


BMJ Open Receipt of routine preventive care among infant daughters and sons of immigrant mothers in Ontario, Canada: a retrospective cohort study

Ariel Pulver ¹, Astrid Guttman,^{2,3,4} Joel G Ray,^{2,5,6} Patricia J O'Campo,^{1,7} Marcelo L Urquia^{1,2,7,8}

To cite: Pulver A, Guttman A, Ray JG, *et al*. Receipt of routine preventive care among infant daughters and sons of immigrant mothers in Ontario, Canada: a retrospective cohort study. *BMJ Open* 2020;**10**:e036127. doi:10.1136/bmjopen-2019-036127

► Prepublication history for this paper is available online. To view these files, please visit the journal online (<http://dx.doi.org/10.1136/bmjopen-2019-036127>).

Received 02 December 2019
Revised 29 March 2020
Accepted 17 April 2020



© Author(s) (or their employer(s)) 2020. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ.

For numbered affiliations see end of article.

Correspondence to
Dr Marcelo L Urquia;
Marcelo_Urquia@cpe.umanitoba.ca

ABSTRACT

Objectives To explore gender disparities in infant routine preventive care across maternal countries of birth (MCOB) and by mother tongue among infants of Indian-born mothers.

Setting Retrospective population-based administrative cohort in Ontario, Canada (births between 2002 and 2014).

Participants 350 366 (inclusive) healthy term singletons belonging to families with a minimum of one opposite gender child.

Outcome measures Fixed effects conditional logistic regression generated adjusted ORs (aORs) for a daughter being underimmunised and having an inadequate number of well-child visits compared with her brother, stratified by MCOB. Moderation by maternal mother tongue was assessed among children to Indian-born mothers.

Results Underimmunisation and inadequate well-child visits were common among both boys and girls, ranging from 26.5% to 58.2% (underimmunisation) and 10.5% to 47.8% (inadequate well-child visits), depending on the maternal birthplace. Girls whose mothers were born in India had 1.19 times (95% CI 1.07 to 1.33) the adjusted odds of inadequate well-child visits versus their brothers. This association was only observed among the Punjabi mother tongue subgroup (aOR: 1.26, 95% CI 1.08 to 1.47). In the Hindi mother tongue subgroup, girls had lower odds of underimmunisation than their brothers (aOR: 0.73, 95% CI 0.54 to 0.98).

Conclusions Gender equity in routine preventive healthcare is mostly achieved among children of immigrants. However, daughters of Indian-born mothers whose mother tongue is Punjabi, appear to be at a disadvantage for well-child visits compared with their brothers. This suggests son preference may persist beyond the family planning stage among some Indian immigrants.

INTRODUCTION

In early childhood, parents are the principal gatekeepers to their child's healthcare use.¹ Barriers facing immigrants in concert with health beliefs and family dynamics may influence parental healthcare decision making around immunisations and well-child check-ups.^{1–3} Evidence shows

Strengths and limitations of this study

- This was the first retrospective population-based cohort study to examine gender disparities across multiple routine preventive care outcomes among children of diverse immigrant populations and language groups.
- Our approach advanced existing research by considering maternal immigration and nativity, rather than ethnicity, as well within-sibling comparison approach to control for within-family unobservable factors.
- Mother tongue is an imperfect proxy for regional and cultural variation and may not accurately reflect the most commonly spoken language around the time of childbearing.

that beliefs about gender norms, roles and relations adversely affect the health and well-being of girls in top source countries of immigrants to Canada including India, Pakistan and China, among others.^{4–15} In select immigrant-sending countries, differential health investments exist towards sons and daughters, to the disadvantage of girls with respect to breastfeeding, immunisation and seeking healthcare for illness,^{10–14} which some researchers have termed 'healthcare neglect'.^{8, 15} Studies have identified son preference among immigrant communities in Canada, the UK and Australia manifesting through sex-selective pregnancy termination.^{5, 16–22} In the Indo-Canadian community, this practice is documented at higher birth orders particularly among mothers whose first language is Punjabi.¹⁸

It is unknown if son preference may affect the routine preventive care of young girls and boys across different immigrant groups. One study British South Asian children could not identify gender differences in immunisation rates due to a limited sample size

and an analytic approach not suited to examine gender bias within families.²³ Daughters in some immigrant groups may experience ‘double jeopardy’ concerning healthcare in early life due to their gender and parental country of birth, and such disparities, if any, must be quantified.²⁴

Ontario, Canada, provides an ideal setting in which to conduct health research on the children of immigrants. Ontario has one of the most diverse immigrant populations in the world,²⁵ and children are covered for universal healthcare in Canada from birth including routine anticipatory care (ie, well-child visits and the recommended series of vaccinations) by a publicly funded health insurance system, without direct cost to the parent.

The primary objective was to identify any existing gender disparities in routine preventive care within families across various maternal countries of birth. Since there is growing evidence of sex-selective pregnancy termination within specific linguistic subgroups in Indian diaspora,¹⁸ the secondary objective was to investigate if gender disparities among this subgroup varied by mother tongue, as a proxy for potential regional and cultural variation.

METHODS

Data sources

The data for this study come from several linked population-based administrative databases at ICES to form a retrospective cohort following children from birth to 24 months of age. A unique coded identity number facilitates record linkage between the databases. The Registered Persons Database (RPDB) is the provincial healthcare registry. It contains information on birth date, sex and postal code that was linked to Canadian Census data to obtain neighbourhood information at the level of a dissemination area, the smallest census geographic unit.

Hospitalisation-related deliveries in Ontario, Canada, between 1 April 2002 and 31 March 2014 were identified from the Discharge Abstract Database of the Canadian Institute for Health Information (capturing 98% of births). Well-child check-ups and vaccinations with family physicians and paediatricians were captured using the Ontario Health Insurance Plan (OHIP) claims database, which contains information on physicians’ billings, such as fee codes for visits, diagnostic codes and date of service. We sourced the Ontario portion of the federally maintained Immigration, Refugees, and Citizenship Canada (IRCC) Permanent Resident Database for information on maternal birthplace, immigrant class and landing date to Canada. Many earlier studies have linked the IRCC databases with the other databases used in this study.^{16 18 19 26} Overall, the IRCC has an 86% match rate to the RPDB. Non-immigrants are those who remain unmatched to the IRCC database. A small proportion of the non-immigrant group may be immigrants who landed before 1985.²⁷ These datasets were linked using unique encoded identifiers and analysed at ICES.

Patient and public involvement

No individual patients were directly involved in this study.

Data availability statement

Data used for the current study are held securely at ICES in Ontario, Canada. Data sharing agreements prohibit ICES from making the dataset publicly available.

Study population

The study population included healthy singleton term siblings born in Ontario, Canada, between 1 April 2002 and 31 March 2014 eligible for OHIP from a paediatrician or family physician/general practitioner until 24.5 months of age. Included infants were those whose maternal country of birth (MCOB) was among the top 15 in Ontario (representing >90% of all births) and those whose mothers delivered an opposite gender sibling in the study period (also to be included).

Infants born as multiples, at <37 weeks’ gestation or weighing <2500 g at birth, or those diagnosed with a complex chronic condition (eg, including major congenital malformations,) were excluded,²⁸ as these may have influenced their experience of routine care. Moreover, due to the nature of siblings sharing a birthdate, it is likely the early primary healthcare experience of multiples is shared, and we would expect these children to exhibit minimal differences in their healthcare experience due to parental volition.

Infants were removed from the study cohort if they had no documented well-child visits or immunisations, or if they received any primary care from community health centres as these physicians do not bill OHIP for their activities. Infants with no healthcare billings may see a salaried physician or other healthcare provider who does not submit billings. Mothers or infants with any missing covariate or outcome data were also excluded, although this is uncommon in the current administrative data. [Figure 1](#) presents a flow chart for the cohort formation.

Variables

Outcomes

Number of vaccinations by a family physician or paediatrician by 24 months of age

An immunisation was measured by identifying the codes physicians use to bill the province for the administration of a vaccine and the number of units delivered on a given day. The total number of vaccinations did not include unscheduled vaccinations occurring before 6 weeks. Infants were categorised as underimmunised if they had received less than the expected number of vaccination doses publicly available and recommended in Ontario at their time of birth. Infants born in 2002–2003, 2004–2009, 2010–2011 and 2013 should have had 5, 12, 11 and 10 vaccines respectively by 24 months, against the availability in Ontario at the time (eg, varied iterations and combinations of DTP/Hib, MMR, pneumococcus, meningococcus and varicella vaccines). We did not examine

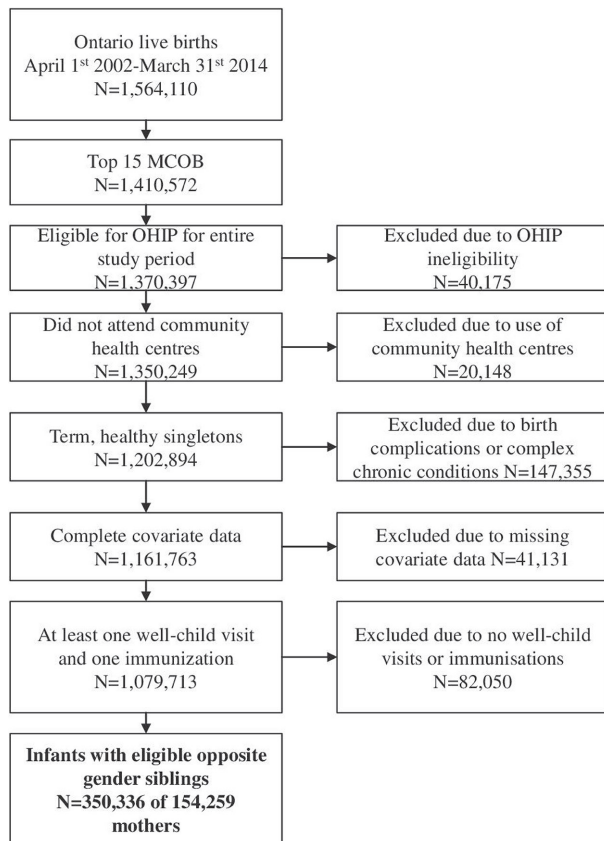


Figure 1 The number 350 336 represents all included children within sibling sets. MCOB, Maternal Countries of Birth; OHIP, Ontario Health Insurance Plan.

specific antigens therefore underimmunisation here does not represent coverage necessarily.

Number of well-child visits by a family doctor or paediatrician by 24 months of age

These were operationalised by a set of core primary care fee codes and diagnostic codes and excluded immunisation-only visits.²⁹ Infants were determined to have *inadequate well-child check-ups* if they had fewer than five check-ups by a family doctor or paediatrician (recommended at 2, 4, 6, 12, 15 (optional) and 18 months of age) in the first 2 years of life.

Vaccines or check-ups documented 2 weeks after 24 months were included as a buffer for appointment scheduling.

Maternal country of birth (MCOB)

MCOB is recorded from notarised documents in the IRCC permanent resident database. If mothers did not have an immigration record, they were classified as Canadian born. In this study, MCOB represents exposure to the health and gender related norms of that country that may differentially affect the use of routine anticipatory care for sons and daughters.

Child gender

Gender norms, roles and relations may differentially affect the receipt of routine, anticipatory healthcare for

boys and girls within the family unit. In this study, biological sex documented at birth was described as gender, as the question under study is gender-based bias.

Covariates

Confounders were selected a priori and included variables that could vary between siblings.³⁰ They included maternal age at delivery of the index child (≤ 19 , 20–34 and ≥ 35 years of age), infant birth year,³¹ birth order (first, second, third, fourth or more),³² neighbourhood income quintile (1=lowest and 5=highest) and urban/rural residence (urban ≤ 40 on Rurality Index of Ontario; rural ≥ 40) of the maternal place of residence at the birth of the index child,^{33 34} and among immigrant mothers, time in Canada (≤ 5 , 6–9, 10–14 and 15+ years). Covariate data originated from the hospital record (maternal age, infant birth year and birth order), Canadian census data (neighbourhood income quintile and urban/rural residence) and IRCC documentation (time in Canada since landing date). Statistics Canada's Postal Code Conversion File links the mother's postal code at delivery to generate values for the census-related variables. Deliveries before 1 January 2004 were linked with the 2001 census, and deliveries afterwards were linked to the 2006 census.

We examined maternal *mother tongue* as a potential effect modifier for the relationship between gender and routine preventive care among children of Indian-born mothers. Female disadvantage appears to vary regionally within countries. For example, states in southern India may not exemplify the same degree of gender bias as seen in northern regions, where Punjabi is the dominant culture and language spoken. Previous research has demonstrated variability in sex-selective pregnancy termination across Indian language groups.¹⁸ Mother tongue was recorded and documented in the IRCC at landing. We chose the three most commonly declared mother tongues to preserve sample size (Punjabi, Gujarati, Hindi and 'other').

Analysis

Cross-tabulations and univariate procedures were used to obtain the baseline proportions of underimmunisation and inadequate well-child visits for each gender within MCOB. Next, a fixed effects approach with conditional logistic regression stratified by MCOB was used to estimate whether daughters have higher odds of adverse outcomes compared with sons *within families, within the given MCOB stratum*. Fixed effects are useful for studying sibling differences by accounting for unobservable differences in maternal/family level variables.^{30 35 36} Within-sibling variation is used to estimate the regression parameter for gender, and all stable characteristics of the family environment are controlled, isolating the effect of child's gender on anticipatory care outcomes within-families. Models were adjusted for maternal age, income quintile, rurality, birth year, birth order and category of time spent in Canada (immigrant models only). A statistical test for interaction was performed between mother

tongue*gender (significant at $p \leq 0.2$) to determine whether gender disparities are dependent on mother tongue for children of Indian-born mothers. Effect modification was also assessed by further stratifying gender disparities by Indian mother tongue.^{13 18}

SAS V.9.4 was used to perform all analyses.

RESULTS

Demographic characteristics

Table 1 describes the characteristics of mothers and infants from each included MCOB. The total eligible population was a total of 350 366 healthy, term, singleton infants who were part of a sibling set (two or more children of the same mother), of 154 259 mothers from the 15 countries most commonly delivering in Ontario. Countries represented included Canada, India, Pakistan, China, Philippines, Sri Lanka, Jamaica, Afghanistan, Vietnam, Poland, Somalia, Iraq, USA, Guyana and Iran. Figure 1 shows the flow of the cohort formation and application of exclusion criteria.

Within-family gender disparities in routine preventive care

Underimmunisation and inadequate well-child visits were common among both boys and girls, ranging from 26.5% to 58.2% (underimmunisation) and from 10.5% to 47.8% (inadequate well-child visits) depending on the maternal birthplace. Table 2 presents the prevalence of the outcomes by MCOB and gender, as well as unadjusted and adjusted within-family ORs and 95% CIs for underimmunisation and inadequate well-child care for daughters compared with sons across MCOB strata.

No significant within-family gender differences were observed for immunisation, although daughters whose mother was born in India had 1.19 times (95% CI 1.07 to 1.33) the odds of inadequate check-ups compared with their male sibling, following adjustments for covariates. Girls in Afghani families had 27% greater odds of inadequate check-ups compared with their brothers (OR: 1.27, 95% CI 1.01 to 1.60); however, the OR was no longer significant after covariate adjustment. Moreover, women had a slight advantage over men of Canadian-born mothers 0.94 (95% CI 0.91 to 0.96); however, this effect was small and disappeared following covariate adjustment. We observed no significant within-family gender disparities for any other countries.

Effect modification by mother tongue among infants of Indian-born mothers

The three most common mother tongues among Indian-born mothers were Punjabi (55.4%), Gujarati (15.9%) and Hindi (9.4%). Among Indian-born mothers, statistical tests for interaction between mother tongue*gender were significant at $p \leq 0.2$ for both outcomes (underimmunisation: $\chi^2=4.79$, $p=0.19$; inadequate well-child check-ups: $\chi^2=5.27$, $p=0.15$). Stratified analysis showed the relationship between gender and inadequate routine care was dependent on maternal mother tongue. Figure 2

shows significantly higher odds for sisters compared with brothers for inadequate well-child visits only for siblings in the Punjabi mother tongue group (aOR: 1.26, 95% CI 1.08 to 1.47) but not for Gujarati, Hindi or other groups. Daughters of mothers in the Hindi group had lower odds of underimmunisation compared with their brothers (aOR: 0.73, 95% CI 0.54 to 0.98).

DISCUSSION

In this population-based study, we did not find evidence of gender disparities in underimmunisation or inadequate well-child visits for most MCOB, except among Indian families where sisters had significantly higher odds of inadequate well-child visits compared with their brothers. To our knowledge, no studies have examined within-family gender disparities in early childhood routine care outcomes by MCOB, which is essential given documented gender disparities in many source countries of immigrants to high-income countries.

Interpretation

Our study contrasts earlier work that did not find gender disparities in vaccinations among British South Asian children.²³ By using a larger sample size and fixed effects analysis,³⁰ we were able to estimate family-held gender biases adversely affecting healthcare for daughters compared with sons within families. We found that gender disparities within Indo-Canadian families varied by the Punjabi mother tongue. This finding is consistent with earlier studies of sex-selective pregnancy terminations in the Indo-Canadian community¹⁸ as well as research from the North-West of India where Punjabi is a dominant language.^{13 37 38} Research within Punjabi populations describes the economic benefits of sons over daughters, including the provision of old age support, higher paid employment, patrilineal kinship systems and avoiding the high cost of dowry or marriage payments.^{5 14 38 39} For some families, son preference may manifest primarily through sex selection and also through healthcare neglect.⁸ It is possible for similar mechanisms related to sex selection to influence gender equity in infant healthcare. In unconditional models, we found female disadvantage among children of Afghanistan-born mothers for inadequate well-child visits. In adjusted models, the effect estimate did not change substantially but precision suffered. Therefore, it is plausible that the 23% increased odds of inadequate women is relevant to clinical or public health practice and would be statistically significant with a larger sample size, such as in the case of India.⁴⁰ Further research may clarify this issue. We also found a female advantage for immunisation among the Hindi language group. There is limited evidence suggesting that greater immunisation among women relates to a belief that immunisations are harmful for men. There have been reports of lower immunisation rates among boys in some African countries, presumably due to fears of male sterilisation.⁴¹ In this case, the female 'advantage' may reflect

Table 1 Descriptive characteristics of included mother–infant sibling sets with at least one boy and one girl, among the 15 countries with the greatest share of births in Ontario, Canada, April 2002–March 2013

	Maternal country of birth														
	Canada	India	Pakistan	China	Philippines	Sri Lanka	Jamaica	Afghanistan	Vietnam	Somalia	Poland	Iraq	USA	Guyana	Iran
N infants=350 336															
154 259 mothers															
N (%)	290 009 (82.8)	123 556 (3.5)	91 500 (2.6)	75 666 (2.2)	56 544 (1.6)	61 699 (1.8)	30 577 (0.9)	26 884 (0.8)	24 224 (0.7)	23 382 (0.7)	23 340 (0.7)	20 300 (0.6)	18 228 (0.5)	16 226 (0.5)	10 611 (0.3)
Maternal age %															
≤19	3.80	0.4	0.8	0.2	1.1	0.3	5.3	1.2	0.5	1.1	0.8	1.1	1.0	2.5	0.5
20–34	80.1	90.0	87.5	75.5	69.3	86.4	79.8	85.2	80.9	74.0	83.9	81.8	75.7	82.1	68.9
35+	16.1	9.6	11.7	24.3	29.5	13.2	14.8	13.4	18.6	24.7	15.3	17.1	23.2	15.4	30.6
Female %	49.8	51.0	50.1	50.3	49.8	49.9	49.5	50.5	50.1	50.0	49.5	50.0	50.1	49.9	49.9
Birth order %															
First	36.8	41.2	35.8	45.0	39.5	39.7	30.6	31.7	39.2	18.5	40.2	32.2	34.3	35.7	46.6
Second	41.1	44.6	39.2	46.3	43.4	42.2	38.5	37.1	43.1	23.7	43.5	37.9	37.6	42.1	48.0
Third	15.5	11.6	19.1	7.7	13.7	15.4	18.9	20.3	13.6	20.9	13.2	21.0	16.0	15.6	4.6
Fourth or greater	6.7	2.6	6.0	1.0	3.4	2.7	12.0	10.8	4.2	37.0	3.1	8.9	12.1	6.6	0.9
Time since landing %															
<5 years	–	57.8	64.0	60.4	43.8	55.5	13.8	45.5	40.0	32.7	16.1	53.6	62.5	21.6	42.6
5–9 years	–	28.8	25.9	31.0	25.5	23.2	23.0	30.1	24.1	30.1	13.6	26.1	18.8	26.2	28.0
10–14 years	–	9.2	7.6	6.9	17.9	13.2	29.7	15.3	17.5	25.4	26.0	13.8	8.7	24.8	15.3
15+ years	–	4.3	2.6	1.7	12.7	8.1	33.5	9.2	18.4	11.9	44.2	6.5	10.1	27.4	14.1
Neighbourhood income quintile															
1: lowest	17.6	28.6	39.9	26.4	32.3	36.7	44.6	50.4	31.9	70.0	13.0	43.0	13.2	36.1	17.3
2	18.5	27.5	22.8	30.2	24.1	29.0	23.8	17.6	25.0	16.4	20.7	21.4	18.4	23.3	11.8
3	20.6	24.3	18.2	19.5	19.7	20.5	18.7	13.6	22.7	7.0	21.2	16.6	18.7	24.5	20.0
4	23.0	14.0	14.1	15.3	15.4	10.3	8.6	12.3	14.5	4.9	26.5	13.0	23.4	11.6	31.5
5: highest	19.6	5.7	5.0	8.3	8.5	3.4	4.2	6.0	5.8	1.5	18.6	5.7	26.2	4.6	19.1
Lives in rural area	14.7	0.3	0.3	0.3	1.0	0.0	0.2	0.3	0.2	0.0	2.0	0.2	10.7	0.4	0.2
Missing data on income or rurality	0.7	0.4	0.4	0.6	0.1	0.2	0.1	0.2	0.1	0.3	0.2	0.4	0.5	0.1	0.6
No documented preventive care in physician billings	10.1	5.8	7.4	7.9	4.5	9.9	6.6	7.5	5.9	12.9	7.5	6.8	10.1	5.9	5.9

Data are complete unless otherwise specified.

Table 2 Within-family gender disparities in routine preventive care outcomes stratified by maternal country of birth, among all opposite-gender sibling sets born in Ontario, Canada, between April 2002 and March 2013

Maternal country of birth	Underimmunisation						Inadequate well-child visits							
	% F		% M		F:M, OR (95% CI)		% F		% M		F:M, OR (95% CI)		F:M, aOR (95% CI)	
Canada 290 009 (82.8)	44.6	44.4	0.99 (0.97 to 1.01)	0.99 (0.97 to 1.00)	16.3	17.0	0.94 (0.91 to 0.96)*	0.96 (0.92 to 1.00)						
India 12 356 (3.5)	38.1	36.9	1.05 (0.97 to 1.14)	1.08 (0.99 to 1.17)	18.8	16.9	1.17 (1.05 to 1.30)*	1.19 (1.07 to 1.33)*						
Pakistan 9 150 (2.6)	41.3	42.7	0.95 (0.97 to 1.05)	0.96 (0.87 to 1.05)	21.9	22.7	0.94 (0.84 to 1.05)	0.95 (0.85 to 1.07)						
China 7 566 (2.2)	30.2	28.9	1.09 (0.97 to 1.22)	1.07 (0.95 to 1.20)	19.9	19.9	1.01 (0.88 to 1.16)	1.02 (0.89 to 1.17)						
Philippines 5 654 (1.6)	30.5	31.1	0.95 (0.84 to 1.08)	0.98 (0.89 to 1.11)	13.4	14.6	0.88 (0.74 to 1.05)	0.89 (0.74 to 1.07)						
Sri Lanka 6 169 (1.8)	34.2	34.3	0.99 (0.88 to 1.12)	1.00 (0.88 to 1.12)	16.5	17.2	0.94 (0.81 to 1.10)	0.92 (0.78 to 1.08)						
Jamaica 3 057 (0.9)	45.2	44.6	1.03 (0.88 to 1.20)	0.98 (0.83 to 1.16)	26.9	25.4	0.93 (0.77 to 1.12)	0.9 (0.73 to 1.10)						
Afghanistan 2 684 (0.8)	38.3	40.1	0.89 (0.75 to 1.06)	0.90 (0.75 to 1.07)	18.8	16.1	1.27 (1.01 to 1.60)*	1.23 (0.96 to 1.56)						
Vietnam 2 424 (0.7)	27.9	27.8	1.01 (0.82 to 1.24)	1.02 (0.82 to 1.26)	10.9	10.5	0.9 (0.66 to 1.23)	0.82 (0.58 to 1.16)						
Somalia 2 382 (0.7)	58.2	53.1	0.79 (0.67 to 0.95)*	0.84 (0.69 to 1.03)	44.5	47.8	0.87 (0.72 to 1.05)	0.99 (0.76 to 1.50)						
Poland 2 340 (0.7)	45.1	43.5	1.08 (0.90 to 1.30)	1.10 (0.91 to 1.35)	16.1	15.6	1.07 (0.83 to 1.39)	1.02 (0.75 to 1.38)						
Iraq 2 030 (0.6)	37.3	37.0	0.99 (0.81 to 1.22)	1.03 (0.83 to 1.28)	18.0	17.7	0.97 (0.74 to 1.26)	0.99 (0.75 to 1.31)						
USA 1 828 (0.5)	45.5	46.8	0.96 (0.78 to 1.18)	0.93 (0.75 to 1.15)	20.3	19.2	1.17 (0.91 to 1.51)	1.2 (0.87 to 1.66)						
Guyana 1 626 (0.5)	39.1	38.3	1.03 (0.83 to 1.29)	1.07 (0.84 to 1.35)	17.1	20.2	0.81 (0.61 to 1.07)	0.83 (0.61 to 1.14)						
Iran 1 061 (0.3)	26.5	28.0	0.94 (0.67 to 1.28)	0.95 (0.67 to 1.34)	13.7	11.0	0.76 (0.50 to 1.16)	0.86 (0.51 to 1.45)						

Adjustment was for maternal age, income quintile, rurality, birth year, birth order and category of time spent in Canada (immigrant models only). Reference group=males.

*Indicates statistical significance at $p < 0.05$.

aOR, adjusted OR.

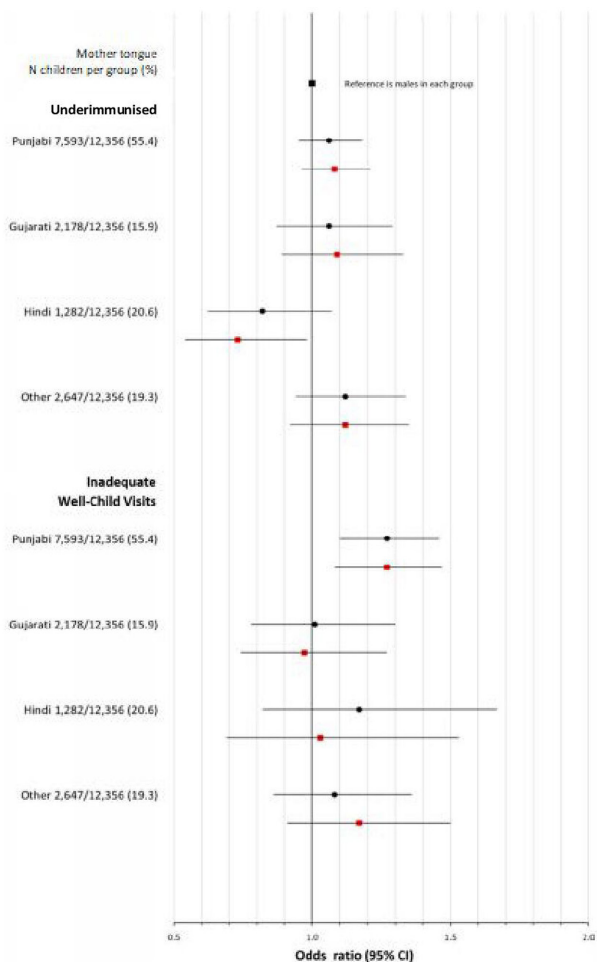


Figure 2 Unadjusted ● and adjusted ■ ORs. Adjustment was for maternal age, income quintile, rurality, birth year, birth order and category of time spent in Canada.

a cultural practice aimed at favouring boys. Despite this possibility, we have not found literature suggesting this may be occurring in India. Therefore, the observed disparity may be due to chance for the following reasons. First, the Hindi group is small relative to other groups, and the observed association is of borderline significance with a wide CI. Second, Hindi is a language spoken all over India, and therefore, it does not directly represent a well-defined linguistic, geographic or cultural group in the same way as Gujarati or Punjabi.

We observed stronger gender differences in inadequate well-child visits but not in immunisations. Doctor's visits require explicit parental decision making and planning; what occurs at the doctor's office, such as the delivery of immunisations, is largely influenced by the doctor himself or herself combined with public health initiatives. In other words, parents can act as gatekeepers for planning and attending doctor's visits, while doctors act as the gatekeepers for immunisation delivery.

Strengths

To our knowledge, this was the first retrospective population-based cohort to examine gender disparities

across multiple routine preventive care outcomes among children of immigrants. Second, due to the substantial diversity of Ontario mothers, we were able to examine gender disparities across many MCOB. Third, this study is the first to examine the issue of gender bias occurring within families that may be affecting the health of children of immigrants and non-immigrants. Our approach advanced existing research by considering maternal immigration and nativity (as opposed to the effects of ethnicity) as well as a within-sibling comparison. Finally, the use of official government immigration data to identify immigration factors and population-based administrative health data help strengthen both the internal and external validity of the study.

Limitations

Immigration data are only available for those arriving in Canada after 1985, so those arriving prior were misclassified as non-immigrants. Therefore, the Canadian-born group may be heterogeneous with health and gender beliefs related to their ancestral immigrant group. However, given an extended duration of residence, beliefs and health practices may be closer to Canadian norms.⁴² Moreover, this population is likely small relative to the Canadian-born population. We were unable to assess paternal country of birth, potentially biasing results towards the null effect. Mother tongue may not necessarily represent a particular geographic region of India nor her most commonly spoken language around the time of the index delivery,¹⁸ introducing possible heterogeneity. We found lower immunisation than earlier reports that ascertained coverage with surveys and immunisation records.⁴³ In the Ontario portion of the Childhood National Immunization Coverage Survey, antigen-specific coverage at 2 years of age ranged from 75.0% (Hib vaccine, *Haemophilus influenzae* Type b) to 93.4% (polio).⁴⁴ Therefore, combining each antigen for an overall vaccine coverage estimate is conditional on the coverage of each antigen each coverage and therefore would much lower and closer to our observed rates. However, the goal of our study was not to estimate antigen-specific coverage but to approximate a measure of routine healthcare utilisation using overall vaccine dose counting. One study using physician billing for dose counting found a similar prevalence (42%) of underimmunisation to ours.⁴⁵

Finally, census-derived variables are measured infrequently and may result in misclassification, contributing to residual confounding. Using a fixed-effects analytic approach helped to control for within-family unobservable factors.^{30 35 36} It is also important to note that immigrants are not representative of the source population, which may explain why we did not find significant effects for most MCOB, even among those where gender inequity is high.^{38 39} Findings may not be generalisable to children born outside of Ontario, Canada, including children who themselves immigrated, although it is also possible that stronger effects may have been observed.

Conclusion and implications

Gender equity in routine preventive healthcare is achieved among children of immigrants, with the notable exception of those from India. In this select case, son preference appears to persist beyond family planning and may adversely affect the well-being of daughters whose mothers migrate from India. This work may help healthcare providers attend to children needing additional preventive care. For example, paediatricians can inquire about siblings and the status of their immunisations and well-child visits. The paediatrician is presented with the opportunity to help ensure gender equity within the family with respect to healthcare in early childhood. Future directions include verifying the mechanisms behind son preference in child healthcare, as well as exploring potential gender-based adversity through other areas of child well-being. Community-led interventions addressing son preference and the well-being of daughters may be helpful in improving gender equity in healthcare among those affected.

Author affiliations

¹Department of Epidemiology, University of Toronto Dalla Lana School of Public Health, Toronto, Ontario, Canada

²ICES, Toronto, Ontario, Canada

³Department of Pediatrics, The Hospital for Sick Children, Toronto, Ontario, Canada

⁴Department of Epidemiology, University of Toronto Dalla Lana School of Public Health, Toronto, Ontario, Canada

⁵Department of Medicine, St. Michael's Hospital, Toronto, Ontario, Canada

⁶Department of Obstetrics and Gynecology, St Michael's Hospital, Toronto, Ontario, Canada

⁷Li Ka Shing Knowledge Institute, St Michael's Hospital, Toronto, Ontario, Canada

⁸University of Manitoba, Winnipeg, Manitoba, Canada

Contributors All authors: planned and conceptualised the study. AP and MU: acquired and analysed the data. All authors: interpreted the data, wrote the manuscript and revised it critically for intellectual context. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

Funding This work was supported by Canadian Institutes for Health Research Grant #MOP-130498 and FDN-154280. AP was supported by a Canadian Institutes for Health Research Doctoral Research Award #337110. MLU holds a Canada Research Chair in Applied Population Health. JR and AG hold CIHR Applied Chairs in Reproductive, Child and Youth Health Services and Policy Research. This study was supported by ICES, which is funded by an annual grant from the Ontario Ministry of Health and Long-Term Care (MOHLTC).

Disclaimer The opinions, results and conclusions reported in this paper are those of the authors and are independent of the funding sources. No endorsement by ICES or the Ontario MOHLTC is intended or should be inferred.

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not required.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data used for the current study are held securely at ICES in Ontario, Canada. Data sharing agreements prohibit ICES from making the dataset publicly available.

Open access This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>.

ORCID iD

Ariel Pulver <http://orcid.org/0000-0001-7010-8496>

REFERENCES

- 1 Condon LJ, McClean S. Maintaining pre-school children's health and wellbeing in the UK: a qualitative study of the views of migrant parents. *J Public Health* 2017;39:455–63.
- 2 Brown KF, Kroll JS, Hudson MJ, *et al*. Factors underlying parental decisions about combination childhood vaccinations including MMR: a systematic review. *Vaccine* 2010;28:4235–48.
- 3 Borràs E, Domínguez A, Batalla J, *et al*. Vaccination coverage in Indigenous and immigrant children under 3 years of age in Catalonia (Spain). *Vaccine* 2007;25:3240–3.
- 4 Lhila A, Simon KI. Prenatal health investment decisions: does the child's sex matter? *Demography* 2008;45:885–905.
- 5 Puri S, Adams V, Ivey S, *et al*. "There is such a thing as too many daughters, but not too many sons": A qualitative study of son preference and fetal sex selection among Indian immigrants in the United States. *Soc Sci Med* 2011;72:1169–76.
- 6 Ebenstein A, Li H, Meng L. *The impact of ultrasound technology on the status of women in China*. Hebrew University and Tsinghua University Working Paper, 2010.
- 7 Bharadwaj P, Dahl GB, Sheth K. Gender discrimination in the family. In: *The economics of the family: how the household affects markets and economic growth*. , 2014: 2, 237.
- 8 Khera R, Jain S, Lodha R, *et al*. Gender bias in child care and child health: global patterns. *Arch Dis Child* 2014;99:369–74.
- 9 Ramakrishnan S, Khera R, Jain S, *et al*. Gender differences in the utilisation of surgery for congenital heart disease in India. *Heart* 2011;97:1920–5.
- 10 Barcellos SH, Carvalho LS, Lleras-Muney A. Child gender and parental investments in India: are boys and girls treated differently? *Am Econ J Appl Econ* 2014;6:157–89.
- 11 Pandey A, Sengupta PG, Mondal SK, *et al*. Gender differences in Healthcare-Seeking during common illnesses in a rural community of West Bengal, India. *J Health Popul Nut* 2002;20:306–11.
- 12 Pande RP. Selective gender differences in childhood nutrition and immunization in rural India: the role of siblings. *Demography* 2003;40:395–418.
- 13 Pande RP, Yazbeck AS. What's in a country average? wealth, gender, and regional inequalities in immunization in India. *Soc Sci Med* 2003;57:2075–88.
- 14 Jayachandran S, Kuziemko I. Why do mothers breastfeed girls less than boys? evidence and implications for child health in India. *Q J Econ* 2011;126:1485–538.
- 15 Fikree FF, Pasha O. Role of gender in health disparity: the South Asian context. *BMJ* 2004;328:823–6.
- 16 Ray JG, Henry DA, Urquia ML. Sex ratios among Canadian liveborn infants of mothers from different countries. *CMAJ* 2012;184:E492–6.
- 17 Urquia ML, Moineddin R, Jha P, *et al*. Sex ratios at birth after induced abortion. *CMAJ* 2016;188:E181–90.
- 18 Brar A, Wanigaratne S, Pulver A, *et al*. Sex ratios at birth among Indian immigrant subgroups according to time spent in Canada. *J Obstet Gynaecol Can* 2017;39:e2:459–64.
- 19 Urquia ML, Ray JG, Wanigaratne S, *et al*. Variations in male-female infant ratios among births to Canadian- and Indian-born mothers, 1990–2011: a population-based register study. *CMAJ Open* 2016;4:E116–23.
- 20 Dubuc S, Coleman D. An increase in the sex ratio of births to India-born mothers in England and Wales: evidence for sex-selective abortion. *Popul Dev Rev* 2007;33:383–400.
- 21 Edvardsson K, Axmon A, Powell R, *et al*. Male-biased sex ratios in Australian migrant populations: a population-based study of 1 191 250 births 1999–2015. *Int J Epidemiol* 2018;47:2025–37.
- 22 Howell EM, Zhang H, Poston DL. Son preference of immigrants to the United States: data from U.S. birth certificates, 2004–2013. *J Immigr Minor Health* 2018;20:711–6.
- 23 Martineau A, White M, Bhopal R. No sex differences in immunisation rates of British South Asian children: the effect of migration? *BMJ* 1997;314:642.
- 24 Pulver A, Ramraj C, Ray JG, *et al*. A scoping review of female disadvantage in health care use among very young children of immigrant families. *Soc Sci Med* 2016;152:50–60.
- 25 Vertovec S. Super-diversity and its implications. *Ethn Racial Stud* 2007;30:1024–54.
- 26 Wanigaratne S, Cole DC, Bassil K, *et al*. The influence of refugee status and secondary migration on preterm birth. *J Epidemiol Community Health* 2016;70:622–8.

- 27 Chiu M, Lebenbaum M, Lam K, *et al*. Describing the linkages of the immigration, refugees and citizenship Canada permanent resident data and vital statistics death registry to Ontario's administrative health database. *BMC Med Inform Decis Mak* 2016;16:135.
- 28 Feudtner C, Feinstein JA, Zhong W, *et al*. Pediatric complex chronic conditions classification system version 2: updated for ICD-10 and complex medical technology dependence and transplantation. *BMC Pediatr* 2014;14:199.
- 29 Guttman A, Shipman SA, Lam K, *et al*. Primary care physician supply and children's health care use, access, and outcomes: findings from Canada. *Pediatrics* 2010;125:1119–26.
- 30 Allison PD. *Fixed effects regression methods for longitudinal data using SAS*. SAS Institute, 2005.
- 31 Schwartz KL, Tu K, Wing L, *et al*. Validation of infant immunization billing codes in administrative data. *Hum Vaccin Immunother* 2015;11:1840–7.
- 32 Hawken S, Kwong JC, Deeks SL, *et al*. Association between birth order and emergency room visits and acute hospital admissions following pediatric vaccination: a self-controlled study. *PLoS One* 2013;8:e81070.
- 33 Kralj B. Measuring “rurality” for purposes of health-care planning: an empirical measure for Ontario. *Ont Med Rev* 2000;67:33–52.
- 34 Gushulak BD, Pottie K, Hatcher Roberts J, *et al*. Migration and health in Canada: health in the global village. *CMAJ* 2011;183:E952–8.
- 35 D'Onofrio BM, Singh AL, Iliadou A, *et al*. Familial confounding of the association between maternal smoking during pregnancy and offspring criminality: a population-based study in Sweden. *Arch Gen Psychiatry* 2010;67:529–38.
- 36 Lahey BB, D'Onofrio BM. All in the family: comparing siblings to test causal hypotheses regarding environmental influences on behavior. *Curr Dir Psychol Sci* 2010;19:319–23.
- 37 Gupta MD. Selective discrimination against female children in rural Punjab, India. *Popul Dev Rev* 1987;13:77–100.
- 38 Das Gupta M, Zhenghua J, Bohua L, *et al*. Why is son preference so persistent in East and South Asia? A cross-country study of China, India and the Republic of Korea. *J Dev Stud* 2003;40:153–87.
- 39 Jayachandran S. The roots of gender inequality in developing countries. *Economics* 2015;7:63–88.
- 40 Hackshaw A, Kirkwood A. Interpreting and reporting clinical trials with results of borderline significance. *BMJ* 2011;343:d3340.
- 41 Jones N, Walsh C, Buse K. *Gender and immunization abridged report. A knowledge stocktaking exercise and an independent assessment of the GAVI alliance overseas*. London, UK: Development Institute, 2008.
- 42 Reitz JG, Phan MB, Banerjee R. Gender equity in Canada's newly growing religious minorities. *Ethn Racial Stud* 2015;38:681–99.
- 43 Wilson SE, Quach S, MacDonald SE, *et al*. Methods used for immunization coverage assessment in Canada, a Canadian immunization research network (CIRN) study. *Hum Vaccin Immunother* 2017;13:1928–36.
- 44 PHAOC. *Vaccine coverage in Canadian children: results from the 2013 childhood national immunization coverage survey (cNICS)*, 2016.
- 45 Dummer TJB, Cui Y, Strang R, *et al*. Immunization completeness of children under two years of age in nova Scotia, Canada. *Can J Public Health* 2012;103:e363–7.