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Variations in male to female ratios among births to Canadian-born and Indian immigrants to Canada, 1990-2011.

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Abstract

Background. Higher than expected male to female (M:F) ratios at birth have been observed among some Asian immigrant groups, especially those from India, a top contributor to births of immigrants in Canada. Details about variation in newborn M:F ratios in Canada are unknown.

Methods. We analyzed the Canadian Vital Statistics Birth Database, 1990-2011. M:F ratios were stratified by livebirth order and plotted by year of birth. Logistic regression was used to assess whether M:F ratios varied between Canadian provinces and according to the birthplace of each parent.

Results. There were 5 853 970 singleton births to Canadian-born and 177 990 to Indian-born mothers. Among Canadian-born mothers, M:F ratios were about 1.05, with negligible fluctuations by birth order, year and province. Among Indian-born mothers, the overall M:F ratio at the third birth was 1.38 (95% CI: 1.34-1.41) and was 1.66 (95% CI: 1.56-1.76) at the fourth or higher-order births. There was little variability in the M:F ratios between provinces. Couples involving at least one Indian-born parent had higher than expected M:F ratios at the second and higher-order births, principally when the father was Indian-born. The deficit in the number of girls among Indian immigrants to Canada in the study period was estimated to be 4472 (95% CI: 3211-5921).

Interpretation. High M:F ratios at the third and higher-order births were found since 1990 among Indian immigrants to Canada, did not substantially vary between provinces and were also observed among mixed nativity couples, including those of a Canadian-born mother and an India-born father.

Higher than expected male to female (M:F) ratios at birth have been observed in several countries, particularly in Asia.[1-8] High M:F ratios at birth have also been observed among some Asian immigrant groups to industrialized countries,[9-14] including Canada.[11;13] In most populations, the normal M:F ratio ranges from 1.03 to 1.07,[5;15-17] although the reasons of why male newborns slightly outnumber girls are still unknown.[18] Higher than expected M:F ratios have been observed in Ontario among second births of South Korean immigrants and second and higher order births of Indian immigrants. The M:F ratio among third-order livebirths to India-born mothers who migrated to Ontario was 1.36.[13] Census data from Canada noted a M:F ratio of 1.90 among third-order births to India-born women with two previous girls.[11]

It is not known the extent to which skewed M:F ratios have existed among Indian immigrants to Canada, in terms of time trends or by province. While previous research focused on the country of birth of the mother, no consideration has been given to the influence of the father's country of birth on M:F ratios, particularly among mixed nativity couples that are increasingly more common within multicultural societies like Canada.[19]

Herein, we focused on immigrants from India because they have the highest documented M:F ratios globally, and they are a top contributor of births to immigrants in Canada. The large number of births to Indian immigrants in Canada allows to assess temporal trends and provincial variations in the M:F ratios among livebirths to women born in Canada or India. We also assessed whether the M:F ratios differed if the mother and father were from the same or different countries, and further estimated the number of missing girls among births to immigrants from India.

Methods

We used national birth cohorts from 1990 to 2011 as contained in the Canadian Vital Statistics Birth Database (CVSBD), administered by Statistics Canada. The database is composed of birth certificate data provided by provincial and territorial Vital Statistics Registrars. Although the current CVSBD begins in 1974, maternal country of birth was poorly captured before 1990, when immigrants from India were collapsed into a single "Asia" group. We restricted our analyses to singleton livebirths among mothers born in Canada or India, who had complete and plausible information about maternal country of birth, number of previous livebirths, infant sex, province and year of birth. Birth order was assessed by a field in the CVSBD reporting the total number of previous livebirths each mother had at each index birth, irrespective of whether they occurred in Canada or not. We excluded births outside of Canada, irrespective of whether the mother was Canadian-born or not, and births in the Yukon, Northwest Territories and Nunavut, because of the negligible number of births to Indian-born women in these jurisdictions.

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Reporting guidelines for the CVSBD mandate the masking of frequencies to prevent re-identification of individuals. We therefore used controlled rounding techniques to randomly approximate all counts to the nearest multiple of 5. Use of the data was approved by Statistics Canada and by the Research Ethics Board of St. Michael's Hospital, Toronto.

Data analysis

A male to female ratio is an odds $(P_{(male)}/(1-P_{(male)}))$. We used intercept-only logistic regression models to calculate M:F ratios (i.e., the odds of a male) within each stratum of birth order (i.e., first, second, third, or fourth birth and higher). To assess linear trends in the M:F ratio over time we used the Cochran-Armitage test for binomial proportions. Logistic regression was then used to obtain adjusted odds ratios (OR) with 95% confidence intervals (CI), comparing the M:F ratios within strata of birth order between provinces. Ontario served as the referent, as it is the largest Canadian province, with the largest concentration of Indian immigrants.[13]

The number of missing girls was calculated by M/(F+x)=1.07, where x is the number of missing girls. To indicate the presence of a deficit in the number of girls, we only considered M:F ratios above 1.07; the upper limit of the established normal biological variability.[5;15-17] The 95% confidence intervals were calculated using bootstrap with 10 000 replications. The lower bound was set to be 0 when negative.

Results

There were 6 074 115 singleton livebirths to mothers born in Canada or India in the 22-year period 1990-2011. Of these, we excluded 42 155 records (0.69%) due to one or more of the following reasons: missing information on the number of previous livebirths (3910 [0.06%]), infant's sex unknown (295 [< 0.01%]), missing or out of range maternal age (7440 [0.12%]), infant's province of birth unknown (185 [0.01%]), and birth occurred in Yukon, Northwest Territories and Nunavut (33,105 [0.55%]). The final sample comprised 6 031 960 livebirths, of which 5 853 970 were to Canadian-born mothers and 177 990 to Indian-born mothers.

About 45% of all births to Canadian-born mothers occurred in BC and Ontario, in contrast to 85% of births to Indian-born mothers (Table 1). There were relatively few births to Indian-born mothers in Quebec. Most fathers were born in the same country as was the mother. Canadian-born mothers tended to have more births than Indian-born mothers after two previous children. Unlike Canadian-born mothers, among Indian-born women, the proportion of males noticeably increased according to birth order and maternal age groups. Unlike Canadian-born mothers, the vast majority Indian-born mothers were married (Table 1).

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Crude M:F ratios among Canadian-born mothers showed little, if any, fluctuation according to birth order and year of birth, ranging between 1.03 to 1.06 (Figure 1, left). In contrast, crude M:F among Indian-born women were consistently high for third and fourth or higher-order births (Figure 1, right). Among Indian-born mothers, the overall M:F ratio at the third birth was 1.38 (95% CI: 1.34-1.41) and increased over time (p < 0.05) from 1.15 (95% CI: 1.04-1.27) in 1990-1991 to 1.38 (95% CI: 1.27-1.50) in 2010-2011, after having peaked to 1.57 (95% CI: 1.43-1.72) in 2000-2001. Conversely, The overall M:F at the fourth and higher-order births among Indian mothers was 1.66 (95% CI: 1.56-1.76), declining from 1.84 (95% CI: 1.51- 2.24) in 1990-1991 to 1.45 (95% CI: 1.22-1.73) in 2010-2011 (Figure 1, right). A *post hoc* analysis suggested that these contrasting trends between third-order and fourth or higher-order births among Indian mothers were accompanied by parallel trends towards smaller families. Specifically, the proportion of third-order births among all births to Indian-born women decreased from 16.4% in 1990-1991 to 11.3% in 2010-2011 (p<0.01), while the proportion of fourth and higher-order births decreased from 4.4% in 1990-1991 to 2.5% in 2010-2011 (p<0.01).

Among Canadian-born mothers, M:F ratios remained unchanged within strata of birth order comparing other provinces to Ontario (Table 2). For Indian-born mothers, provincial variation was also minimal, except among fourth and higher-order births in British Columbia (adjusted OR 1.28, 95% CI: 1.12 to 1.47) (Table 2).

For the assessment of M:F ratios within groups jointly defined by maternal and paternal country of birth, we further included 1 464 330 infants born to mothers not born in Canada or India, after exclusions, obtaining 7 496 290 births for these analyses.

Comparing M:F ratios by maternal and paternal country of birth, the highest ratio was among two Indian-born parents (Table 3). Since most births to Indian-born parents were to couples in which both parents were from India, this arrangement explained about 95% of the deficit in the number of girls. Interestingly, the presence of an Indian-born father was associated with higher than expected M:F ratios at the second and higher birth orders, irrespective of whether the mother was born in India or not.

For mixed nativity unions, the M:F ratios were higher at the 3 or 4+ birth order if one of the parents was Indian-born, but the most marked effect at the fourth birth was among couples comprising a Canadian-born mother and an Indian-born father (M:F ratio 1.46; 95% CI: 1.18 to 1.82), followed by couples involving an Indian-born mother and a father not born in Canada or India (M:F ratio 1.38; 95% CI: 1.16 to 1.64) (Table 3).

The top birthplaces of mothers not born in Canada or India coupled with an Indian-born father were the UK (32%), followed by Pakistan (10%) and Philippines (5%). The top birthplaces of

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fathers not born in Canada or India coupled with an Indian-born mother were unknown (48%), followed by the UK (32%), Pakistan (6%) and Sri Lanka (4%).

Interpretation

Main findings

We evaluated most registered livebirths to Indian immigrants to Canada over more than two decades, and compared them to nearly all livebirths to Canadian-born parents. Among Indian immigrants, high M:F ratios were observed at third-order and 4+ order births, which did not vary considerably across provinces. We conservatively estimated that 4472 girls of Indian immigrants to Canada were unaccounted for over the last two decades – so-called "missing girls" [7-9]-- largely among couples of two Indian-born parents (89.4%).

Consistency with previous studies

Our study confirms that the majority of missing girls occurs at the third birth (n = 2616, 58.5%), and that this phenomenon is more common among fourth and higher order births (n = 1092, 24.4%) than among second order births (n = 764, 17.1%). Few previous studies were large enough to examine M:F ratios at fourth and higher-order births.[6;13] Unlike in our prior study that was limited to Ontario, and in which we included livebirths and stillbirths in defining birth order,[13] here we only included livebirths. Counting stillbirths dilutes the association between birth order and M:F ratios, since fertility decisions are thought to be made based on the current number and sex of the living children in the family.[1]

Our study is the first to quantify the contribution of both maternal and paternal country of birth to M:F newborn sex ratios. Paternal influence has been postulated to be a key influence on M:F ratios,[20] and our findings suggests that this is so even among couples of mixed nativity. Certainly, some Canadian-born mothers may have been of second-generation Indian ancestry. Data from the 2001 and 2006 Canadian censuses reported a M:F ratio of 1.32 within households of "Asian" couples with two previous girls, in which one or both parents were Canadian-born.[11] Interestingly, among mixed couples, most parents in the "Other" group (i.e., not born in Canada or India) were born in the UK, where a large Indian diaspora exists, including second generation Indians. Further studies may clarify to what extent the skewed sex ratios among mixed nativity couples involve second generation Indians. Although mixed nativity couples accounted for only 10.6% of the total number of missing girls in the current study, it remains to be seen how M:F ratios will change within this emerging demographic group.[19]

Limitations and strengths

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As a limitation, the CVSBD does not distinguish between births from the same mother and, therefore, we could not examine finer patterns in the M:F ratios according to the sex of the previous siblings. While our aggregation at the level of livebirth order would have diluted the effect sizes observed herein, this limitation should not have severely underestimated of the number of missing girls, due to our large sample size. Second, The CVSBD does not have data on induced abortions, which would provide more direct information about the practice of prenatal sex selection. However, our companion paper addresses this limitation.[21] Third, although we used novel data about both maternal and paternal country of birth, recording of father's birthplace was not as complete as that of the mother. Finally, the CVSBD does not ascertain year of immigration. Such information could help to determine whether duration of residence in Canada leads to more balanced M:F ratios, as seen among newborns of two Canadian-born parents. Finally, grandparents' birthplace was not captured, so second-generation immigrants could not be identified.

Despite these limitations, this study provides a comprehensive portrait of skewed M:F ratios among Indian immigrants to Canada, including M:F ratios among fourth and higher-order births, something not possible in studies using Canadian census data.[11] Our inclusion of fourth and higher-order births specifically revealed that missing girls are common in this stratum, and that the failure to account for fourth and higher-order births may underestimate the calculation of the number of missing girls by about 25%.

Interpretation

Our findings highlight the magnitude of the skewed sex ratios at birth among Indian immigrants to Canada but do not explain them. There are numerous speculations regarding the factors that may affect natural sex ratios, most of which are surrounded by conflicting evidence.[18] Human intervention, in the form of prenatal sex selection, specifically induced abortion of female fetuses following prenatal ultrasonography, is the most commonly cited explanation in settings where son preference and strong patriarchal cultures are prevalent, although direct evidence of such link is lacking. [22] Our companion paper adds plausibility to such claim by showing that high M:F ratios are associated with preceding induced abortions in Ontario.[21] As son-biased sex ratios among Indian immigrants did not differ according to Canadian provinces in this study, those Ontario findings are likely to apply to the rest of Canada. A qualitative study supports the link between son preference and prenatal sex selection among Indian immigrants in the US,[23] not limited to induced abortion but also involving assisted reproductive technologies. Future studies may further elucidate the specific contribution of the distinct pathways.

It appears that skewed M:F ratios among some Indian immigrants to Canada have been present for at least two decades, accruing about 4472 missing girls. This estimate may be conservative, since calculations of missing girls based on M:F ratios do not account for repeated induced

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abortions of female fetuses.[21] Since the biological probability of having a male livebirth is independent of the sex of the previous births of the same mother,[24] consecutive pregnancies of female fetuses are likely to occur. Some couples may, therefore, undergo repeated induced abortions until they carry a male fetus.[21;23]

We found increasing temporal trends in the M:F ratio at the third birth paralleled by decreasing trends at higher-order births. This is likely a function of declining trends in family size over time. Under the hypothesis of the son preference, securing a boy by the third birth may release the pressure of getting a boy in subsequent births.

The lack of substantial provincial differences in the sex ratios of Indian immigrants suggests that the place of origin may be more influential than that of destination. Although the M:F ratio at the fourth birth was somewhat higher in British Columbia and Manitoba and Saskatchewan compared to Ontario, something worthy of further exploration, it was higher than expected in all Canadian provinces.

Finally, our study highlights the importance of the father as a key figure to take into account when conducting further research on the topic or designing strategies to curve down the skewed sex ratios within certain communities.

Conclusion

In Canada, a higher M:F ratio at birth among Indian immigrants may have produced a deficit of about 4472 girls over the past two decades. While we lacked the data required to explain the deficit, this study provides a comprehensive account of missing girls to Indian immigrants in Canada.

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Reference List

(1) Arnold F. Measuring the effect of sex preference on fertility: the case of Korea. *Demography* 1985; 22(2):280-288.

(2) Arnold F, Kishor S, Roy TK. Sex-Selective Abortions in India. *Population and Development Review* 2002; 28(4):759-785.

(3) Chatterjee P. Sex ratio imbalance worsens in Vietnam. *Lancet* 2009; 374(9699):1410.

(4) Guilmoto CZ, Hoang X, Van TN. Recent increase in sex ratio at birth in Viet Nam. *PLoS One* 2009; 4(2):e4624.

(5) Hesketh T, Xing ZW. Abnormal sex ratios in human populations: causes and consequences. *Proc Natl Acad Sci U S A* 2006; 103(36):13271-13275.

(6) Jha P, Kumar R, Vasa P, Dhingra N, Thiruchelvam D, Moineddin R. Low female[corrected]-to-male [corrected] sex ratio of children born in India: national survey of 1.1 million households. *Lancet* 2006; 367(9506):211-218.

(7) Sen A. Missing women. *BMJ* 1992; 304(6827):587-588.

(8) Sen A. Missing women--revisited. *BMJ* 2003; 327(7427):1297-1298.

(9) Abrebaya J. Are there missing girls in the United States? Evidence from birth data. *American Economic Journal: Applied Economics* 2009; 1(2):1-34.

(10) Almond D, Edlund L. Son-biased sex ratios in the 2000 United States Census. *Proc Natl Acad Sci U S A* 2008; 105(15):5681-5682.

(11) Almond D, Edlund L, Milligan K. Son preference and the persistence of culture: Evidence from Asian immigrants to Canada. Working Paper 15391. 2009. Cambridge, MA, National Bureau of Economic Research. NBER Working Paper Series.

(12) Dubuc S, Coleman D. An Increase in the Sex Ratio of Births to India-born Mothers in England and Wales: Evidence of Sex-Selective Abortion. *Population and Development Review* 2007; 33(2):383-400.

(13) Ray JG, Henry DA, Urquia ML. Sex ratios among Canadian liveborn infants of mothers from different countries. *CMAJ* 2012; 184(9):E492-E496.

(14) Tonnessen M, Aalandslid V, Skjerpen T. Changing trend? Sex ratios of children born to Indian immigrants in Norway revisited. *BMC Pregnancy Childbirth* 2013; 13:170.

(15) Chahnazarian A. Determinants of the sex ratio at birth: review of recent literature. *Soc Biol* 1988; 35(3-4):214-235.

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(16) Jacobsen R, Moller H, Mouritsen A. Natural variation in the human sex ratio. *Hum Reprod* 1999; 14(12):3120-3125.

(17) Markle GE. Sex ratio at birth: values, variance, and some determinants. *Demography* 1974; 11(1):131-142.

(18) Wilcox A. Fertility and Pregnancy. An Epidemiologic Perspective. New York: Oxford University Press; 2010.

(19) Parker JD, Madans JH. The correspondence between interracial births and multiple-race reporting. *Am J Public Health* 2002; 92(12):1976-1981.

(20) Sever A. Discarded Daughters: The Patrialchal Grip, Dowry Deaths, Sex Ratio Imbalances & Foeticide in India. *Women's Health & Urban Life* 2008; 7(1):56-75.

(21) Urquia ML, Moineddin R, Jha P, O'Campo PJ, McKenzie K, Glazier RH et al. Sex ratios at birth after induced abortion. *CMAJ (submitted)* 2016.

(22) World Health Organization. Preventing gender-biased sex selection An interagency statement OHCHR, UNFPA, UNICEF, UN Women and WHO. http://whqlibdoc.who.int/publications/2011/9789241501460_eng.pdf . 2011. Geneva, World Health Organization.

(23) Puri S, Adams V, Ivey S, Nachtigall RD. "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(7):1169-1176.

(24) Rogers JLDD. Does Having Boys or Girls Run in the Family? *Chance* 2001; 14(4):8-13.

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Table 1. Characteristics of livebirths to Canadian-born and Indian-born mothers, Canada, 1990-2011

		Canadian-born mothers			Indian-born mothers		
		Livebirths	(%)	% male	Livebirths	(%)	% male
All births		5853 970	(100.0)	51.3	177 990	(100.0)	52.8
Birth characteristics							
Period of birth	1990-1999	2 856 050	(48.8)	51.3	64 775	(36.4)	53.1
	2000-2009	2 476 435	(42.3)	51.3	92 155	(51.8)	52.8
	2010-2011	521 485	(8.9)	51.3	21 060	(11.8)	51.9
Province of birth	British Columbia	635 670	(10.8)	51.2	55 740	(31.3)	52.9
	Alberta	720 805	(12.3)	51.3	17 770	(10.0)	52.4
	Manitoba-Saskatchewan	558 425	(9.5)	51.2	4005	(2.2)	54.3
	Ontario	1 987 715	(34.0)	51.3	94 855	(53.3)	52.8
	Quebec	1 455 615	(24.9)	51.4	4945	(2.8)	51.5
	Atlantic Canada*	495 740	(8.5)	51.2	675	(0.4)	51.1
Father's birthplace	Canadian-born	4 967 520	(84.8)	51.3	7195	(4.1)	51.7
	Indian-born	9315	(0.2)	52.1	155 760	(87.5)	52.9
	Other/ Unknown	877 140	(15.0)	51.1	15 030	(8.4)	52.0
Birth order	1st birth	2 635 520	(45.0)	51.3	82 355	(46.3)	51.5
	2nd birth	2 056 130	(35.1)	51.3	69 695	(39.2)	52.1
	3rd birth	783 970	(13.4)	51.2	21 090	(11.8)	57.9
	4th or higher	378 350	(6.5)	51.1	4850	(2.7)	62.4
Mother's age at birth, y	15 to 19	357 805	(6.1)	51.4	1005	(0.6)	50.7
	20 to 24	1 121 195	(19.2)	51.3	32 785	(18.4)	52.0
	25 to 29	1 938 765	(33.1)	51.3	72 820	(40.9)	52.2
	30 to 34	1 697 830	(29.0)	51.3	52 035	(29.2)	53.4
	35 to 55	738 380	(12.6)	51.2	19 345	(10.9)	54.8
Father's age at birth, y	15 to 24	705 155	(12.1)	51.4	8310	(4.7)	52.1
	25 to 34	3 391 905	(57.9)	51.3	113 710	(63.9)	52.3
	35 to 44	1 275 765	(21.8)	51.2	48 805	(27.4)	53.8
	45 to 54	97 345	(1.7)	51.4	3460	(1.9)	54.3
	55 to 80	7070	(0.1)	51.6	235	(0.1)	51.1
	Unknown	376 735	(6.4)	50.8	3465	(2.0)	53.4
Mother's marital status	Single never married	1 828 175	(31.2)	51.3	1520	(0.9)	53.0
	Married	3 448 310	(58.9)	51.3	167 920	(94.3)	52.8
	Widowed, divorced or separated	104 585	(1.8)	51.3	810	(0.5)	51.9
	Unknown	472 905	(8.1)	51.0	7740	(4.3)	51.9

* Includes Newfoundland and Labrador, Prince Edward Island, Nova Scotia and New Brunswick

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Figure 1. Time trends in Male to Female ratios among livebirths to Canadian-born mothers (left panel) and Indian-born mothers (right panel), according to livebirth order, Canada 1990-2011.
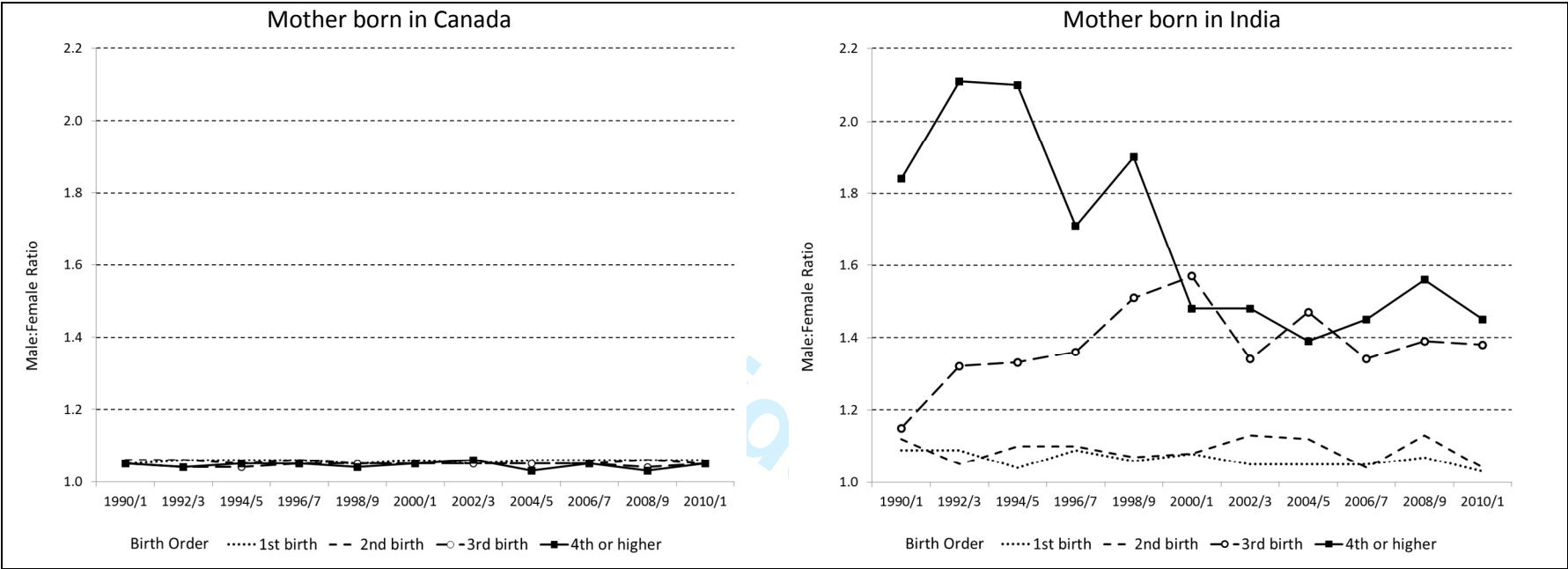
Table 2. Male to Female (M:F) ratios at birth among Canadian-born and India-born mothers, by livebirth order, and adjusted odds ratios for giving birth to a male infant in different Canadian provinces, by maternal birthplace and birth order, Canada 1990-2011.

Mother's birthplace	Live birth Order							
	1st birth		2nd birth		3rd birth		4th birth or higher	
Canada								
By Province	Males / Females	Adjusted Odds Ratio (95% CI)	Males / Females	Adjusted Odds Ratio (95% CI)	Males / Females	Adjusted Odds Ratio (95% CI)	Males / Females	Adjusted Odds Ratio (95% CI)
British Columbia	150645/142595	1.00 (1.00, 1.01)	113790/108470	1.00 (0.99, 1.01)	41985/40370	0.99 (0.97, 1.00)	19250/18565	0.98 (0.96, 1.00)
Alberta	157590/149540	1.00 (0.99, 1.01)	126080/118940	1.01 (1.00, 1.02)	53990/51670	0.99 (0.98, 1.00)	31995/31000	0.98 (0.96, 1.00)
Manitoba-Saskatchewan	113295/107115	1.00 (0.99, 1.01)	90070/86445	0.99 (0.98, 1.00)	46000/44160	0.99 (0.97, 1.00)	36405/34935	0.99 (0.97, 1.01)
Ontario	461840/438865	1.00 (referent)	364210/346025	1.00 (referent)	135840/128685	1.00 (referent)	57680/54570	1.00 (referent)
Quebec	351060/331635	1.00 (1.00, 1.01)	269580/255200	1.01 (1.00, 1.01)	91755/87180	1.00 (0.99, 1.01)	35325/33885	0.98 (0.96, 1.00)
Atlantic Canada	118815/112525	1.00 (0.99, 1.01)	90590/86730	0.99 (0.98, 1.00)	31715/30620	0.98 (0.97, 1.00)	12765/11980	1.01 (0.99, 1.03)
M:F Ratio in all provinces (95% CI)	**1.06 (1.05, 1.06)**		**1.05 (1.05, 1.06)**		**1.05 (1.04, 1.05)**		**1.05 (1.04, 1.05)**	
	1st birth		2nd birth		3rd birth		4th birth or higher	
India								
By Province	Males / Females	Adjusted Odds Ratio (95% CI)	Males / Females	Adjusted Odds Ratio (95% CI)	Males / Females	Adjusted Odds Ratio (95% CI)	Males / Females	Adjusted Odds Ratio (95% CI)
British Columbia	13215/12370	1.00 (0.97, 1.03)	10925/10260	0.97 (0.94, 1.00)	4345/3095	1.02 (0.96, 1.08)	1020/510	**1.28 (1.12, 1.47)**
Alberta	4255/4075	0.99 (0.94, 1.03)	3730/3385	1.00 (0.95, 1.05)	1110/855	0.94 (0.85, 1.03)	220/135	1.05 (0.84, 1.32)
Manitoba-Saskatchewan	1030/910	1.07 (0.98, 1.17)	800/700	1.04 (0.94, 1.16)	280/190	1.06 (0.88, 1.28)	65/35	1.33 (0.87, 2.04)
Ontario	22505/21275	1.00 (referent)	19795/17980	1.00 (referent)	6150/4445	1.00 (referent)	1620/1085	1.00 (referent)
Quebec	1225/1160	1.00 (0.92, 1.08)	930/925	0.91 (0.83, 1.00)	300/255	0.86 (0.72, 1.02)	90/55	0.91 (0.65, 1.28)
Atlantic Canada	170/165	1.01 (0.82, 1.26)	130/130	0.93 (0.73, 1.18)	65***	***	15***	***
M:F Ratio in all provinces (95% CI)	**1.06 (1.05, 1.08)**		**1.09 (1.07, 1.10)**		**1.38 (1.34, 1.41)**		**1.66 (1.56, 1.76)**	

* Except Yukon, Northwest Territories and Nunavut

** Adjusted for period of birth (1990-1999, 2000-2009, 2010-2011), maternal age groups (15 to 19 years, 20 to 24, 25 to 29, 30 to 34, 35 to 55), paternal age groups (15 to 24 years, 25 to 34, 35 to 44, 45 to 54, 55 to 80 and unknown) and marital status (Single never married, Married, Widowed, divorced or separated and unknown)

*** M:F ratios based on < 100 observations are not disclosed and therefore these frequencies include both males and females

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Table 3. Unadjusted Male to Female (M:F) Ratios by maternal and paternal birthplace and birth order, Canada 1990-2011.

Mother's birthplace	Father's birthplace	Birth order	Males/Females	M:F ratio (95% CI)	Estimated number of missing girls (95% CI)	Estimated % of missing girls
Canada	Canada	1	1 127 735 / 1 066 260	1.06 (1.05, 1.06)	*	
		2	917 940 / 871 550	1.05 (1.05, 1.06)	*	
		3	344 585 / 328 605	1.05 (1.04, 1.05)	*	
		4+	159 060 / 151 785	1.05 (1.04, 1.06)	*	
Canada	India	1	2345 / 2275	1.03 (0.97, 1.09)	*	
		2	1695 / 1540	**1.10 (1.03, 1.18)**	44 (0, 152)	0.98
		3	605 / 510	**1.19 (1.05, 1.33)**	55 (0, 119)	1.23
		4+	205 / 140	**1.46 (1.18, 1.82)**	52 (17, 86)	1.16
Canada	Other	1	223 175 / 213 735	1.04 (1.04, 1.05)	*	
		2	134 680 / 128 720	1.05 (1.04, 1.05)	*	
		3	56 095 / 53 570	1.05 (1.03, 1.06)	*	
		4+	34 150 / 33 010	1.03 (1.02, 1.05)	*	
India	Canada	1	1970 / 1855	1.06 (1.00, 1.13)	*	
		2	1305 / 1235	1.06 (0.98, 1.14)	*	
		3	370 / 310	**1.19 (1.03, 1.39)**	36 (0, 86)	0.81
		4+	80 / 75	1.07 (0.78, 1.46)	*	
India	India	1	36 640 / 34 550	1.06 (1.05, 1.08)	*	
		2	32 255 / 29 490	**1.09 (1.08, 1.11)**	657 (181, 1129)	14.69
		3	10 885 / 7775	**1.40 (1.36, 1.44)**	2398 (2141, 2655)	53.62
		4+	2640 / 1525	**1.73 (1.63, 1.84)**	942 (824, 1060)	21.06
India	Other	1	3785 / 3555	1.06 (1.02, 1.11)	*	
		2	2755 / 2650	1.04 (0.99, 1.10)	*	
		3	960 / 790	**1.22 (1.11, 1.34)**	107 (28, 187)	2.39
		4+	310 / 225	**1.38 (1.16, 1.64)**	65 (20, 109)	1.45
Other	Canada	1	81 970 / 77 410	1.06 (1.05, 1.07)	*	
		2	63 990 / 60 275	1.06 (1.05, 1.07)	*	
		3	23 165 / 22 275	1.04 (1.02, 1.06)	*	
		4+	11 365 / 10 595	1.07 (1.04, 1.10)	*	
Other	India	1	2045 / 1970	1.04 (0.98, 1.10)	*	
		2	1795 / 1615	**1.11 (1.04, 1.19)**	63 (0, 175)	1.41
		3	695 / 630	**1.10 (0.99, 1.23)**	20 (0, 89)	0.45
		4+	255 / 205	**1.24 (1.03, 1.49)**	33 (0, 74)	0.74
Other	Other	1	233 015 / 220 120	1.06 (1.05, 1.06)	*	
		2	200 585 / 190 785	1.05 (1.04, 1.06)	*	
		3	84 170 / 80 160	1.05 (1.04, 1.06)	*	
		4+	48 965 / 46 275	1.06 (1.04, 1.07)	*	
Total			3 848 240 / 3 648 050	1.06 (1.05, 1.06)	4472 (3211, 5921)	100.00

* Only M:F ratios > 1.07 are considered to exceed the natural range of 1.03 to 1.07, and therefore, are included in the calculation of missing girls

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Birth Order ····· 1st birth − − 2nd birth −o· 3rd birth ■ 4th or higher