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3 **Title:** Unintentional injuries in children and youth from immigrant families in Ontario, Canada.

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22 **Short title:** Pediatric immigrant unintentional injuries.
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24 **Key words:** immigration, injury, Ontario, pediatric
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27 **Funding Source:** Astrid Guttman and Alison Macpherson are funded through Applied Chairs
28 in Child Health Services and Policy Research from the Canadian Institutes for Health Research.
29

30 **Financial Disclosure:** All authors have no financial relationships relevant to this article to
31 disclose.
32

33
34 **Conflict of Interest:** All authors have no conflicts of interest to disclose.
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37 **Contributors' Statement:** N. Saunders conceptualized and designed the study, interpreted the
38 results, drafted the initial manuscript, revised the manuscript, and approved the final manuscript
39 as submitted. L. Sheng analyzed the data, revised the manuscript, and approved the final
40 manuscript as submitted. A. Macpherson and A. Guttman conceptualized and designed the
41 study, interpreted the results, revised the manuscript, and approved the final manuscript as
42 submitted. All authors approved the final manuscript as submitted and agree to be accountable
43 for all aspects of the work.
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46 **Disclaimer:** This study was supported by the Institute for Clinical Evaluative Sciences (ICES),
47 which is funded by an annual grant from the Ontario Ministry of Health and Long-Term Care
48 (MOHLTC). The opinions, results and conclusions reported in this paper are those of the authors
49 and are independent from the funding sources. No endorsement by ICES or the Ontario
50 MOHLTC is intended or should be inferred. Parts of this material are based on data and
51 information compiled and provided by the Canadian Institute for Health Information (CIHI).
52 However, the analyses, conclusions, opinions and statements expressed herein are those of the
53 authors, and not necessarily those of CIHI.
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Abstract

Background: Unintentional injury is the leading cause of childhood death. Injury is associated with a number of socio-demographic characteristics but little is known about risk in immigrants. The objective was to examine family immigrant status and unintentional injury.

Methods: Population-based, cross-sectional study of all children and youth (0 to 24 years) residing in Ontario, Canada from 2008-2012. Multiple health administrative databases were linked to Immigration, Refugees and Citizenship Canada's Permanent Resident Database. Unintentional injury events (emergency department visits, hospitalizations, deaths) were analyzed using Poisson regression models to estimate risk ratios (RR).

Results: Annualized injury rates were 11,749/100,000 ED visits, 267/100,000 hospitalizations, and 12/100,000 deaths. Injury risk was lower in immigrants across all causes of unintentional injuries (adjusted RR 0.56; 95% CI 0.53, 0.58). Within non-immigrants, lowest neighbourhood income quintile was associated with highest risk (RR 1.13; 95% CI 1.08, 1.18, quintile 5 vs. 1) whereas within immigrants, was associated with lowest risk of injury (RR 0.96; 95% CI 0.94, 0.98, quintile 5 vs. 1). Highest risk of injury in non-immigrants was among adolescents (15 to 19 years: RR 1.19; 95% CI 1.14, 1.24; versus 20 to 24 years) but within immigrants, was highest among young children (0 to 4 years: RR 1.23; 95% CI 1.15, 1.31; versus 20 to 24 years).

Interpretation: Risk of unintentional injury is lower among immigrants than 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.

Background

Injury is one of the leading causes of emergency department (ED) visits and is the leading cause of death for children and youth in Canada^{1,2} and in high income countries³. While some minor injuries may reflect healthy, active living, the vast majority of injuries cause some degree of harm and are preventable. Epidemiologic literature has identified a number of risk factors for unintentional childhood injuries. Adolescent males have consistently been shown to be at highest risk of injuries requiring medical attention compared with females and younger children^{1,4,5}. Children living in rural areas have higher per capita rates of bicycle-related head injuries compared to those in urban settings⁶ and individuals from lower income neighbourhoods or families are more likely to be injured⁷⁻¹¹. A number of important policies and by-laws have been implemented over the past two decades in Ontario and elsewhere, such as mandatory bicycle helmets for minors riding bikes¹²⁻¹⁴, maximum water temperature by-laws for residential hot water heaters¹⁵, and improved playground safety standards¹⁶ which have all effectively reduced injury rates in youth^{7,13,17-19}. Despite these important strides, preventable injuries continue to occur suggesting room for improvement in policy development and education and behaviour modification for families to prevent injury, especially 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 youth from immigrant families. Immigrants now make up approximately 20% of the Canadian population²⁰. Exposures before and after migration may influence risk taking behaviours and awareness and implementation of safety standards. Known socio-demographic 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^{21,22} and the literature reporting risk of injury in European and American immigrants is either conflicting or limited to adult occupational, race-related injuries^{9,23-31}. Capitalizing on population-based linked data sources, our objectives were to 1) determine the prevalence of unintentional injury-related ED visits, hospitalizations, and deaths both overall and according to cause of injury in children and youth from immigrant families in Ontario, Canada; and 2) to test the association of unintentional injury and immigrant status, controlling

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3 for other important predictors. We hypothesized immigrants' risk of injury would be lower
4 compare with those from non-immigrant families.
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7 **Methods**

8 *Study Design*

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10 This was a population-based cross-sectional study using data available at the Institute for
11 Clinical Evaluative Sciences (ICES) through a research agreement from the Ontario Ministry of
12 Health and Long-Term Care. Research ethics board approval was obtained from The Hospital
13 for Sick Children and Sunnybrook Health Sciences Centre in Toronto, Ontario.
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20 *Data Sources*

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22 Data sets from health administrative and demographic databases were linked using unique,
23 encoded health identification numbers. Ontario has a single-payer universal Ontario Health
24 Insurance Plan (OHIP) through which residents are insured for medically necessary care from
25 physicians and hospitals. Immigrants admitted to Canada as permanent residents are eligible for
26 OHIP after 3 months of residing in Ontario. Ontario's health care registry, the Registered
27 Persons Database (RPDB), contains socio-demographic information for all residents eligible for
28 OHIP and includes their age, sex, and postal code. The Canadian Institute for Health Information
29 (CIHI) Discharge Abstract Database (DAD) and National Ambulatory Care Reporting System
30 (NACRS) contains information, including diagnoses during admissions and ED visits to Ontario
31 hospitals, respectively. Injury related deaths that occurred both in and out of hospital were
32 ascertained from the Ontario Registrar General – Death (Vital Stats). Neighbourhood income
33 quintile was obtained using Statistics Canada's Postal Code conversion file to link a patient's
34 postal code at the dissemination area level (400 to 700 persons) based on the 2006 Canadian
35 Census³². Rurality was determined using the Rurality Index of Ontario, a census derived
36 rurality score determined by population density and travel time to a health care facility³³.
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50 The Permanent Resident Data System (PRDS), a federal database maintained by Immigration,
51 Refugees and Citizenship Canada, holds socio-demographic and immigration information on all
52 permanent residents landing in Ontario from January 1st, 1985 to the present. Permanent
53 residents are immigrants who have been granted to the right to stay and work in Canada without
54 limitations on their stay. It does not include data on temporary or undocumented immigrants.
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Information is collected from official immigration documents, last updated at the port of entry on the date of landing. Overall probabilistic linkage to the RPDB identifies approximately 86% of immigrants³⁴. The MOMBABY database, an ICES derived database, pairs all mothers with their newborns, delivered in hospital in Ontario. It links CIHI-DAD inpatient admission records of delivering mothers and their newborns. 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 residing in Ontario with a valid OHIP number from January 1st 2008 to December 31st, 2012. Records with a missing or invalid health card number, age, or sex were excluded.

Outcome Measures

The main outcome measure was an unintentional injury-related visit to an ED or a hospitalization, or an unintentional injury-related death (in and out of hospital). The cause of injury was grouped according to the International Classification of Disease 10-CM External Cause of Injury Codes³⁵. Multiple visits for the same patient were included however only one event per patient per day was included. Duplicated, overlapping, or transferred ED visits and hospitalizations were excluded.

Predictor

The main exposure was immigrant status. Immigrants were defined as any child or youth who was a permanent resident (landed immigrant) arriving in Canada after January 1st, 1985 or any child or youth with a mother who was a permanent resident arriving in Canada after January 1st, 1985. Children of immigrant mothers arriving prior to development of the PRDS in 1985 were considered non-immigrants.

Covariates

We included a number of relevant covariates potentially associated with injury based on the literature or clinical plausibility. Adolescents and males have both been shown to have higher risk of injury compared with children and females^{1, 4, 36} and therefore age (at the time of injury) and sex were included. Neighbourhood income quintile at the time of injury and urban/rural

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3 residence (dichotomized) were included as low income and rural residence have been associated
4 with risk of injury^{6, 8, 11, 14}. These demographic characteristics were based on information from
5 health records during each study year.
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8 9 *Statistical Analysis*

10 Descriptive statistics were performed for the main independent variables, outcome variables and
11 covariates. The total number of events as well as the age-sex standardized (2006 Canadian
12 census) and crude injury rates were calculated. To compare outcomes of all immigrants and non-
13 immigrants, multiple variable Poisson regression models were used to compute risk ratios with
14 95% confidence intervals. For each model, variables were selected *a priori* and included in the
15 regression analysis. The main model included both immigrants and non-immigrants but because
16 the initial descriptive results suggested different associations between socio-demographics and
17 injury in immigrants and non-immigrants, analyses were also carried out stratifying by each
18 exposure group. To determine cause-specific injury risk, crude rates of injury events pooled for
19 each specific cause were calculated by immigrant status. Subsequently, multiple variable
20 Poisson regression models were used to compare cause-specific risk of injury by immigrant
21 status. All statistical modelling was carried out using SAS version 9.3 (SAS Institute, Cary,
22 NC).
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35 **Results**

36 There was an annualized mean of 3,173,391 non-immigrants and 910,258 immigrants included
37 in the study. Compared with non-immigrants, immigrants had a greater proportion of young,
38 urban, and lower neighbourhood income quintile individuals (Table 1). Overall age-sex
39 standardized annual rates of unintentional injuries were 11,749/100,000 ED visits, 267/100,000
40 hospitalizations, and 12/100,000 deaths.
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47 Table 2 shows rates of unintentional injury-related events by immigrant status. Compared with
48 non-immigrants, immigrants had lower rates of ED visits, hospitalizations, and deaths from
49 unintentional injury across all age groups. Rates of injury-related ED visits by age differed
50 between immigrants and non-immigrants. Within immigrants, those in the youngest age group
51 (0 to 4 years) had the highest ED visit rates (7754/100,000) whereas within non-immigrants
52 those in the 15 to 19-year age group highest rates (15,940/100,000). Injury related
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3 hospitalizations and deaths showed similar patterns by age in immigrants and non-immigrants
4 with highest rates in the 15 to 19 and 20 to 24-year age groups. Among non-immigrants,
5 individuals in the lowest neighbourhood income quintile had the highest rates of ED visits for
6 injury. This is in contrast to findings within immigrants, where those in the highest income
7 quintile had the highest rates of ED visits. These differential trends in the association between
8 neighbourhood income quintile and injury rates were not observed in injuries requiring
9 hospitalization or causing death. Rural and male populations had higher rates of injury in both
10 immigrant and non-immigrant groups, regardless of injury severity.

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12 After adjustment for age, sex, income, and rurality, immigrants had a 44% lower risk of
13 unintentional injury overall compared with non-immigrants (risk ratio [RR] = 0.56, 95%
14 confidence intervals [CI] 0.53, 0.58). Predictors of injury included male sex (RR 1.42, 95% CI
15 1.38, 1.46) and rural residence (RR = 1.60, 95% CI 1.54, 1.67). In the models stratified by
16 immigrant status, age and income predicted injury differently in immigrants and non-immigrants
17 (Table 3). Young age (0 to 4 years) had the highest risk of injury within immigrants (RR = 1.23,
18 95% CI 1.15, 1.31) whereas older age (15 to 19 years) had the highest risk of injury in non-
19 immigrants (RR = 1.19, 95% CI 1.14, 1.24). Low income quintile was associated with a lower
20 risk of injury within immigrants (RR = 0.87, 95% CI 0.81, 0.93 quintile 1 vs. 5) whereas it was
21 associated with higher risk of injury in non-immigrants (RR = 1.13, 95% CI 1.08, 1.18 quintile 1
22 vs. 5).

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

29 **Discussion**

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31 In this large, population-based study, we report a 44% lower risk of unintentional injury in
32 immigrant children and youth compared with those from non-immigrant families. The reduced
33 risk was observed across all causes of injury. Income, which has traditionally had an inverse
34 association with injuries^{1, 8, 10, 14, 36} had the opposite association in immigrant populations for ED
35 visits. Specifically, high neighbourhood income quintile was associated with a high risk of
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3 injury in immigrants. Adolescents had the highest risk of injury among non-immigrants,
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5 whereas among immigrants, risk was highest in infants and young children.
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8 To our knowledge, this is the first population-based study in North America to estimate the
9 overall risk of unintentional injury in immigrant children and youth. One Danish registry study
10 evaluated unintentional injuries in children of foreign born mothers and reported lower rates
11 compared with children of Danish mothers. Lower rates of injury were observed for all causes
12 except burns and foreign bodies in the ear⁹. Smaller Canadian studies have shown a 1.35 times
13 higher relative risk of bicycling related injuries in new (≤ 5 years in Canada) immigrants³⁷ and a
14 higher risk of serious falls from buildings²¹ and from falling televisions²² in immigrants
15 compared with non-immigrants. A few studies have evaluated injury fatalities in foreign born
16 populations and found mixed results. Karimi et al. showed that compared to native Swedes,
17 children with foreign backgrounds had higher risk of injury fatality with a particularly high risk
18 of transportation and drowning related deaths in boys and fire/flame and fall deaths in girls³¹.
19 Similarly, Kahl et al.³⁸ reported higher rates of drowning in young immigrant boys compared
20 with native Germans and Stirbu et al.³⁹ have shown higher risk of injury mortality in ethnic
21 minorities in the Netherlands. These studies are in contrast to ours and that of Sorenson et al.⁴⁰
22 in which immigrant children have lower risk of injury fatality.
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35 The associations with high injury risk and low socioeconomic status and adolescent age are
36 well established in general populations of both Canadian and other children^{1, 7, 9, 13, 35}. However,
37 our study suggests that this may not be the case in all subgroups. Our findings, the first to report
38 a higher risk of injury in high income and young immigrants, demonstrate different causal
39 pathways may exist for injury in immigrants and strategies for prevention should be targeted
40 accordingly. Only one other study testing the association of socioeconomic status and injuries in
41 immigrant children has been published. They report within foreign born children in Sweden, the
42 risk of hospitalization and death due to unintentional injuries is higher in children with the lowest
43 parental education compared to those with the highest parental education²³.
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51 The lower observed rates of unintentional injury in Ontario's immigrant population may be
52 explained by Canada's immigrant selection and settlement policies that select for healthy, highly
53 educated, motivated, and resourceful individuals. Certain sociocultural factors in foreign-born
54 families such as reduced risk taking behaviours²⁵, familial and social support systems⁴¹, and
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3 less physical activity, especially through high risk sporting activities, may explain some of our
4 injury findings. This latter explanation may account for the higher rates of injuries in non-
5 immigrant adolescents. Socioeconomic differences in injury rates, especially for milder injuries
6 not requiring hospitalization, may be due to different care seeking behaviours among immigrants
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11 ⁴²⁻⁴⁴ or disparities in access to primary care ⁴⁵.

12 *Strengths and Limitations*

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14 Major strengths of this study include the large sample size using population level databases.
15 This study is distinguished from existing ones which are based on smaller cohorts, rely on self-
16 report, or focus exclusively on adults. However, there are important limitations. These include
17 not capturing minor injuries that did not result in an ED or hospital interaction that may have
18 been treated in a medical office or at home. Care seeking behaviour may differ between study
19 groups which may have affected results for minor injuries. Better information on contributing
20 factors (alcohol, drugs, behavioural disorders, and education levels) would have helped to
21 contextualize our results. Misclassification of some immigrants (i.e. temporary/undocumented
22 immigrants, immigrant mothers who landed in Canada prior to 1985 when our PRDS database
23 began, immigrants who landed in another Canadian province and subsequently moved to
24 Ontario) may have also affected our results. Paternal immigration status may also be important
25 in understanding risk of injury but linkage was not feasible.
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37 **Conclusions**

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39 Children and youth from immigrant families have a lower risk of unintentional injury compared
40 with Canadian-born children and youth. Socio-demographic factors that traditionally predict
41 injury in most populations do not apply universally to immigrant populations suggesting
42 different causal pathways for injury. Ongoing epidemiologic studies within immigrants can help
43 identify protective factors within this group that may be helpful for improving injury prevention
44 in the general population while maintaining healthy and active development.
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3 **Abbreviations**
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5 (CI) Confidence interval, (CIHI) Canadian Institute for Health Information, (DAD) Discharge
6 Abstract Database, (ED) Emergency department, (ICES) Institute for Clinical Evaluative
7 Sciences, (MOHLTC) Ministry of Health and Long-Term Care, (NACRS) National Ambulatory
8 Care Reporting System, (OHIP) Ontario Health Insurance Plan, (PRDS) Permanent Resident
9 Data System, (RPDB) Registered Persons Database, (RR) Risk ratio
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Table 1. Cohort of immigrant and non-immigrant children and youth in Ontario, 2010

	Non-immigrants		Immigrants	
	N	%	N	%
Overall	3,171,110		914,372	
Age group (years)				
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
Neighborhood 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, hospitalizations, and deaths by immigrant status, 2008 to 2012.

	Emergency department visits				Hospitalizations				Deaths			
	Immigrants		Non-immigrants		Immigrants		Non-immigrants		Immigrants		Non-immigrants	
	N	Rate per 100,000	N	Rate per 100,000	N	Rate per 100,000	N	Rate per 100,000	N	Rate per 100,000	N	Rate per 100,000
Age group (years)												
0 - 4	71791	7754.4	307481	11288.5	1702	183.8	6653	244.2	30	3.2	184	6.7
05-09	54354	5827.5	273305	9637.1	1450	155.4	5781	203.8	14	1.5	60	2.1
10-14	62561	6542.3	450183	14538.9	1207	126.1	6837	220.7	16	1.7	115	3.7
15-19	61219	6794.2	569594	15940.5	1879	208.8	14664	410.4	83	9.2	738	20.6
20-24	57815	6895.1	495019	13587.1	1754	209.3	12898	354.0	165	19.7	1140	31.3
Sex												
Female	117063	5201.2	843147	10869	2948	133.0	17647	225.0	88	4.2	613	7.6
Male	190677	8210.0	1252435	15311	5044	219.7	29186	353.6	220	10.6	1624	19.1
Neighborhood income quintile												
Q1 - lowest	87203	6508.3	408717	14407.9	2550	192.4	9858	341.0	112	9.0	606	20.0
Q2	63893	6418.4	394427	13693.9	1748	178.4	8768	299.4	65	7.3	411	13.3
Q3	60562	6615.2	410798	13055.1	1513	167.2	8989	283.0	56	7.0	403	12.4
Q4	57083	7129.9	444584	12700.7	1332	169.1	9568	272.2	53	7.7	422	12.0
Q5 - highest	38999	7508.3	437056	12124.3	849	164.7	9650	265.7	22	4.8	395	10.6
Rural												
Urban	300162	6650.2	1667436	12146.5	7853	176.2	38255	275.8	298	7.3	1698	11.8
Rural	7578	13652.5	428146	19218.8	139	257.3	8578	383.1	10	18.7	539	23.7

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Table 3. Risk ratios of unintentional injuries for children and youth ages 0 to 24 years by immigration status, annualized 2008-2012.

	Immigrants (N = 4551291)	Non-immigrants (N = 15866954)
	Risk ratio (95% CI)	Risk ratio (95% CI)
Age		
00-04	1.23 (1.15, 1.31)	0.90 (0.86, 0.94)
05-09	0.92 (0.86, 0.99)	0.77 (0.73, 0.81)
10-14	1.02 (0.95, 1.09)	1.14 (1.09, 1.19)
15-19	1.01 (0.94, 1.08)	1.19 (1.14, 1.24)
20-24	Reference	Reference
Sex		
Male	1.53 (1.47, 1.60)	1.40 (1.36, 1.45)
Female	Reference	Reference
Neighborhood income quintile		
Q1-lowest	0.87 (0.81, 0.93)	1.13 (1.08, 1.18)
Q2	0.86 (0.80, 0.92)	1.10 (1.05, 1.15)
Q3	0.88 (0.82, 0.95)	1.06 (1.01, 1.11)
Q4	0.95 (0.89, 1.03)	1.04 (0.99, 1.09)
Q5-highest	Reference	Reference
Rurality		
Rural	2.04 (1.79, 2.33)	1.59 (1.53, 1.65)
Urban	Reference	Reference

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

Injury cause	Adjusted* risk ratio (95% CI) (Reference = non-immigrants)	Crude injury rate per 100,000 immigrants	Crude injury rate per 100,000 non- immigrants
Fall	0.59 (0.57, 0.62)	2108.6	3574.9
Struck by/against	0.48 (0.45, 0.51)	1347.6	3069.3
Overexertion	0.57 (0.53, 0.62)	568.4	1104.2
Cut/pierce	0.47 (0.44, 0.50)	372.9	917.5
Natural/environmental	0.39 (0.37, 0.42)	183.0	511.9
Other bicycle (Non-motor vehicle collision)	0.53 (0.48, 0.58)	165.8	327.8
Poisoning	0.60 (0.56, 0.63)	136.6	230.6
Motor vehicle traffic	0.76 (0.72, 0.80)	308.5	468.4
Hot object/scald	0.71 (0.65, 0.77)	88.5	132.0
Fire/flame	0.37 (0.32, 0.42)	12.4	40.5
Other pedestrian (Non-motor vehicle collision)	0.65 (0.59, 0.73)	10.3	15.9
Machinery	0.56 (0.50, 0.64)	17.2	40.7
Suffocation	0.65 (0.56, 0.75)	5.5	8.2
Other land transport	0.23 (0.20, 0.26)	36.6	230.8
Drowning	0.72 (0.59, 0.87)	2.9	4.0
Firearm	0.50 (0.40, 0.63)	3.3	7.1
Other or not specified	0.63 (0.60, 0.67)	1335.9	2257.2

* Adjusted for age, sex, income, and rurality
CI, Confidence interval