontaneous fetal deaths, excluding potential late pregnancy terminations.^{30,31}

Covariates included birthing parent age, parity, and marital status; non-birthing parent age and place of birth (Canada or outside of Canada); and year and province or territory of the infant's birth based on birth records, which were available for all births. For comparisons among immigrants only, we included birthing parent age, knowledge of official languages at landing, world region of origin, duration of residence in Canada between landing and birth, and family size-adjusted household income in the year before the birth from tax records, which were all available in the IMDB.

Statistical analysis

We compared rates of adverse outcomes between births to Canadian-born and immigrant birthing parents (all immigrants as a single group), and between those to immigrant parents only by immigration category. We estimated risk ratios and risk differences based on predictions of the risk ratio (RR) models for outcomes using generalized estimating equations models, accounting for clustering by birthing parent, before and after adjustment for parental age, marital status, parity, non-birthing parent's birthplace, and year and province or territory of the infant's birth. To evaluate whether heterogeneity of outcomes within the immigrant population was explained by characteristics at the time of landing, we also adjusted for these characteristics in the analysis of immigrants only. We then further adjusted for family income to account for economic circumstances before birth among immigrants. We used economic-class immigrants as the reference because this group had the lowest adverse outcome rates among immigrants in our data.

To evaluate the robustness of the results, we conducted sensitivity analyses. First, we restricted the sample to the first births of both Canadian-born and immigrant birthing parents to increase comparability between subgroups. Second, we estimated RRs of outcomes among births to immigrant parents, stratified by duration of residence since landing to birth (≤ 5 yr, 6–9 yr, ≥ 10 yr), versus those to Canadian-born parents, to evaluate whether the patterns of association varied by duration of residence in Canada and immigration category.³²

Results

Our analytic sample included 7 980 650 births to 4 519 980 birthing parents (Figure 1 and Table 1). Immigrants gave birth to 1 715 050 (21.5%) of these infants, among whom 853 540 (49.8%) were born to family-class immigrants, 632 760 (36.9%) to economic class-immigrants, and 228 740 (13.3%) to refugees (Table 1).

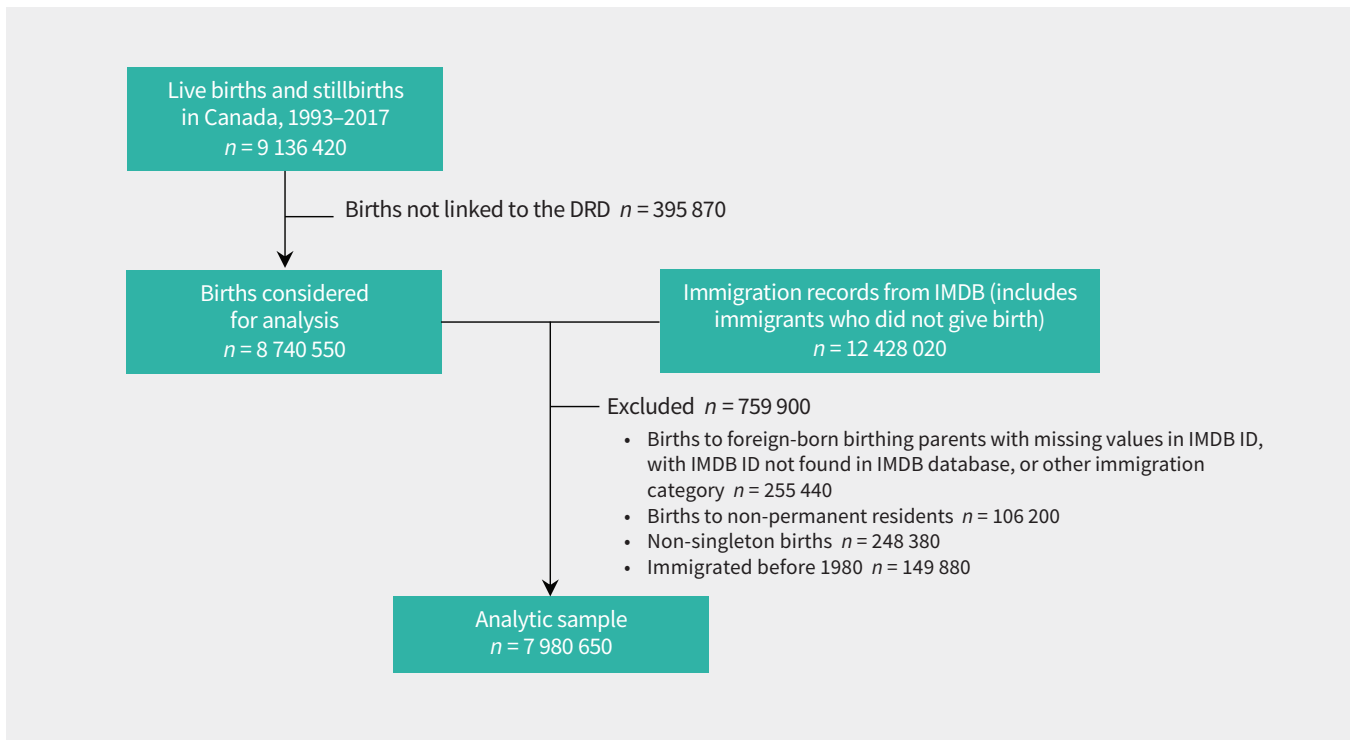


Figure 1: Study flow diagram. Note: DRD = Derived Record Depository, ID = identification number, IMDB = Longitudinal Immigration Database.

Although immigrants were more frequently married at the time of the birth than Canadian-born parents, refugees were more often unmarried (19.0%) than immigrants of other categories (< 10%). Refugees were more likely to be multiparous, while economic-class immigrants were more likely to be aged 35 years or older at the time of delivery, compared with other immigrant categories or Canadian-born birthing parents. Refugees also originated more frequently from African or Middle Eastern countries, were younger and had lower education levels at landing, and had lower household income than economic- and family-class immigrants (Table 2).

Compared with Canadian-born birthing parents, rates of preterm birth, SGA birth, and stillbirth were higher among immigrants, while rates of LGA birth and infant mortality were lower (Table 3). However, we observed heterogeneity when immigrants were disaggregated by immigration category. Compared with Canadian-born birthing parents, the risk of preterm birth was highest among refugees (RR 1.13, 95% confidence interval [CI] 1.11–1.16), followed by family-class immigrants (RR 1.11, 95% CI 1.09–1.12) and economic-class immigrants (RR 1.04, 95% CI 1.02–1.05), after adjusting for sociodemographic characteristics (Figure 2), with larger differences observed for early preterm birth. The risk of early preterm birth remained higher among refugees than economic class immigrants (RR 1.08, 95% CI 1.01–1.15) after further adjustment for immigration characteristics at the time of landing and family income (Figure 3). Results expressed as risk differences are presented in Appendix 1, eFigures 1 and 2.

The adjusted risk of SGA birth was highest among family-class immigrants (RR 1.45, 95% CI 1.43–1.46) and lowest among refugees (RR 1.19, 95% CI 1.17–1.21) (Figure 2). Although these immigrant

subgroup differences were attenuated after further adjustment for immigration characteristics at landing, the overall pattern of differences remained similar (Figure 3). All 3 immigrant groups were less likely to have LGA births than Canadian-born birthing parents (Figure 2). When compared within immigrants (Figure 3), the risk of LGA birth among refugees remained highest after accounting for immigration characteristics.

Risk of stillbirth was also highest among refugees (RR 1.21, 95% CI 1.10–1.32), followed by family-class (RR 1.11, 95% CI 1.05–1.18) and economic-class (RR 1.05, 95% CI 0.99–1.12) immigrant birthing parents, relative to those born in Canada (Figure 4). The risk of stillbirth among refugees (v. economic-class immigrants) remained higher after accounting for characteristics at landing but was attenuated with further adjustment for family income at birth (Figure 5). Differences in risks were largely unchanged when we used the alternative definition of stillbirth as occurring at 25 weeks' gestation or later (Appendix 1, eTable 1).

Crude estimates of the risk of overall infant death were lower among all immigrant birthing parents, compared with Canadian-born birthing parents, but differences were eliminated or attenuated after adjustment for sociodemographic characteristics (Figure 4). When neonatal and post-neonatal deaths were evaluated separately, the adjusted risk of neonatal death was lower among immigrants, while the risk of post-neonatal death did not differ significantly between immigrant and Canadian-born birthing parents, primarily reflecting differences in characteristics of birthing parents (Appendix 1, eTable 4). However, the risk of post-neonatal death remained higher among family-class immigrants than Canadian-born birthing parents (RR 1.11, 95% CI 1.00–1.23) and was also higher

Table 1 (part 1 of 2): Characteristics of births and parents at the time of delivery, by birthing parent immigration category, among singleton births in Canada, 1993–2017

Characteristic	No. (%) of births or birthing parents*†				
	Economic-class immigrants	Family-class immigrants	Refugees	All immigrants	Canadian-born birthing parents
Birth characteristics					
No. of births	632 760	853 540	228 740	1 715 050	6 265 600
Infant sex					
Male	326 390 (51.6)	439 370 (51.5)	116 960 (51.2)	882 740 (51.5)	3 210 790 (51.3)
Female	306 250 (48.4)	413 970 (48.5)	111 710 (48.9)	831 930 (48.5)	3 053 600 (48.8)
Place of birth					
Atlantic‡	7630 (1.2)	7180 (0.8)	1970 (0.9)	16 750 (1.0)	500 060 (8.0)
Quebec	129 470 (20.5)	143 800 (16.9)	42 620 (18.6)	315 900 (18.4)	1 566 480 (25.0)
Ontario	289 510 (45.8)	439 210 (51.5)	125 500 (54.9)	854 220 (49.8)	2 068 290 (33.0)
Western§	106 680 (16.9)	122 340 (14.3)	38 430 (16.8)	267 450 (15.6)	1 410 340 (22.5)
British Columbia	98 800 (15.6)	140 060 (16.4)	20 150 (8.8)	259 000 (15.1)	687 140 (11.0)
Territories	680 (0.1)	950 (0.1)	90 (0.0)	1720 (0.1)	33 320 (0.5)
Year of birth					
1993–1997	66 470 (10.5)	134 550 (15.8)	36 070 (15.8)	237 090 (13.8)	1 333 210 (21.3)
1998–2002	85 470 (13.5)	151 710 (17.8)	35 820 (15.7)	273 000 (15.9)	1 178 320 (18.8)
2003–2007	122 260 (19.3)	178 200 (20.9)	43 040 (18.8)	343 500 (20.0)	1 201 830 (19.2)
2008–2012	156 390 (24.7)	195 760 (22.9)	52 390 (22.9)	404 540 (23.6)	1 291 190 (20.6)
2013–2017	202 170 (32.0)	193 320 (22.7)	61 410 (26.9)	456 900 (26.6)	1 261 060 (20.1)
Parental characteristics					
No. of birthing parents	431 400	487 460	135 900	1 054 750	3 465 230
No. of births in cohort per birthing parent					
1	269 980 (62.6)	222 700 (45.7)	70 990 (52.2)	563 670 (53.4)	1 458 810 (42.1)
2	129 970 (30.1)	188 120 (38.6)	44 620 (32.8)	362 710 (34.4)	1 433 590 (41.4)
3	25 580 (5.9)	58 750 (12.1)	14 860 (10.9)	99 200 (9.4)	424 310 (12.2)
≥ 4	5880 (1.4)	17 870 (3.7)	5420 (4.0)	29 170 (2.8)	148 520 (4.3)
Birthing parent's age at delivery, yr					
< 20	4200 (0.7)	10 490 (1.2)	5,210 (2.3)	19 890 (1.2)	321 290 (5.1)
20–24	31 150 (4.9)	115 010 (13.5)	28 870 (12.6)	175 040 (10.2)	1 109 200 (17.7)
25–29	133 460 (21.1)	283 340 (33.2)	66 780 (29.2)	483 570 (28.2)	2 003 470 (32.0)
30–34	252 530 (39.9)	281 590 (33.0)	75 120 (32.9)	609 260 (35.5)	1 927 240 (30.8)
35–39	169 490 (26.8)	134 850 (15.8)	42 000 (18.4)	346 350 (20.2)	776 050 (12.4)
≥ 40	41 790 (6.6)	27 850 (3.3)	10 590 (4.6)	80 240 (4.7)	126 860 (2.0)
Parity					
0	263 150 (41.8)	366 050 (43.1)	80 000 (35.1)	709 210 (41.6)	2 773 360 (44.8)
1	241 960 (38.5)	306 520 (36.1)	73 530 (32.3)	622 000 (36.5)	2 162 350 (34.9)
≥ 2	123 830 (19.7)	177 030 (20.8)	74 170 (32.6)	375 030 (22.0)	1 254 740 (20.3)

among family-class immigrants than economic-class immigrants (RR 1.19, 95% CI 1.03–1.38) after additional adjustment for characteristics at landing and family income (Figure 5). Causes of infant deaths were generally similar across immigration categories,

although rates of sudden infant death syndrome appeared lower among refugees (Appendix 1, eTable 5). For comparison, associations of other covariates with study outcomes in the primary analysis models are shown in Appendix 1, eTables 6–13.

Table 1 (part 2 of 2): Characteristics of births and parents at the time of delivery, by birthing parent immigration category, among singleton births in Canada, 1993–2017

Characteristic	No. (%) of births or birthing parents*†				
	Economic-class immigrants	Family-class immigrants	Refugees	All immigrants	Canadian-born birthing parents
Marital status					
Married	546 360 (86.3)	726 230 (85.1)	162 720 (71.1)	1 435 290 (83.7)	3 477 720 (55.5)
Unmarried	54 100 (8.6)	77 560 (9.1)	43 440 (19.0)	175 100 (10.2)	2 190 500 (35.0)
Missing	32 310 (5.1)	49 760 (5.8)	22 590 (9.9)	104 650 (6.1)	597 390 (9.5)
Non-birthing parent's age at delivery‡, yr					
< 20	1120 (0.2)	1720 (0.2)	990 (0.4)	3830 (0.2)	96 290 (1.5)
20–24	13 100 (2.1)	30 650 (3.6)	10 280 (4.5)	54 030 (3.2)	606 640 (9.7)
25–29	74 530 (11.8)	142 570 (16.7)	37 160 (16.3)	254 260 (14.8)	1 569 180 (25.0)
30–34	205 900 (32.5)	257 010 (30.1)	65 080 (28.5)	527 990 (30.8)	2 013 250 (32.1)
35–39	199 230 (31.5)	216 800 (25.4)	55 500 (24.3)	471 560 (27.5)	1 124 190 (17.9)
40–44	90 770 (14.4)	110 990 (13.0)	28 770 (12.6)	230 550 (13.4)	366 010 (5.8)
≥ 45	34 260 (5.4)	62 230 (7.3)	13 530 (5.9)	110 020 (6.4)	124 480 (2.0)
Missing	13 830 (2.2)	31 570 (3.7)	17 430 (7.6)	62 820 (3.7)	365 530 (5.8)
Non-birthing parent birthplace					
Canada	96 200 (15.2)	141 820 (16.6)	25 900 (11.3)	263 920 (15.4)	5 339 980 (85.2)
Outside of Canada	482 270 (76.2)	626 430 (73.4)	164 020 (71.7)	1 272 730 (74.2)	479 060 (7.7)
Missing	54 300 (8.6)	85 290 (10.0)	38 820 (17.0)	178 400 (10.4)	446 550 (7.1)
Time between landing and each birth, yr					
< 2	98 940 (15.8)	152 010 (17.9)	24 540 (10.7)	275 490 (16.2)	NA
2–3	127 180 (20.3)	162 670 (19.2)	30 920 (13.5)	320 780 (18.8)	
4–5	98 640 (15.7)	136 430 (16.1)	28 090 (12.3)	263 160 (15.4)	
6–9	118 490 (18.9)	186 040 (21.9)	46 670 (20.4)	351 210 (20.6)	
≥ 10	184 060 (29.3)	211 240 (24.9)	98 350 (43.0)	493 680 (29.0)	
Family size–adjusted household income in the calendar year before each birth (converted to 2002 Canadian dollars), mean (IQR)	37 711 (15 538–49 865)	29 483 (13 970–36 791)	25 496 (10 794–32 291)	31 982 (13 726–40 823)	NA

Note: IQR = interquartile range, NA = not applicable.
*Unless indicated otherwise.
†Numbers were randomly rounded up or down to the nearest 10, according to Statistics Canada disclosure regulations; < 2% of data were missing for maternal age, parity, and infant sex.
‡New Brunswick, Newfoundland and Labrador, Nova Scotia, and Prince Edward Island.
§Alberta, Saskatchewan, and Manitoba.
¶Data on non-birthing parents were missing for 5.8% of births to Canadian-born birthing parents and 3.7% of births for births to immigrant birthing parents. Study identification numbers of birthing parents were provided for all births, enabling the counting of unique birthing parents. However, identification numbers were not provided for non-birthing parents, so we were unable to identify the number of unique non-birthing parents but only the number of births with information on non-birthing parents present or missing in our data.

In a sensitivity analysis limited to first births only, the overall pattern of results was similar to the primary analysis, with the risk of most adverse outcomes being lowest among economic-class immigrants and highest among refugees (Table 4 and Appendix 1, eTable 2). However, in this analysis, the risk of pre-term birth was lower among economic-class immigrants than

Canadian-born birthing parents (adjusted RR 0.95, 95% CI 0.93–0.97) and birthing parents of other immigration categories. The risk of post-neonatal death did not differ significantly by immigration category after full adjustment. In a sensitivity analysis stratified by duration of residence in Canada and immigration category, RRs for immigrant birthing parents as a single group,

Table 2: Immigration characteristics at the time of landing in Canada among immigrant birthing parents by immigration category, 1993–2017

Characteristic	No. (%) of birthing parents*			
	Economic-class immigrants n = 431 400	Family-class immigrants n = 487 460	Refugees n = 135 900	All immigrants n = 1 054 750
World region of origin				
Europe	82 960 (19.2)	53 130 (10.9)	22 490 (16.6)	158 570 (15.0)
Africa and the Middle East	78 650 (18.2)	75 750 (15.5)	45 490 (33.5)	199 880 (19.0)
Southern Asia	62 060 (14.4)	129 800 (26.6)	15 850 (11.7)	207 710 (19.7)
Eastern Asia	90 000 (20.9)	62 130 (12.8)	3740 (2.8)	155 860 (14.8)
Oceania and other Asia	77 220 (17.9)	67 700 (13.9)	26 840 (19.8)	171 770 (16.3)
South and Central America	35 710 (8.3)	79 740 (16.4)	21 020 (15.5)	136 480 (12.9)
United States or other	4800 (1.1)	19 200 (3.9)	470 (0.3)	24 470 (2.3)
Age, yr				
< 5	9080 (2.1)	4680 (1.0)	6660 (4.9)	20 430 (1.9)
5–12	37 440 (8.7)	26 930 (5.5)	19 900 (14.7)	84 290 (8.0)
13–17	30 750 (7.1)	36 920 (7.6)	16 630 (12.3)	84 310 (8.0)
≥ 18	354 010 (82.1)	418 700 (85.9)	92 570 (68.2)	865 290 (82.1)
Education, yr				
< 10	88 900 (20.7)	118 490 (24.5)	67 540 (50.0)	274 910 (26.2)
10–12	52 950 (12.3)	120 890 (25.0)	34 030 (25.2)	207 880 (19.8)
> 12 yr, with non-university diploma	99 030 (23.1)	120 160 (24.8)	24 680 (18.3)	243 880 (23.3)
Bachelor degree	139 960 (32.6)	97 570 (20.1)	7980 (5.9)	245 510 (23.4)
Graduate degree	48 290 (11.3)	27 410 (5.7)	990 (0.7)	76 680 (7.3)
Knowledge of official languages				
English only	248 160 (57.6)	247 580 (50.9)	46 130 (34.0)	541 850 (51.4)
French only	27 660 (6.4)	29 820 (6.1)	10 280 (7.6)	67 760 (6.4)
English and French	51 240 (11.9)	18 900 (3.9)	3640 (2.7)	73 790 (7.0)
Neither English nor French	104 160 (24.2)	190 590 (39.1)	75 610 (55.7)	370 360 (35.2)

*Numbers were randomly rounded up or down to the nearest 10 according to Statistics Canada disclosure regulations; < 2% of data were missing for maternal age at landing.

compared with Canadian-born birthing parents, increased with longer duration in Canada for most outcomes. However, the pattern of associations by duration varied across immigration categories, with the largest changes seen among family-class immigrants (Table 5 and Appendix 1, eTable 3).

Interpretation

In this population-based study, we found that infants born to immigrant birthing parents had increased risk of preterm birth, SGA birth, and stillbirth, and lowered risk of LGA birth and infant death, compared with those born to Canadian-born birthing parents. Moreover, across immigration categories, risk of preterm birth and stillbirth differed, with the lowest risk among births to economic-class immigrants and the highest among births to refugees. Lower risks among economic-class immigrants were

more pronounced among first births. Immigration characteristics at the time of landing explained some of the differences among immigrants, particularly between economic- and family-class immigrants. It is worth noting that the differences in risk by immigration category observed in our study were small in magnitude compared with differences by other known risk factors for adverse birth and postnatal outcomes, such as advanced maternal age and parity.^{33,34}

The heterogeneity across outcomes and by immigrant subgroup observed in our study, particularly the lower risks among economic-class immigrants, is consistent with a small body of existing studies showing differential health care use and experiences by immigration category. Economic-class immigrants use more primary care services than refugees and family-class immigrants, and refugees are less likely to have a regular physician than non-refugees.^{35,36} In addition, the

Table 3: Adverse birth and postnatal outcomes by birthing parent immigration category among singleton births in Canada, 1993–2017 (1993–2018 for postnatal deaths)

Outcome	Economic-class immigrants		Family-class immigrants		Refugees		All immigrants		Canadian-born birthing parents	
	No. of births* n = 632 760	Rate† (95% CI)	No. of births* n = 853 540	Rate† (95% CI)	No. of births* n = 228 740	Rate† (95% CI)	No. of births* n = 1 715 050	Rate† (95% CI)	No. of births* n = 6 265 600	Rate† (95% CI)
Non-fatal outcomes										
Overall preterm birth (< 37 wk)	38 780	6.2 (6.1–6.2)	54 860	6.5 (6.4–6.5)	15 870	7.0 (6.9–7.1)	109 490	6.4 (6.4–6.5)	372 620	6.0 (6.0–6.0)
Moderate–late preterm birth (32–36 wk)	33 780	5.4 (5.3–5.4)	47 730	5.6 (5.6–5.7)	13 720	6.1 (6.0–6.2)	95 230	5.6 (5.6–5.6)	327 890	5.3 (5.3–5.3)
Early preterm birth (< 32 wk)	4990	0.8 (0.8–0.8)	7120	0.8 (0.8–0.9)	2130	0.9 (0.9–1.0)	14 250	0.8 (0.8–0.9)	44 720	0.7 (0.7–0.7)
Small-for-gestational-age birth	68 840	11.0 (10.9–11.1)	102 720	12.2 (12.1–12.2)	23 030	10.2 (10.1–10.3)	194 590	11.5 (11.4–11.5)	495 280	8.0 (8.0–8.0)
Large-for-gestational-age birth	47 190	7.5 (7.5–7.6)	62 620	7.4 (7.4–7.5)	20 790	9.2 (9.1–9.3)	130 590	7.7 (7.7–7.7)	714 320	11.5 (11.5–11.5)
Fatal outcomes										
Stillbirth	3670	5.9 (5.7–6.1)	5140	6.2 (6.1–6.4)	1510	6.9 (6.5–7.2)	10 320	6.2 (6.1–6.3)	31 480	5.2 (5.1–5.2)
Infant mortality	1510	2.4 (2.3–2.5)	2000	2.3 (2.2–2.5)	580	2.5 (2.3–2.8)	4080	2.4 (2.3–2.5)	18 990	3.0 (3.0–3.1)
Neonatal (< 28 d) mortality	1080	1.7 (1.6–1.8)	1290	1.5 (1.4–1.6)	370	1.6 (1.5–1.8)	2720	1.6 (1.5–1.7)	12 400	2.0 (2.0–2.0)
Post-neonatal (28–364 d) mortality	440	0.7 (0.6–0.8)	700	0.8 (0.8–0.9)	200	0.9 (0.8–1.0)	1340	0.8 (0.8–0.8)	6580	1.1 (1.0–1.1)
Note: CI = confidence interval. *Numbers were randomly rounded up or down to the nearest 10 according to Statistics Canada disclosure regulations. †Rates of nonfatal outcomes are per 100 births; rates of fatal outcomes are per 1000 births.										

healthy immigrant effect was not present for all immigrant subgroups in our study, consistent with other studies on maternal behaviours, perinatal health, and health care use.^{7,9,10,37,38} The elevated risk of several adverse outcomes — preterm birth, LGA birth, and stillbirth — among infants of refugee birthing parents compared with those of Canadian-born and non-refugee immigrant birthing parents also align with previous studies reporting that refugees are a vulnerable subgroup of immigrants.^{5,39–41}

The lower risk of SGA birth among refugee birthing parents than economic- and family-class immigrants may reflect much lower proportions of people from southern and eastern Asia among refugees. Births to immigrants from East and South Asian countries that are deemed to be small for gestational age based on the Canadian reference are more likely to include healthy infants,⁴² and this is reflected in our results of no difference in risk of infant death between refugees and non-refugee immigrants. We found that the increased risk of preterm birth

among immigrant birthing parents compared with Canadian-born birthing parents was more pronounced for early preterm birth (< 32 wk gestation) than for moderate-to-late preterm birth (32–36 wk gestation). A few studies differentiating early and moderate-to-late preterm birth have reported exposure to smoking, being underweight, and intrauterine infection as risk factors for early preterm birth;^{43–45} these risk factors may be more prevalent among immigrants.³⁷ In addition, immigrants may encounter systematic racism, which has long been demonstrated as a determinant of adverse birth outcomes including preterm birth.^{46,47} Despite the increased risk of early preterm birth, immigrants, including refugees, did not have a higher risk of infant death in our study, probably owing to the low occurrence of early preterm birth (13% of all preterm births), and non-refugee immigrants had lower risk of neonatal death after adjusting for covariates.

We used population-based, national data to quantify differences in outcomes not only by foreign-born or Canadian-born

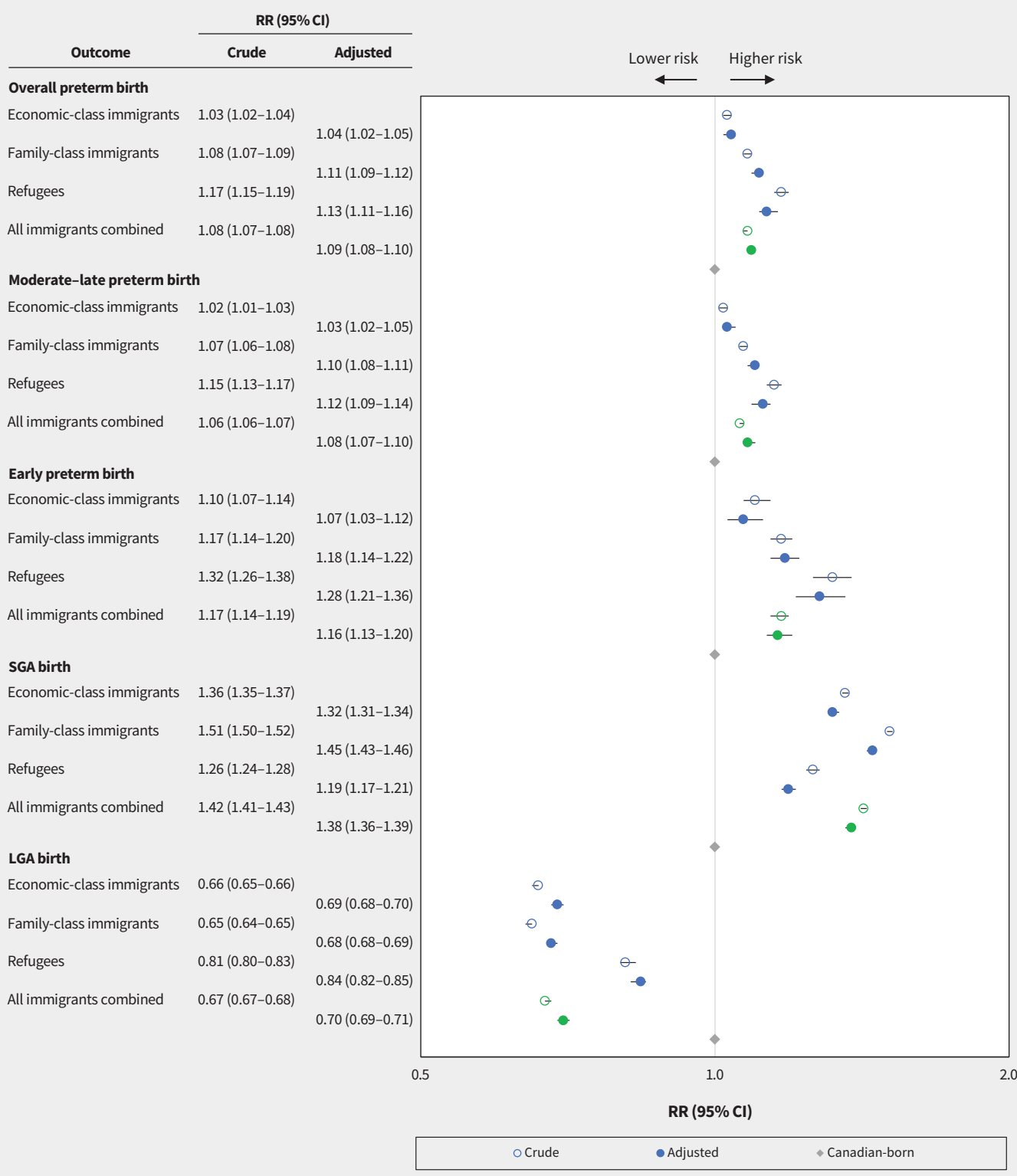


Figure 2: Risk ratios (RRs) with 95% confidence intervals (CIs) for adverse nonfatal birth and postnatal outcomes of singleton births among immigrant versus Canadian-born birthing parents in Canada, by immigrant category, 1993–2017 (1993–2018 for postnatal deaths). Analyses were adjusted for age of both parents, parity, marital status, non-birthing parent birthplace, and year and region of birth. All models accounted for clustering by birthing parent. Note: LGA = large for gestational age, SGA = small for gestational age.

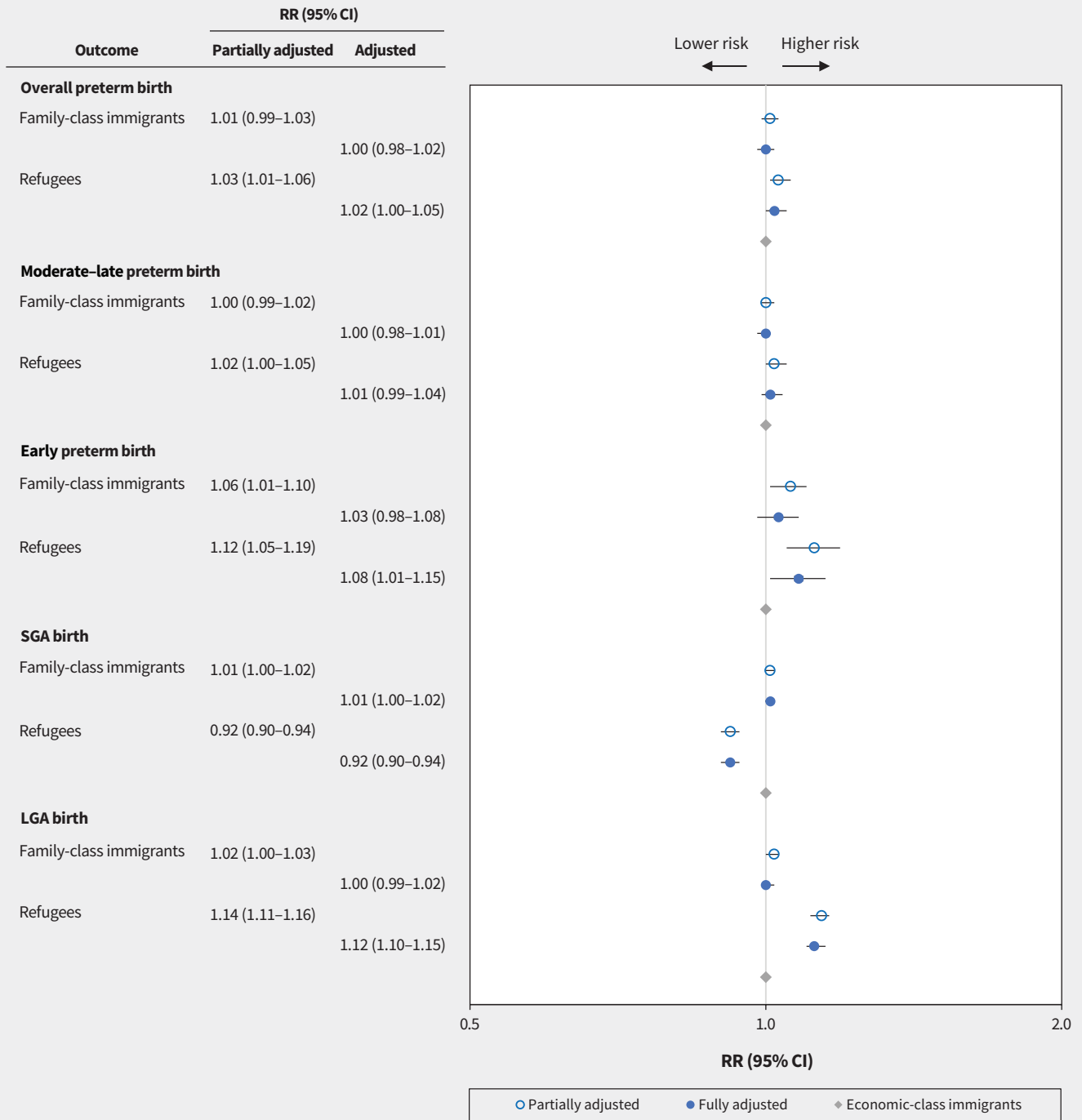


Figure 3: Risk ratios (RRs) with 95% confidence intervals (CIs) for adverse nonfatal birth and postnatal outcomes of singleton births among immigrants in Canada, by immigration category (using economic-class immigrants as the comparison group), 1993–2017 (1993–2018 for postnatal deaths). Partially adjusted models included age of both parents, parity, marital status, non-birthing parent birthplace, year and region of birth, birthing parent world region of origin, time from landing to birth, and knowledge of official languages at landing. Fully adjusted models included all variables from partially adjusted models, as well as log-transformed income and income-squared. All models accounted for clustering by birthing parent. Note: LGA = large for gestational age, SGA = small for gestational age.

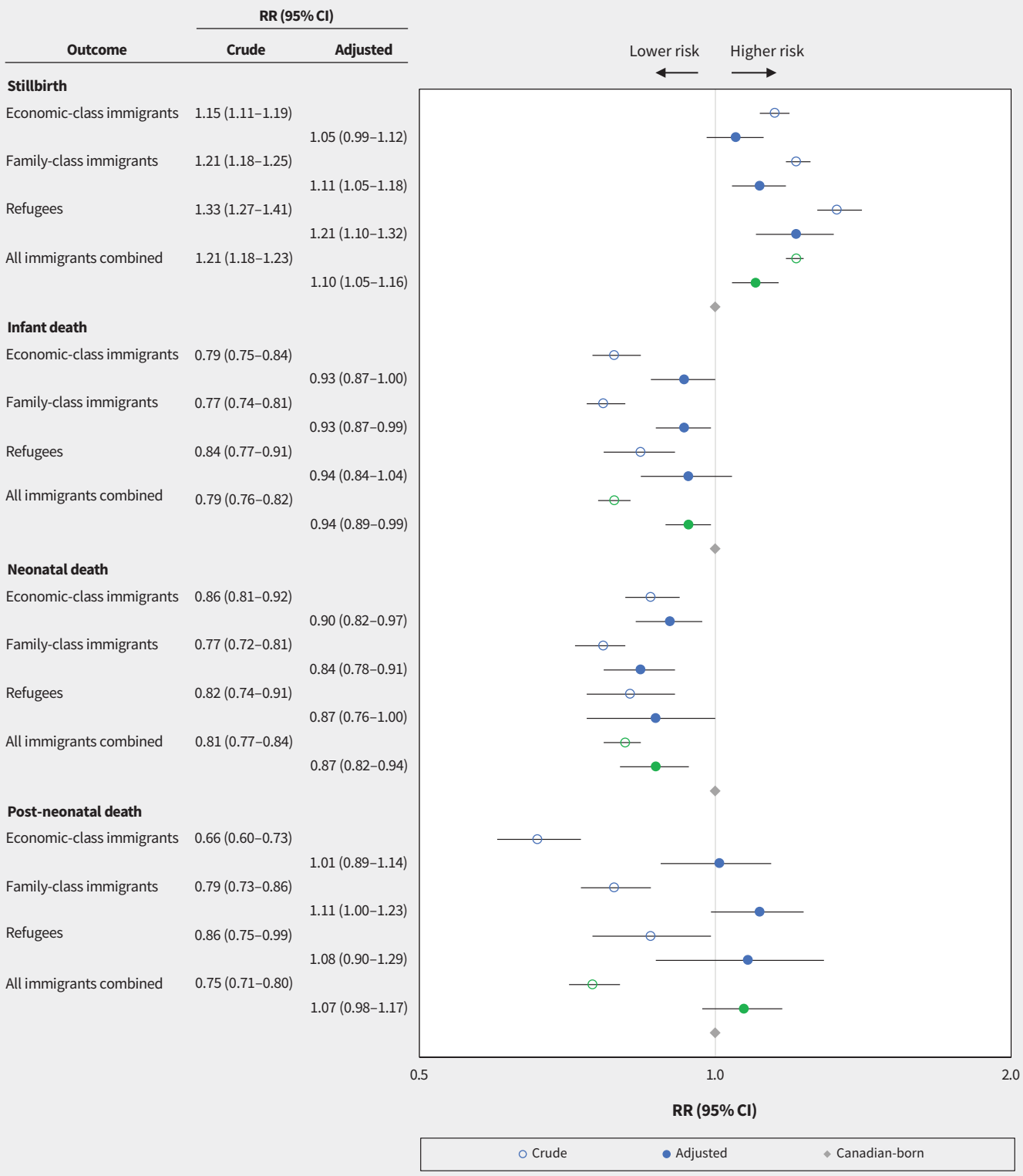


Figure 4: Risk ratios (RRs) with 95% confidence intervals (CIs) for adverse fatal birth and postnatal outcomes of singleton births among immigrant versus Canadian-born birthing parents in Canada, by immigrant category, 1993–2017 (1993–2018 for postnatal deaths). Analyses were adjusted for age of both parents, parity, marital status, non-birthing parent birthplace, and year and region of birth. All models accounted for clustering by birthing parent. Ontario births in 1998 and 1999 were excluded from analyses for stillbirth.

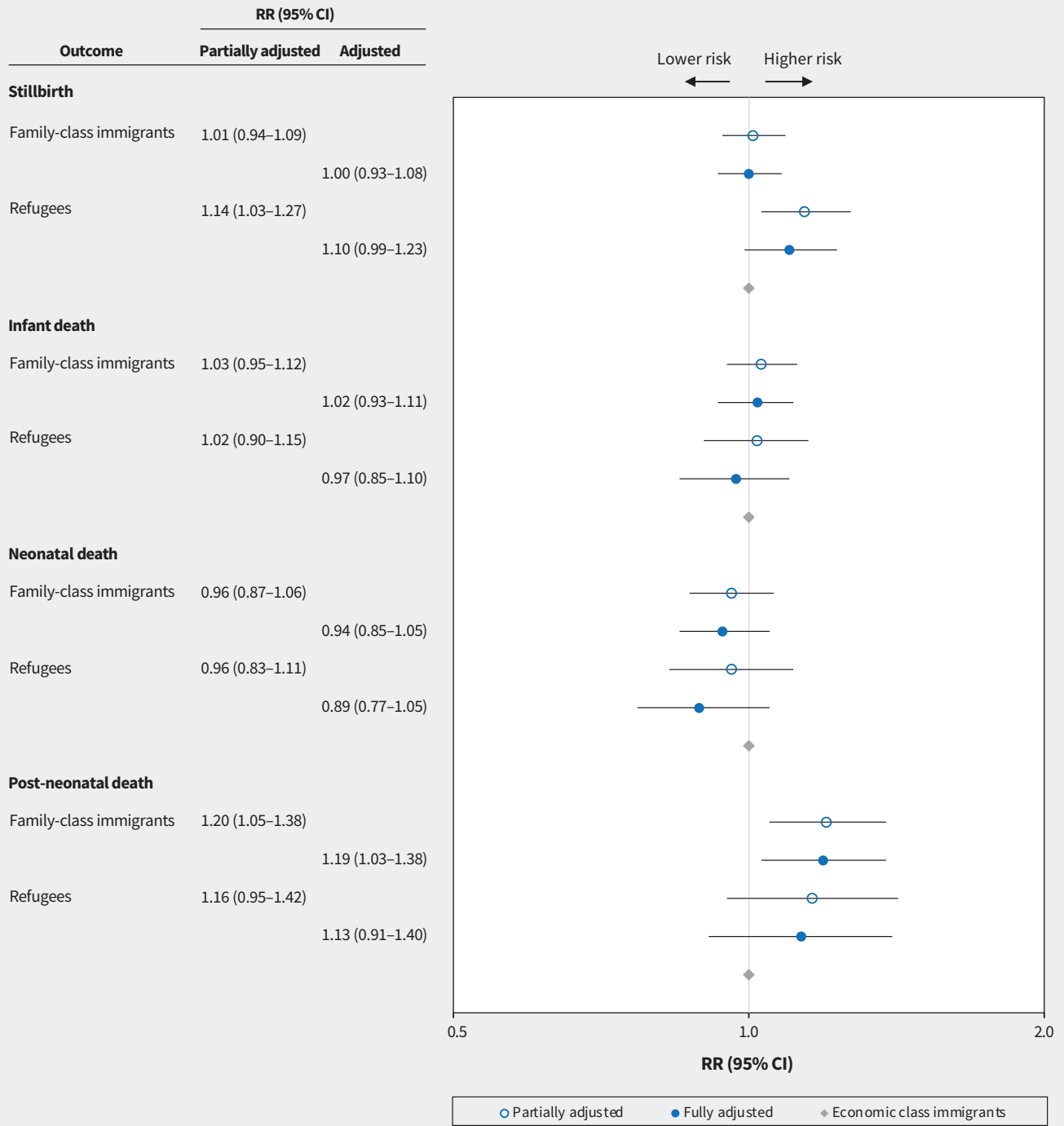


Figure 5: Risk ratios (RRs) with 95% confidence intervals (CIs) for adverse fatal birth and postnatal outcomes of singleton births among immigrants in Canada, by immigration category (using economic-class immigrants as the comparison group), 1993–2017 (1993–2018 for postnatal deaths). Partially adjusted models included age of both parents, parity, marital status, non-birthing parent birthplace, year and region of birth, birthing parent world region of origin, time from landing to birth, and knowledge of official languages at landing. Fully adjusted models included all variables from partially adjusted models, as well as log-transformed income and income-squared. All models accounted for clustering by birthing parent. Ontario births in 1998 and 1999 were excluded from analyses for stillbirth.

Table 4 (part 1 of 2): Relative risk of adverse birth outcomes associated with immigration category among first births of immigrants in Canada, 1993–2017 (1993–2018 for postnatal deaths)

Outcome	RR (95% CI)		
	Economic-class immigrants <i>n</i> = 260 010	Family-class immigrants <i>n</i> = 359 620	Refugees <i>n</i> = 78 400
All birthing parents (ref: Canadian-born birthing parents)*			
Preterm birth			
Crude	0.98 (0.97–1.00)	1.01 (1.00–1.03)	1.11 (1.08–1.15)
Adjusted	0.95 (0.93–0.97)	1.01 (0.99–1.03)	1.10 (1.07–1.14)
Moderate–late preterm birth			
Crude	0.98 (0.96–0.99)	1.00 (0.99–1.02)	1.09 (1.06–1.12)
Adjusted	0.95 (0.93–0.98)	1.00 (0.98–1.03)	1.08 (1.04–1.12)
Early preterm birth			
Crude	1.03 (0.98–1.07)	1.10 (1.06–1.14)	1.31 (1.22–1.40)
Adjusted	0.94 (0.89–0.99)	1.08 (1.02–1.13)	1.28 (1.17–1.39)
SGA birth			
Crude	1.47 (1.46–1.49)	1.67 (1.65–1.68)	1.39 (1.36–1.42)
Adjusted	1.33 (1.31–1.35)	1.54 (1.52–1.56)	1.21 (1.18–1.24)
LGA birth			
Crude	0.60 (0.59–0.61)	0.59 (0.58–0.60)	0.76 (0.74–0.78)
Adjusted	0.67 (0.66–0.69)	0.65 (0.63–0.66)	0.86 (0.83–0.89)
Stillbirth			
Crude	1.20 (1.14–1.27)	1.24 (1.18–1.30)	1.50 (1.37–1.64)
Adjusted	1.06 (0.96–1.17)	1.17 (1.07–1.28)	1.40 (1.20–1.64)
Infant death			
Crude	0.83 (0.76–0.90)	0.82 (0.76–0.88)	0.85 (0.73–0.98)
Adjusted	0.87 (0.78–0.97)	0.91 (0.83–1.01)	0.99 (0.83–1.18)
Neonatal death			
Crude	0.87 (0.79–0.96)	0.81 (0.75–0.89)	0.87 (0.73–1.03)
Adjusted	0.82 (0.72–0.93)	0.85 (0.76–0.96)	0.97 (0.79–1.20)
Post-neonatal death			
Crude	0.73 (0.62–0.86)	0.83 (0.73–0.94)	0.80 (0.61–1.05)
Adjusted	1.01 (0.82–1.24)	1.09 (0.91–1.30)	1.05 (0.75–1.46)

status of birthing parents, but also by specific immigration category, reflecting differential motivations for immigration and admission criteria and processes. Our classification of immigrant subgroups was based on official admission status rather than self-reported category, as used in many previous studies.^{3,5,48,49} In addition, we differentiated economic- and family-class immigrants, who have often been classified into a single non-refugee immigrant group.²⁰ However, the immigration admission category, although important, is but 1 characteristic to differentiate among immigrants, and we note other potentially important characteristics to further disaggregate immigrants, such as educational level and knowledge of official languages at landing among immigrants who migrated as adults.

Limitations

Our study was limited by the availability of data to account for individual-level characteristics. Birth outcomes of immigrants may differ according to post-immigration experiences (e.g., further education, exposure to discrimination, access to and use of health care). Studies have reported differences in access to and quality of prenatal care among immigrants in many countries including those with publicly funded health care.^{50,51} A recent study in Canada also showed that adequate prenatal care differed by immigrant admission category (government-assisted v. privately sponsored) even among refugees;⁵² thus, initiation and adequacy of prenatal care may differ between immigrants of the 3 categories evaluated in our study. Other important data

Table 4 (part 2 of 2): Relative risk of adverse birth outcomes associated with immigration category among first births of immigrants in Canada, 1993–2017 (1993–2018 for postnatal deaths)

Outcome	RR (95% CI)		
	Economic-class immigrants n = 260 010	Family-class immigrants n = 359 620	Refugees n = 78 400
Immigrant birthing parents only (ref: economic-class immigrants)†			
Preterm birth			
Partially adjusted		1.03 (0.97–1.08)	1.03 (0.97–1.08)
Fully adjusted		1.04 (1.00–1.08)	1.23 (1.18–1.29)
Moderate–late preterm birth			
Partially adjusted		0.99 (0.96–1.03)	1.03 (0.97–1.08)
Fully adjusted		1.03 (0.98–1.08)	1.21 (1.15–1.27)
Early preterm birth			
Partially adjusted		1.03 (0.95–1.11)	1.27 (1.12–1.44)
Fully adjusted		1.16 (1.02–1.31)	1.45 (1.27–1.66)
SGA birth			
Partially adjusted		1.07 (1.05–1.09)	0.92 (0.89–0.96)
Fully adjusted		0.92 (0.90–0.95)	0.95 (0.92–0.98)
LGA birth			
Partially adjusted		1.00 (0.96–1.03)	1.30 (1.23–1.37)
Fully adjusted		1.12 (1.07–1.18)	1.19 (1.13–1.25)
Stillbirth			
Partially adjusted		0.95 (0.83–1.09)	1.25 (0.99–1.57)
Fully adjusted		0.89 (0.74–1.08)	1.05 (0.85–1.29)
Infant death			
Partially adjusted		1.07 (0.92–1.25)	1.03 (0.78–1.36)
Fully adjusted		1.03 (0.81–1.31)	1.17 (0.91–1.51)
Neonatal death			
Partially adjusted		1.06 (0.89–1.27)	1.06 (0.77–1.47)
Fully adjusted		1.16 (0.86–1.55)	1.33 (0.97–1.83)
Post-neonatal death			
Partially adjusted		1.11 (0.84–1.49)	0.97 (0.56–1.66)
Fully adjusted		0.83 (0.56–1.24)	0.91 (0.59–1.42)

Note: CI = confidence interval, LGA = large-for-gestational-age, ref. = reference, RR = risk ratio, SGA = small-for-gestational age.
 *All models accounted for clustering by birthing parent. Adjusted models included age of both parents, parity, marital status, non-birthing parent's birthplace, and year and region of birth. Ontario births in 1998 and 1999 were excluded from analyses for stillbirth.
 †Partially adjusted models included age of both parents, parity, marital status, non-birthing parent's birthplace, year and region of birth, birthing parent's world region of origin, time between landing and birth, and knowledge of official languages at landing. Fully adjusted models included all variables from partially adjusted models, as well as log-transformed income and income-squared.

unavailable in our study included use of tobacco, alcohol, and other substances that are associated with adverse birth outcomes.⁵³ Identification of SGA and LGA births in our study, based on a reference derived mostly from White births in Canada,²⁹ would have misclassified healthy infants of immigrants as SGA or LGA births because of different birth weight distributions between ethnic groups;^{42,54} thus, cautious interpretation is warranted. Finally, our complete case analysis excluded more births to refugees than to other groups. Since most missing data were

on non-birthing parent information and such births were at increased risk of adverse birth outcomes,³⁰ our estimated risks for refugees are likely underestimates.

Conclusion

This population-based study of all births to landed immigrants over a 25-year period provides a national portrait of perinatal health inequalities for 3 distinct immigrant populations in Canada. Births to immigrant parents had increased risk of several

Table 5: Relative risk of adverse birth outcomes associated with immigration category among births to immigrants in Canada, compared with those to Canadian-born parents, 1993–2017 (1993–2018 for postnatal deaths), stratified by time between landing and birth*

Outcome	RR (95% CI)			
	Economic-class immigrants	Family-class immigrants	Refugees	All immigrants combined
Preterm birth				
≤ 5 yr since landing	1.03 (1.01–1.05)	1.04 (1.03–1.06)	1.13 (1.09–1.17)	1.04 (1.03–1.06)
6–9 yr since landing	1.04 (1.01–1.07)	1.12 (1.10–1.15)	1.08 (1.04–1.13)	1.09 (1.07–1.10)
≥ 10 yr since landing	1.07 (1.05–1.10)	1.24 (1.22–1.26)	1.17 (1.14–1.21)	1.16 (1.14–1.18)
Moderate–late preterm birth				
≤ 5 yr since landing	1.02 (1.00–1.04)	1.05 (1.03–1.07)	1.11 (1.07–1.15)	1.04 (1.03–1.06)
6–9 yr since landing	1.03 (1.00–1.06)	1.12 (1.10–1.15)	1.07 (1.02–1.12)	1.08 (1.06–1.10)
≥ 10 yr since landing	1.08 (1.05–1.10)	1.21 (1.18–1.23)	1.16 (1.12–1.19)	1.15 (1.13–1.16)
Early preterm birth				
≤ 5 yr since landing	1.07 (1.02–1.12)	1.02 (0.97–1.07)	1.33 (1.21–1.45)	1.06 (1.02–1.10)
6–9 yr since landing	1.14 (1.06–1.22)	1.17 (1.10–1.24)	1.18 (1.05–1.33)	1.15 (1.10–1.20)
≥ 10 yr since landing	1.07 (1.01–1.14)	1.56 (1.48–1.64)	1.32 (1.22–1.43)	1.32 (1.27–1.37)
SGA birth				
≤ 5 yr since landing	1.34 (1.32–1.36)	1.48 (1.47–1.50)	1.17 (1.15–1.21)	1.41 (1.39–1.42)
6–9 yr since landing	1.24 (1.22–1.26)	1.41 (1.39–1.44)	1.14 (1.10–1.18)	1.32 (1.30–1.34)
≥ 10 yr since landing	1.36 (1.34–1.38)	1.41 (1.39–1.43)	1.23 (1.20–1.26)	1.36 (1.34–1.38)
LGA birth				
≤ 5 yr since landing	0.68 (0.67–0.69)	0.67 (0.66–0.68)	0.86 (0.84–0.89)	0.69 (0.68–0.69)
6–9 yr since landing	0.72 (0.70–0.74)	0.68 (0.67–0.70)	0.89 (0.87–0.92)	0.72 (0.71–0.73)
≥ 10 yr since landing	0.68 (0.67–0.70)	0.71 (0.69–0.72)	0.78 (0.76–0.80)	0.71 (0.70–0.72)
Stillbirth				
≤ 5 yr since landing	1.14 (1.05–1.23)	1.09 (1.01–1.17)	1.28 (1.11–1.47)	1.12 (1.06–1.19)
6–9 yr since landing	1.04 (0.92–1.17)	1.22 (1.11–1.35)	1.13 (0.93–1.38)	1.14 (1.05–1.23)
≥ 10 yr since landing	0.91 (0.82–1.02)	1.12 (1.01–1.23)	1.21 (1.06–1.39)	1.05 (0.99–1.13)
Infant death				
≤ 5 yr since landing	0.96 (0.87–1.05)	0.87 (0.80–0.94)	1.02 (0.87–1.21)	0.91 (0.85–0.98)
6–9 yr since landing	0.91 (0.79–1.04)	0.89 (0.79–1.00)	0.76 (0.60–0.97)	0.87 (0.80–0.96)
≥ 10 yr since landing	0.93 (0.84–1.04)	1.11 (1.00–1.22)	0.97 (0.83–1.13)	1.01 (0.94–1.09)
Neonatal death				
≤ 5 yr since landing	0.93 (0.84–1.04)	0.79 (0.71–0.87)	0.93 (0.76–1.15)	0.85 (0.79–0.93)
6–9 yr since landing	0.89 (0.76–1.05)	0.79 (0.68–0.92)	0.69 (0.51–0.94)	0.81 (0.73–0.91)
≥ 10 yr since landing	0.90 (0.76–1.00)	1.05 (0.93–1.19)	0.94 (0.78–1.12)	0.95 (0.87–1.04)
Post-neonatal death				
≤ 5 yr since landing	1.00 (0.84–1.17)	1.05 (0.92–1.20)	1.22 (0.94–1.58)	1.05 (0.94–1.17)
6–9 yr since landing	0.92 (0.72–1.19)	1.09 (0.91–1.33)	0.90 (0.61–1.33)	1.02 (0.87–1.18)
≥ 10 yr since landing	1.09 (0.90–1.32)	1.23 (1.04–1.45)	1.04 (0.80–1.36)	1.14 (1.01–1.29)

Note: CI = confidence interval, LGA = large-for-gestational-age, RR = risk ratio, SGA = small-for-gestational-age.

*Canadian-born birthing parents were reference group. All models accounted for clustering by birthing parent. Models included age of both parents, parity, marital status, non-birthing parent birthplace, and year and region of birth. Ontario births in 1998 and 1999 were excluded from analyses for stillbirth.

but not all adverse outcomes. Differential risk of adverse outcomes by immigrant category underscores the importance of disaggregating foreign-born populations in health research. Further studies evaluating patterns of association specific to race and ethnicity, socioeconomic trajectory, and post-migration health care experiences among immigrants, as well as temporal changes, are warranted to better understand the nature of perinatal health differences between immigrants and non-immigrants, as well as by immigration category.

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Affiliations: Department of Epidemiology, Biostatistics and Occupational Health (Yang, Shapiro), McGill University, Montréal, Que.; Health Analysis Division (Ng), Statistics Canada, Ottawa, Ont.; School of Nursing (Vissandjée), Université de Montréal; School of Human Ecology (Vang), University of Wisconsin–Madison, Madison, Wis.

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Correspondence to: Seungmi Yang, seungmi.yang@mcgill.ca