

# Unintentional injuries in children and youth from immigrant families in Ontario, Canada: a population-based cross-sectional study

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## Abstract

**Background:** Unintentional injury is the leading cause of childhood death. Injury is associated with a number of sociodemographic characteristics, but little is known about risk in immigrants. Our objective was to examine the association between family immigrant status and unintentional injury in children and youth.

**Methods:** We performed a population-based, cross-sectional study involving children and youth (age 0–24 yr) residing in Ontario from 2008 to 2012. Multiple linked health and administrative databases were used to describe unintentional injuries by family immigrant status. Unintentional injury events (e.g., emergency department visits, admissions to hospital, deaths) were analyzed using Poisson regression models to estimate rate ratios (RRs) for injury by immigrant status.

**Results:** Annualized injury rates were 11 749 emergency department visits per 100 000 population, 267 hospital admissions per 100 000 population and 12 deaths per 100 000 population. Injury rates were lower among immigrants across all causes of unintentional injury (adjusted RR 0.56, 95% confidence interval [CI] 0.54–0.59). Among nonimmigrants, lowest neighbourhood income quintile was associated with the highest rates (RR 1.13, 95% CI 1.08–1.18, quintile 5 v. 1); among immigrants, lowest income quintile was associated with the lowest rates of injury (RR 0.88, 95% CI 0.82–0.94, quintile 5 v. 1). Highest rates of injury for nonimmigrants were among adolescents (age 10–14 yr, RR 1.23, 95% CI 1.18–1.28; v. 20–24 yr), but for immigrants, was highest among young children (0–4 yr RR 1.23, 95% CI 1.16–1.31; v. 20–24 yr).

**Interpretation:** Rates of unintentional injury are lower among immigrant than among Canadian-born children, supporting a healthy immigrant effect. Socioeconomic status and age have different associations with injury risk, suggesting alternative causal pathways for injuries in immigrant children and youth.

Injury is one of the leading causes of visits to the emergency department and is the leading cause of death for children and youth in Canada and other high-income countries.<sup>1–3</sup> Although some minor injuries (scrapes and bruises) occur during physical activity and may reflect healthy, active living, many injuries cause some degree of harm and are preventable. Epidemiologic literature has identified a number of risk factors for unintentional childhood injuries. Adolescent boys have consistently been shown to be at highest risk of injuries that require medical attention compared with girls and younger children.<sup>3–5</sup> Children living in rural areas have higher per capita rates of bicycle-related head injuries compared with children in urban settings,<sup>6</sup> and children from lower income neighbourhoods or families are

more likely to be injured.<sup>7–11</sup> A number of important policies and by-laws have been implemented over the past 2 decades in Ontario and elsewhere, such as mandatory bicycle helmets for minors,<sup>12–14</sup> maximum water temperature by-laws for residential hot water heaters<sup>15</sup> and improved playground safety standards,<sup>16</sup> which have all effectively reduced injury rates in

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youth.<sup>7,13,17–19</sup> Despite these important strides, preventable injuries continue to occur, suggesting room for improvement in policy development in addition to education and behaviour modification for families to prevent injury, particularly in high-risk groups. Identifying such groups, in particular by cause of injury, is important for effective injury prevention strategies.

One particular group that demands our attention is youths from immigrant families. Immigrants now make up about 20% of the Canadian population.<sup>20</sup> Exposures before and after migration, including home country safety standards, cultural norms and housing environment, may influence risk-taking behaviours and awareness and implementation of safety standards. Known sociodemographic predictors of injury in the general population may have a different effect in immigrant populations. There is a paucity of published data describing injuries in immigrant children<sup>21,22</sup> and the literature reporting risk of injury in European and American immigrants is either conflicting or limited to adult occupational, race-related injuries.<sup>9,23–31</sup> It is not known whether the healthy immigrant effect, the notion that immigrants arrive in better health despite facing social disadvantage, extends to injury outcomes.<sup>32</sup> Moreover, data on patterns of all-cause visits to the emergency department by immigrants has suggested a lower proportion of visits for injury compared with nonimmigrant children.<sup>33</sup>

Capitalizing on population-based linked data sources, our objectives were to determine the prevalence of unintentional injury-related visits to emergency departments, admissions to hospitals and deaths both overall and according to cause of injury among children and youth from immigrant families in Ontario, and to test the association of unintentional injury and immigrant status, controlling for other important predictors. We hypothesized immigrants' risk of injury would be lower compared with children from nonimmigrant families.

## Methods

### Setting

This study took place in Ontario, Canada's most populous province (population about 13 million) and used outcome data collected from Jan. 1, 2008, to Dec. 31, 2012. Individual characteristics of participants who met the study's inclusion criteria were collected from Jan. 1, 1985, to Dec. 31, 2012.

### Study design

We performed a population-based cross-sectional study using data available at the Institute for Clinical Evaluative Sciences (ICES) through a research agreement from the Ontario Ministry of Health and Long-Term Care.

### Data sources

Data from health administrative and demographic databases were linked using unique, encoded health identification numbers. Ontario has a single-payer universal Ontario Health Insurance Plan (OHIP), through which residents are

insured for medically necessary care from physicians and hospitals. Immigrants admitted to Canada as permanent residents are typically eligible for OHIP after 3 months of residing in Ontario. Ontario's health care registry, the Registered Persons Database, contains sociodemographic information for all residents eligible for OHIP and includes their age, sex and postal code. The Canadian Institute for Health Information Discharge Abstract Database and National Ambulatory Care Reporting System contain diagnoses during hospital admissions and visits to Ontario emergency departments, respectively. Record linkage for these diagnostic codes are 97.5%–99.9%.<sup>34</sup> Injury-related deaths that occurred both in and out of hospital were ascertained from the Ontario Registrar General — Death with cause-of-death linkage at 97.4%.<sup>34</sup> Neighbourhood income quintile was obtained using Statistics Canada's Postal Code conversion file to link a patient's postal code at the dissemination area level (400–700 people) using the Rurality Index of Ontario, a census-derived rurality score.<sup>36</sup>

The Permanent Resident Data System, a federal database maintained by Immigration, Refugees and Citizenship Canada, holds sociodemographic and immigration information on all permanent residents who landed in Ontario from Jan. 1, 1985, to the present. Permanent residents are immigrants who have been granted the right to stay and work in Canada without limitations on their stay. This database does not include data on temporary or undocumented immigrants. Information is collected from official immigration documents upon landing. Overall probabilistic linkage to the Registered Persons Database identifies about 86% of immigrants.<sup>37,38</sup> The MOMBABY database, derived at ICES, pairs mothers with their newborns delivered in Ontario hospitals. It links inpatient admission records of delivering mothers and their newborns with linkage rates of more than 96%.<sup>34</sup> Through this database, newborns born in Canada to immigrant mothers were identified.

### Study population

The study population included all children and youth from birth to 24 years of age who resided in Ontario with a valid OHIP number from Jan. 1, 2008, to Dec. 31, 2012. Records with a missing health card number, age or sex were excluded.

Participants entered the study on Jan. 1, 2008, or upon their birth, whichever occurred first. Study exit was either the end of study (Dec. 31, 2012) or Dec. 31 of the year the participant turned 25 years of age.

### Outcome measures

The main outcome measure was unintentional injury-related hospital visit (emergency department visit, hospital admission, death) and out-of-hospital injury-related death. The cause of injury was grouped according to the International Classification of Diseases, 10th revision, (ICD-10) External Cause of Injury codes.<sup>39</sup> Multiple visits for the same patient were included; however, only 1 event per patient per day was included. Duplicated, overlapping or transferred emergency department visits and hospital admissions were excluded.

## Predictor

The main exposure was immigrant status. Immigrants were defined as any child or youth who was a permanent resident (landed immigrant) who arrived in Canada after Jan. 1, 1985, or any child or youth with a mother who was a permanent resident who arrived in Canada after Jan. 1, 1985. Children of immigrant mothers arriving before development of the Permanent Resident Data System in 1985 were considered nonimmigrants. Maternal immigrant status was included to show injury outcomes related to the family unit or environment, rather than only to the child.

## Covariates

We included a number of relevant covariates potentially associated with injury based on the literature or clinical plausibility. Adolescents and boys have both been shown to have higher risk of injury compared with children and girls,<sup>4,40</sup> and therefore age and sex were included. Neighbourhood income quintile at the time of injury and urban or rural residence were included because low income and rural residence have been associated with risk of injury.<sup>6,8,11,14</sup> Demographic characteristics were based on information from health records during each study year.

## Statistical analysis

Descriptive statistics were performed for the main exposure and outcome variables and covariates. The total number of events and crude injury rates were calculated. To compare outcomes of all immigrants and nonimmigrants, multiple variable Poisson regression models adjusting for overdispersion were used to compute rate ratios (RRs) with 95% confidence intervals (CIs) using 2011–2012 data. For each model, variables were selected a priori and included in the regression analysis. The main model included both immigrants and nonimmigrants, but because the initial descriptive results suggested different associations between sociodemographics and injury in immigrants and nonimmigrants, we also carried out a stratified analysis. To determine cause-specific injury risk, crude injury rates for each cause were calculated by immigrant status. Subsequently, multiple variable Poisson regression models were used to compare cause-specific RRs of injury by immigrant status. All statistical modelling was carried out using SAS Enterprise Guide, version 6.1 (SAS Institute).

## Ethics approval

Research ethics board approval was obtained from The Hospital for Sick Children and Sunnybrook Health Sciences Centre in Toronto.

## Results

There was an annualized mean of 3 173 391 nonimmigrants and 910 258 immigrants included in the study. Compared with nonimmigrants, immigrants had a greater proportion of young, urban and lower neighbourhood income quintile individuals (Table 1). Overall age- and sex-standardized

annual rates of unintentional injuries were 11 749 emergency department visits per 100 000 population, 267 hospital admissions per 100 000 population and 12 deaths per 100 000 population.

Table 2 shows rates of unintentional injury-related events by immigrant status. Compared with nonimmigrants, immigrants had lower rates of visits to the emergency department, admissions to hospital and deaths from unintentional injury across all age groups. Rates of injury-related visits to the emergency department by age differed between immigrants and nonimmigrants. Among immigrants, children in the youngest age group had the highest visit rates (7754/100 000 population), whereas among nonimmigrants, children in the 15- to 19-year age group had the highest rates (15 940/100 000 population). Injury-related admissions to hospital and deaths showed similar patterns by age in immigrants and nonimmigrants, with the highest rates in the 15- to 19- and 20- to 24-year age groups. Among nonimmigrants, children in the lowest neighbourhood income quintile had the highest rates of visits to the emergency department for injury. This is in contrast to findings among immigrants, where those in the highest income quintile had the highest rates of visits. These differential trends in neighbourhood income quintile and injury rates were not seen for injuries that required hospital admission or caused death. Rural and male populations had higher rates of injury in both immigrant and nonimmigrant groups, regardless of injury severity.

**Table 1: Characteristics of the study cohort**

Characteristic	Nonimmigrants, no. (%) <i>n</i> = 3 171 110	Immigrants, no. (%) <i>n</i> = 914 372
Age group, yr		
0–4	544 938 (17.2)	186 770 (20.4)
5–9	565 129 (17.8)	186 052 (20.3)
10–14	613 955 (19.4)	191 901 (21.0)
15–19	719 693 (22.7)	178 666 (19.5)
20–24	727 395 (22.9)	170 983 (18.7)
Sex		
Female	1 547 106 (48.8)	445 381 (48.7)
Male	1 624 004 (51.2)	468 991 (51.3)
Neighbourhood income quintile		
Q1 (lowest)	563 314 (17.8)	268 317 (29.3)
Q2	571 014 (18.0)	199 314 (21.8)
Q3	625 353 (19.7)	183 429 (20.1)
Q4	698 687 (22.0)	160 234 (17.5)
Q5 (highest)	712 742 (22.5)	103 078 (11.3)
Rurality		
Urban	2 731 160 (86.1)	903 371 (98.8)
Rural	439 950 (13.9)	11 001 (1.2)

**Table 2: Unintentional injury–related emergency department visits, hospital admissions and deaths by immigrant status, 2008–2012**

Characteristic	Emergency department visits				Hospital admissions				Deaths			
	Immigrants		Nonimmigrants		Immigrants		Nonimmigrants		Immigrants		Nonimmigrants	
	<i>n</i>	Rate per 100 000 population	<i>n</i>	Rate per 100 000 population	<i>n</i>	Rate per 100 000 population	<i>n</i>	Rate per 100 000 population	<i>n</i>	Rate per 100 000 population	<i>n</i>	Rate per 100 000 population
Age group, yr												
0–4	71 791	7754.4	307 481	11 288.5	1702	183.8	6653	244.2	30	3.2	184	6.7
5–9	54 354	5827.5	273 305	9637.1	1450	155.4	5781	203.8	14	1.5	60	2.1
10–14	62 561	6542.3	450 183	14 538.9	1207	126.1	6837	220.7	16	1.7	115	3.7
15–19	61 219	6794.2	569 594	15 940.5	1879	208.8	14 664	410.4	83	9.2	738	20.6
20–24	57 815	6895.1	495 019	13 587.1	1754	209.3	12 898	354.0	165	19.7	1140	31.3
Sex												
Female	117 063	5201.2	843 147	10 869	2948	133.0	17 647	225.0	88	4.2	613	7.6
Male	190 677	8210.0	1 252 435	15 311	5044	219.7	29 186	353.6	220	10.6	1624	19.1
Neighbourhood income quintile												
Q1 (lowest)	87 203	6508.3	408 717	14 407.9	2550	192.4	9858	341.0	112	9.0	606	20.0
Q2	63 893	6418.4	394 427	13 693.9	1748	178.4	8768	299.4	65	7.3	411	13.3
Q3	60 562	6615.2	410 798	13 055.1	1513	167.2	8989	283.0	56	7.0	403	12.4
Q4	57 083	7129.9	444 584	12 700.7	1332	169.1	9568	272.2	53	7.7	422	12.0
Q5 (highest)	38 999	7508.3	43 7056	12 124.3	849	164.7	9650	265.7	22	4.8	395	10.6
Rurality												
Urban	300 162	6650.2	1 667 436	12 146.5	7853	176.2	38 255	275.8	298	7.3	1698	11.8
Rural	7578	13 652.5	428 146	19 218.8	139	257.3	8578	383.1	10	18.7	539	23.7

After adjustment for age, sex, income and rurality, immigrants had a 44% lower risk of unintentional injury overall compared with nonimmigrants (RR 0.56, 95% CI 0.54–0.59). Predictors of injury included male sex (RR 1.39, 95% CI 1.35–1.44) and rural residence (RR = 1.59, 95% CI 1.53–1.66). In the models stratified by immigrant status, age and income predicted injury differently in immigrants and nonimmigrants (Table 3). Young age had the highest risk of injury among immigrants, whereas adolescents had the highest risk of injury among nonimmigrants. Low income was associated with a lower risk of injury among immigrants, whereas it was associated with higher risk of injury among nonimmigrants.

Table 4 describes cause-specific injury risk by immigrant status. Risk of unintentional injury was lower across all causes of injury among immigrants. The most common causes of unintentional injury in both groups were falls and being struck. Motor vehicle injuries were the most common cause of death among immigrants (1.3 deaths/100 000 population) and nonimmigrants (3.6 deaths/100 000 population), followed by poisoning (0.6 deaths/100 000 population among immigrants; 1.9 deaths/100 000 population among nonimmigrants).

## Interpretation

In this large, population-based study, we report a 44% lower risk of unintentional injury among immigrant children and youth compared with children and youth from nonimmigrant families. The reduced risk was seen across all causes of injury. Income, which has traditionally had an inverse association with injuries,<sup>3,8,10,14</sup> had the opposite association in our immigrant population for visits to the emergency department — high neighbourhood income quintile was associated with a high risk of injury among immigrants. Adolescents had the highest risk of injury among nonimmigrants; among immigrants, risk was highest in infants and young children.

A Danish registry study evaluated unintentional injuries in children of foreign-born mothers and reported lower rates compared with children of Danish mothers. Lower rates of injury were seen for all causes except burns and foreign bodies in the ear.<sup>9</sup> Smaller Canadian studies have shown a 1.35-times higher relative risk of bicycling-related injuries in new immigrants<sup>41</sup> and a higher risk of serious falls from buildings<sup>21</sup> and from falling televisions<sup>22</sup> in immigrants compared with nonimmigrants. A few studies have evaluated injury fatalities in foreign-born populations and found mixed

results. Karimi and colleagues showed that compared with native Swedes, children with foreign backgrounds had higher risk of injury fatality, with a particularly high risk of transportation- and drowning-related deaths in boys and fire/flame and fall deaths in girls.<sup>31</sup> Similarly, Kahl and colleagues<sup>42</sup> reported higher rates of drowning in young immigrant boys compared with native Germans, and Stirbu and colleagues<sup>43</sup> have shown higher risk of injury mortality in ethnic minorities in the Netherlands. These studies are in contrast to ours and that of Sorenson and colleagues,<sup>44</sup> in which immigrant children have lower risk of injury fatality.

The associations with high injury risk and low socioeconomic status and adolescent age are well-established in the general populations of Canada and other countries.<sup>1,7,9,13,35</sup> However, our study suggests that this may not be the case in all subgroups. Our findings show different causal pathways may exist for injury in immigrants, and strategies for prevention should be targeted accordingly. One other study that tested the association of socioeconomic status and injuries in immigrant children reported that, among foreign-born children in Sweden, the risk of admission to hospital and death owing to unintentional injuries is higher in children with the lowest parental education compared with those with the highest parental education.<sup>23</sup>

The lower observed rates of unintentional injury in Ontario's immigrant population may be explained by Canada's immigrant selection and settlement policies, which target healthy,<sup>45</sup> highly educated, motivated and resourceful people. Certain sociocultural factors in foreign-born families, such as reduced risk-taking behaviours (e.g., substance use),<sup>25</sup> familial and social support systems that promote healthy behaviours and a sense of well-being<sup>32</sup> and less physical activity, especially through high-risk sporting activities, may explain some of our findings. This latter explanation may account for the higher rates of injuries in nonimmigrant adolescents. Socioeconomic differences in injury rates, particularly for milder injuries that do not require admission to hospital, may be due to different care-seeking behaviours among immigrants<sup>46–48</sup> or disparities in access to primary care.<sup>49</sup>

### Strengths and limitations

Strengths of this study include the large sample size and the use of population-level databases. This study is distinguished from existing ones, which are based on smaller cohorts, rely on self-report or focus exclusively on adults.

Limitations include not capturing minor injuries that did not result in an emergency department or hospital interaction that may have been treated in a medical office or at home, or injuries in people who leave the province. Care-seeking behaviour may differ between study groups, which may have affected results for minor injuries. Better information on contributing factors (alcohol, drugs, behavioural disorders and education levels) would have helped to contextualize our results. Misclassification of some immigrants (i.e., temporary/undocumented immigrants, immigrant mothers who landed in Canada before 1985, immigrants who landed in another province or foreign-born Canadian citizens who

**Table 3: Rate ratios of unintentional injuries for children and youth ages 0–24 years by immigration status, 2011–2012**

Immigration status	Overall adjusted* model RR (95% CI)	
	Immigrants	0.56 (0.54–0.59)
Nonimmigrants	Reference	
Characteristic	Stratified models RR (95% CI)*	
	Immigrants <i>n</i> = 999 951	Nonimmigrants <i>n</i> = 3 296 559
Age group, yr		
0–4	1.23 (1.16–1.31)	0.91 (0.87–0.95)
5–9	0.92 (0.87–1.00)	0.80 (0.76–0.84)
10–14	1.05 (0.98–1.12)	1.23 (1.18–1.28)
15–19	1.02 (0.95–1.09)	1.22 (1.17–1.27)
20–24	Reference	Reference
Sex		
Male	1.51 (1.45–1.58)	1.37 (1.34–1.41)
Female	Reference	Reference
Neighbourhood income quintile		
Q1 (lowest)	0.88 (0.82–0.94)	1.13 (1.08–1.18)
Q2	0.86 (0.80–0.92)	1.10 (1.05–1.15)
Q3	0.89 (0.83–0.95)	1.07 (1.02–1.12)
Q4	0.95 (0.89–1.02)	1.05 (1.01–1.09)
Q5 (highest)	Reference	Reference
Rurality		
Rural	1.98 (1.74–2.25)	1.58 (1.53–1.64)
Urban	Reference	Reference

Note: CI = confidence interval, RR = rate ratio.

\*Adjusted for age, sex, neighbourhood income quintile and rurality.

subsequently moved to Ontario) may have also affected our results. Results may not be generalizable to temporary or undocumented immigrants. In addition, paternal immigration status may be important in understanding risk of injury, but linkage was not feasible.

### Conclusion

Children and youth from immigrant families have a lower risk of unintentional injury compared with those from non-immigrant families. Sociodemographic factors that traditionally predict injury in most populations do not apply universally to immigrant populations, suggesting different causal pathways for injury. Ongoing epidemiologic studies involving immigrants can help identify protective factors within this group that may be helpful for improving injury prevention in the general population while maintaining healthy and active development.



**Table 4: Adjusted rate ratios and crude rates of cause-specific unintentional injury-related emergency department visits, hospital admissions and deaths in children and youth ages 0–24 years by immigration status, annualized 2008–2012**

Cause of injury	Adjusted* RR (95% CI) (Reference = nonimmigrants)	Crude injury rate per 100 000 immigrants	Crude injury rate per 100 000 nonimmigrants
Fall	0.60 (0.58–0.62)	2108.6	3574.9
Struck by/against	0.48 (0.45–0.51)	1347.6	3069.3
Overexertion	0.59 (0.54–0.64)	568.4	1104.2
Cut/pierce	0.47 (0.44–0.50)	372.9	917.5
Natural/environmental	0.40 (0.37–0.44)	183.0	511.9
Other bicycle (Non-motor vehicle collision)	0.53 (0.48–0.58)	165.8	327.8
Poisoning	0.61 (0.57–0.65)	136.6	230.6
Motor vehicle traffic	0.73 (0.69–0.77)	308.5	468.4
Hot object/scald	0.71 (0.64–0.78)	88.5	132.0
Fire/flame	0.39 (0.32,0.46)	12.4	40.5
Other pedestrian (Non-motor vehicle collision)	0.74 (0.63–0.86)	10.3	15.9
Machinery	0.55 (0.47–0.64)	17.2	40.7
Suffocation	0.68 (0.54–0.84)	5.5	8.2
Other land transport	0.23 (0.19–0.26)	36.6	230.8
Drowning	0.69 (0.53–0.91)	2.9	4.0
Firearm	0.43 (0.33–0.56)	3.3	7.1
Other or not specified	0.64 (0.61–0.68)	1335.9	2257.2

Note: CI = confidence interval, RR = rate ratio.  
\*Adjusted for age, sex, income and rurality, 2011–2012 data only for model.

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