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## Abstract

**Background**
Research suggests that living in more affluent neighbourhoods positively influences children's health. Relationships with injury are less clear. This study examines variations in rates of unintentional injury hospitalization by neighbourhood income for the population aged 0 to 19 in urban Canada.

**Data and methods**
Acute-care inpatient hospitalization discharge records from 2001/2002 through 2004/2005 for 0- to 19-year-olds were examined. Injuries were classified using the International Classification of Diseases. Census Dissemination Areas were used as neighbourhood proxies; income quintiles were calculated from the 2001 Census. Age-standardized rates of hospitalization per 10,000 person-years at risk were calculated for each type of injury, by sex, age group and neighbourhood income quintile.

**Results**
Children and teenagers in the lowest neighbourhood income quintile generally had a higher rate of unintentional injury hospitalization than did those in the highest. The pattern was particularly evident among children aged 0 to 9 in lower-income neighbourhoods for injuries due to land transportation, poisoning, fire, drowning/suffocation, being cut or pierced, and the natural environment.

**Interpretation**
Canadian children in lower-income neighbourhoods generally have higher rates of hospitalization due to unintentional injuries, compared with children in higher-income neighbourhoods.

## Keywords
Child development, hospital records, social class, social conditions, socio-economic status, trauma, wounds and injuries

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Unintentional injury of children and teenagers has been identified as a public health problem in Canada.[1] In 2004, unintentional injuries were responsible for 30,345 hospitalizations of children and youth aged 0 to 19.[2] About one-fifth of all acute-care inpatient hospitalization costs for children in 2003/2004 were attributable to injuries and poisonings.[3] Severe injury and trauma in childhood are associated with disability and poor health-related quality of life in both the short- and long-term.[4-7] Moreover, unintentional injury is the leading cause of death among Canadian children and teenagers, accounting for 664 deaths in 2004.[8]

The neighbourhood environment has been identified as an important factor in children's health.[9-13] But while research suggests that living in more affluent neighbourhoods positively influences children's health, relationships with injury are less clear, and growing evidence indicates that associations depend on the type of injury.[14-22]

For several reasons, neighbourhood income may be related to childhood injury. The social and physical environments in lower-income neighbourhoods may place children at risk of injury.[23-26] As well, associations between neighbourhood income and injury may reflect individual and family factors. For instance, children in low-income families are less likely than those in more affluent families to use bicycle helmets,[27,28] and more likely to be exposed to hazards in the home.[29]

Previous studies have examined associations between neighbourhood disadvantage and childhood injury using self- or parent-reported survey data[30-32] or administrative data on hospitalizations and mortality.[22,33-35] Surveys, however, typically collect information about only one injury, and the reported prevalence of severe injuries (that is, resulting in hospitalization) is low. Studies based on administrative data tend to focus on a single hospital or city,[22,35] or do not

investigate a full range of unintentional injuries.[33,34]

To address some of these shortcomings, this study uses national hospital data to examine relationships between urban neighbourhood income and hospitalization for unintentional injury among children and teenagers.

## Methods

The Hospital Morbidity Database (HMBD) contains discharge records for each hospital stay. Health Person-Oriented Information (HPOI), processed from the HMBD, links these records at the person level. HPOI includes the patient's age, sex, medical diagnoses, admission/discharge dates, and place of residence.

For this analysis, 87% of the hospital morbidity records were linked at the person level. Of the 13% that were not linked, 10% were for newborns (excluded), and 3% contained an invalid identifier. This study is based on 852,234 hospitalization records for children and youth aged 0 to 19 in urban Canada who had been discharged from acute-care hospitals during fiscal years (April to March) 2001/2002 to 2004/2005.

### Injury classification

The International Classification of Diseases (ICD) was used to classify unintentional injuries. Not all Canadian provinces used the same version of the ICD during the study period; ICD codes were analysed by the version submitted (Appendix Table A).

The data represent "injury episodes," not the number of hospital discharges or unique individuals.

Hospital discharge records allow multiple diagnoses to be listed; records were included in this analysis if an unintentional injury appeared as a diagnosis at least once.

HPOI has a unique record for each hospital discharge. To prevent multiple counting of a single injury, an "injury episode" was constructed for people discharged and readmitted (for example, transferred between hospitals) on the same day. During the study period, there were 76,227 unintentional "injury episodes" for 0- to 19-year-olds, representing 73,244 individuals. The vast majority of these individuals (96.3%, n=70,537) were hospitalized once; 3.7% (n=2,707) had more than one unintentional injury hospitalization during the four years.

In all provinces except Quebec, multiple injury codes can be recorded for a single injury. A total of 349 hospitalizations (0.45% of all cases) had injury codes in multiple categories. A sample of cases with multiple injuries was examined, and because all appeared plausible (for instance, hypothermia and motor vehicle traffic injury), they were included in the study.

## Definitions

*Unintentional injury* refers to all unintentional injuries excluding adverse effects or complications of medical and surgical care. Unintentional injuries were grouped into nine categories based on injury classifications from the Public Health Agency of Canada[36]: falls, land transportation, being struck, being cut/pierced, poisoning, fire, drowning/suffocation, natural environment, and other. This classification system was originated by the International Collaborative Effort on Injury.

Injuries from *falls* result from falls on ice/snow, furniture, playground equipment, trees, or cliffs. Falls involving transport vehicles, in water (for instance, drowning), and associated with fire are categorized elsewhere.

*Land transportation* injuries pertain to accidents on land involving pedestrians, cyclists, motorcycles, cars, pick-up trucks, vans, heavy transport vehicles, buses, trains, streetcars, industrial vehicles, and off-road vehicles.

*Struck* refers to injuries due to being struck by or against a thrown object, sports equipment, a person or crowd, or walking into an object.

*Cut/Pierce* injuries (including those due to machinery) result from contact with objects such as glass, knives, hand tools, lawnmowers, powered tools and household machinery, and contact with lifting devices, agricultural machinery or unspecified machinery.

*Fire* injuries result from fires in private dwelling, buildings, or other structures, outside of buildings (for example, forest fire), ignition of clothing, and from the burning of objects.

*Poisoning* includes accidental poisoning by exposure to medication, narcotics, pesticides, chemicals, gases and vapours.

*Drowning/Suffocation* (separate causes that were combined into one category) refers to drowning or submersion in a bathtub, swimming pool or natural body of water, and suffocation due to earth or other substances, obstruction of respiratory tract, confinement in a low-oxygen environment, or in bed.

*Natural environment* includes being bitten, stung or struck by an animal, insect, plant; exposure to noise, vibration, heat, cold, change in air pressure; and lack of food and water.

*Other* encompasses injuries due to firearms, overexertion, explosion of an object, exposure to electric current, sequelae or late effects of an event classified elsewhere, and non-land transportation accidents.

Dissemination Areas (DAs)—small geographic census units with a population of 400 to 700—were used as proxies for neighbourhoods. During data processing, the DAs in which patients lived were determined from their postal code by the Postal Code Conversion File + .[37] DA assignment was less precise in the province of Quebec, where hospital discharge records contain only the first three digits of the six-digit postal code. Sensitivity analyses that excluded Quebec did not produce significantly different results, so Quebec was included in all analyses. DAs in Census Metropolitan Areas (CMAs) or Census Agglomerations (CAs) were considered urban. CMAs are urban areas with a population of at least 100,000; CAs have an urban core of at least 10,000.[38]

Neighbourhood income quintiles were constructed from the 2001 Census using the average income per single-person equivalent in each DA, which adjusts for differences in household size. Average income per single-person equivalent was calculated by dividing the total household income of the DA by the total number of single-person equivalents. To account for variations in the cost of living across Canada, income quintiles were constructed within each CMA and CA. Income was suppressed in DAs with populations less than 250, and in such cases, was imputed from surrounding DAs with unsuppressed data.

A total of 1,086 unintentional injury hospitalizations (1.4%) were excluded from analyses because DA income data were not available: in 1,049 of these cases, this was because of a missing or invalid postal code; in 37 cases, income data could not be imputed because of suppression in surrounding DAs.

### Statistical methods

Hospitalization rates for unintentional injuries were calculated based on the 2001 Census. Rates were age-standardized to account for the unequal distribution of the population by age across neighbourhood income quintiles.

Person-years at risk were used as the denominator for hospitalization rates. This was interpolated from the 2001 and 2006 Census using the mid-point of the fiscal year (October). The final denominator was the sum of the interpolated populations across the four fiscal years: 2001/2002 through 2004/2005. Rates per 10,000 person-years at risk were calculated by age group (0 to 9 and 10 to 19) and by sex for income quintiles; 95% confidence intervals were based on a Poisson distribution.

The t-test was used to determine if injury hospitalization rates in the highest neighbourhood income quintile differed significantly from the lower quintiles. A Linear Trend Test (LTT) was used to detect linear relationships between injury hospitalization rates and neighbourhood income quintiles.[39] An alpha level of $p<0.05$ was used to determine significance. SAS (version 9.1, SAS Institute, USA) software was used for all statistical analyses.

## Results

### Rates higher among males/teens

During the four years from 2001/2002 through 2004/2005, hospitalizations for unintentional injuries among 0- to 19-year-olds in urban areas totalled 76,227 (Table 1). Males accounted for two-thirds of these hospitalizations, so as might be expected, the crude hospitalization rate per 10,000 person-years at risk was much higher for males (40.8) than for females (21.6). Crude rates tended to rise with age from about 30 hospitalizations per 10,000 person-years at risk for children younger than 10 to almost 35 per 10,000 person-years at risk for 15- to 19-year-olds.

Falls were the leading cause of unintentional injury hospitalizations (43%), followed by injuries associated with land transportation (21%) (Figure 1). Another 11% of unintentional injury hospitalizations resulted from being struck. Relatively few were attributable to poisoning (5%), cut/pierce (3%), fire (2%), natural environment (2%), or drowning/suffocation (1%).

Because of the uneven age distribution of the population across neighbourhood income quintiles, unintentional injury hospitalization rates were age-standardized. The age-standardized rates fell from about 33 hospitalizations per 10,000 person-years at risk in the lowest-income neighbourhoods to about 30 per

**Table 1**
**Number of hospitalizations for unintentional injury, person-years at risk and crude rate per 10,000 person-years at risk, urban population aged 0 to 19, Canada, 2001/2002 to 2004/2005**

| | | | Rate per 10,000 person-years at risk | |
|---|---|---|---|---|
| | Hospitalizations | Person-years at risk | Crude | Age-standardized |
| **Total** | **76,227** | **24,295,310** | **31.4** | **31.3** |
| **Sex** | | | | |
| Male | 50,653 | 12,426,567 | 40.8 | 40.7 |
| Female | 25,574 | 11,868,743 | 21.6 | 21.6 |
| **Age (years)** | | | | |
| 0 to 4 | 16,212 | 5,391,425 | 30.1 | ... |
| 5 to 9 | 16,556 | 6,008,589 | 27.6 | ... |
| 10 to 14 | 20,972 | 6,395,095 | 32.8 | ... |
| 15 to 19 | 22,487 | 6,500,201 | 34.6 | ... |
| **Neighbourhood income quintile** | | | | |
| 1 (lowest ) | 14,806 | 4,514,570 | 32.8 | 32.7 |
| 2 | 14,346 | 4,500,780 | 31.9 | 31.9 |
| 3 | 15,401 | 4,852,265 | 31.7 | 31.7 |
| 4 | 16,139 | 5,266,500 | 30.6 | 30.6 |
| 5 (highest) | 15,535 | 5,161,195 | 30.1 | 29.9 |
| **Injury category†** | | | | |
| Falls | 32,695 | 24,295,310 | 13.5 | 13.5 |
| Land transportation | 15,880 | 24,295,310 | 6.5 | 6.5 |
| Struck | 8,335 | 24,295,310 | 3.4 | 3.4 |
| Poisoning | 3,953 | 24,295,310 | 1.6 | 1.6 |
| Cut/Pierce | 2,230 | 24,295,310 | 0.9 | 0.9 |
| Natural environment | 1,760 | 24,295,310 | 0.7 | 0.7 |
| Fire | 1,750 | 24,295,310 | 0.7 | 0.7 |
| Drowning/Suffocation | 993 | 24,295,310 | 0.4 | 0.4 |
| Other | 8,980 | 24,295,310 | 3.7 | 3.7 |

† because multiple injuries were recorded, subcategories add to more than total
... not applicable
**Source:** 2001/2002 to 2004/2005 Hospital Morbidity Database.

**Table 2**
**Age-standardized rate of unintentional injury hospitalizations per 10,000 person-years at risk, by injury category, neighbourhood income quintile, sex and age group, urban population aged 0 to 19, Canada, 2001/2002 to 2004/2005**

| | | | | | Sex | | | | | | | | Age group (years) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total | | | | Male | | | | Female | | | | 0 to 9 | | | | 10 to 19 | | | |
| | | 95% confidence interval | | | | 95% confidence interval | | | | 95% confidence interval | | | | 95% confidence interval | | | | 95% confidence interval | | |
| Injury category/ Neighbourhood income quintile | Rate | from | to | LTT† | Rate | from | to | LTT† | Rate | from | to | LTT† | Rate | from | to | LTT | Rate | from | to | LTT† |
| **Total** | | | | | | | | | | | | | | | | | | | | |
| Total | 31.3 | 31.1 | 31.6 | -0.02* | 40.7 | 40.4 | 41.1 | -0.02* | 21.6 | 21.3 | 21.8 | -0.03* | 28.7 | 28.4 | 29.0 | -0.05* | 33.7 | 33.4 | 34.0 | 0.0 |
| 1 (lowest) | 32.7* | 32.2 | 33.3 | | 42.4* | 41.6 | 43.3 | | 22.8* | 22.2 | 23.4 | | 32.2* | 31.5 | 33.0 | | 33.2 | 32.5 | 34.0 | |
| 2 | 31.9* | 31.4 | 32.4 | | 41.1* | 40.3 | 41.9 | | 22.2* | 21.6 | 22.9 | | 29.8* | 29.0 | 30.5 | | 33.8 | 33.0 | 34.5 | |
| 3 | 31.7* | 31.2 | 32.2 | | 41.2* | 40.4 | 42.0 | | 21.7* | 21.1 | 22.3 | | 28.7* | 28.0 | 29.4 | | 34.4 | 33.7 | 35.1 | |
| 4 | 30.6* | 30.1 | 31.1 | | 39.7 | 39.0 | 40.5 | | 20.9 | 20.4 | 21.5 | | 27.2* | 26.5 | 27.8 | | 33.6 | 33.0 | 34.3 | |
| 5 (highest) | 29.9 | 29.4 | 30.3 | | 39.1 | 38.3 | 39.8 | | 20.2 | 19.7 | 20.8 | | 25.8 | 25.2 | 26.5 | | 33.4 | 32.8 | 34.1 | |
| **Falls** | | | | | | | | | | | | | | | | | | | | |
| Total | 13.5 | 13.3 | 13.6 | 0.0 | 17.1 | 16.9 | 17.3 | 0.0 | 9.7 | 9.5 | 9.9 | 0.0 | 14.6 | 14.4 | 14.8 | -0.02* | 12.5 | 12.3 | 12.7 | 0.01* |
| 1 (lowest) | 13.5 | 13.2 | 13.9 | | 17.1 | 16.5 | 17.6 | | 9.9 | 9.5 | 10.3 | | 15.2* | 14.7 | 15.7 | | 12.1* | 11.6 | 12.5 | |
| 2 | 13.6 | 13.3 | 14.0 | | 17.2 | 16.7 | 17.8 | | 9.9 | 9.5 | 10.3 | | 14.9 | 14.4 | 15.5 | | 12.5 | 12.0 | 12.9 | |
| 3 | 13.4 | 13.1 | 13.7 | | 16.9 | 16.4 | 17.4 | | 9.7 | 9.3 | 10.1 | | 14.5 | 14.0 | 15.0 | | 12.4 | 12.0 | 12.8 | |
| 4 | 13.3 | 13.0 | 13.6 | | 17.1 | 16.6 | 17.6 | | 9.4 | 9.0 | 9.8 | | 14.1 | 13.6 | 14.6 | | 12.7 | 12.3 | 13.1 | |
| 5 (highest) | 13.5 | 13.2 | 13.8 | | 17.2 | 16.8 | 17.8 | | 9.6 | 9.2 | 10.0 | | 14.3 | 13.8 | 14.8 | | 12.8 | 12.4 | 13.2 | |
| **Land transportation** | | | | | | | | | | | | | | | | | | | | |
| Total | 6.5 | 6.4 | 6.6 | -0.1 | 8.8 | 8.6 | 8.9 | 0.0 | 4.2 | 4.1 | 4.3 | -0.1 | 3.3 | 3.2 | 3.4 | -0.12* | 9.4 | 9.2 | 9.6 | 0.0 |
| 1 (lowest) | 6.9* | 6.6 | 7.1 | | 9.2* | 8.8 | 9.6 | | 4.5* | 4.2 | 4.8 | | 4.2* | 3.9 | 4.5 | | 9.3* | 8.9 | 9.7 | |
| 2 | 6.8* | 6.6 | 7.1 | | 9.1* | 8.8 | 9.5 | | 4.4* | 4.1 | 4.7 | | 3.5* | 3.3 | 3.8 | | 9.8* | 9.4 | 10.2 | |
| 3 | 7.1* | 6.8 | 7.3 | | 9.5* | 9.1 | 9.8 | | 4.6* | 4.3 | 4.9 | | 3.5* | 3.2 | 3.7 | | 10.3* | 9.9 | 10.7 | |
| 4 | 6.3* | 6.1 | 6.6 | | 8.5* | 8.2 | 8.8 | | 4.1* | 3.8 | 4.3 | | 3.1* | 2.9 | 3.3 | | 9.2* | 8.9 | 9.6 | |
| 5 (highest) | 5.7 | 5.5 | 5.9 | | 7.7 | 7.4 | 8.0 | | 3.6 | 3.3 | 3.8 | | 2.5 | 2.3 | 2.7 | | 8.5 | 8.2 | 8.9 | |
| **Struck** | | | | | | | | | | | | | | | | | | | | |
| Total | 3.4 | 3.4 | 3.5 | 0.07* | 5.3 | 5.1 | 5.4 | 0.06* | 1.5 | 1.4 | 1.6 | 0.08* | 1.9 | 1.8 | 2.0 | 0.0 | 4.8 | 4.7 | 4.9 | 0.10* |
| 1 (lowest) | 3.0* | 2.8 | 3.1 | | 4.6* | 4.3 | 4.9 | | 1.3* | 1.2 | 1.5 | | 2.0 | 1.8 | 2.1 | | 3.9* | 3.6 | 4.2 | |
| 2 | 3.2* | 3.0 | 3.3 | | 4.9* | 4.7 | 5.2 | | 1.3* | 1.2 | 1.5 | | 1.9 | 1.7 | 2.1 | | 4.3* | 4.1 | 4.6 | |
| 3 | 3.3* | 3.2 | 3.5 | | 5.2* | 4.9 | 5.5 | | 1.4* | 1.2 | 1.5 | | 1.9 | 1.7 | 2.0 | | 4.6* | 4.4 | 4.9 | |
| 4 | 3.6 | 3.5 | 3.8 | | 5.6 | 5.3 | 5.9 | | 1.6 | 1.5 | 1.8 | | 1.9 | 1.7 | 2.1 | | 5.2* | 4.9 | 5.4 | |
| 5 (highest) | 3.9 | 3.7 | 4.0 | | 5.8 | 5.5 | 6.1 | | 1.8 | 1.7 | 2.0 | | 1.8 | 1.6 | 2.0 | | 5.7 | 5.5 | 6.0 | |
| **Poisoning** | | | | | | | | | | | | | | | | | | | | |
| Total | 1.6 | 1.6 | 1.7 | -0.13* | 1.7 | 1.7 | 1.8 | -0.14* | 1.5 | 1.4 | 1.6 | -0.12* | 2.3 | 2.2 | 2.4 | -0.13* | 1.0 | 1.0 | 1.1 | -0.13* |
| 1 (lowest) | 2.2* | 2.0 | 2.3 | | 2.4* | 2.2 | 2.6 | | 2.0* | 1.8 | 2.2 | | 3.0* | 2.8 | 3.2 | | 1.4* | 1.3 | 1.6 | |
| 2 | 1.7* | 1.6 | 1.8 | | 1.8* | 1.7 | 2.0 | | 1.6* | 1.4 | 1.8 | | 2.4* | 2.2 | 2.6 | | 1.2* | 1.0 | 1.3 | |
| 3 | 1.5* | 1.4 | 1.7 | | 1.7* | 1.5 | 1.8 | | 1.4* | 1.3 | 1.6 | | 2.2* | 2.0 | 2.4 | | 0.9 | 0.8 | 1.1 | |
| 4 | 1.4 | 1.3 | 1.5 | | 1.4 | 1.3 | 1.5 | | 1.4* | 1.2 | 1.5 | | 1.9 | 1.8 | 2.1 | | 0.9 | 0.8 | 1.0 | |
| 5 (highest) | 1.3 | 1.2 | 1.4 | | 1.4 | 1.2 | 1.5 | | 1.2 | 1.0 | 1.3 | | 1.7 | 1.6 | 1.9 | | 0.9 | 0.8 | 1.0 | |
| **Cut/Pierce** | | | | | | | | | | | | | | | | | | | | |
| Total | 0.9 | 0.9 | 1.0 | -0.13* | 1.3 | 1.3 | 1.4 | -0.11* | 0.5 | 0.5 | 0.5 | -0.18* | 0.7 | 0.6 | 0.7 | -0.10* | 1.1 | 1.1 | 1.2 | -0.14* |
| 1 (lowest) | 1.2* | 1.1 | 1.3 | | 1.7* | 1.6 | 1.9 | | 0.6* | 0.5 | 0.7 | | 0.9* | 0.7 | 1.0 | | 1.5* | 1.3 | 1.6 | |
| 2 | 1.0* | 0.9 | 1.1 | | 1.5* | 1.3 | 1.6 | | 0.6* | 0.5 | 0.7 | | 0.7 | 0.6 | 0.8 | | 1.3* | 1.2 | 1.5 | |
| 3 | 0.9* | 0.8 | 1.0 | | 1.3 | 1.1 | 1.4 | | 0.5* | 0.4 | 0.6 | | 0.7 | 0.6 | 0.8 | | 1.1* | 1.0 | 1.2 | |
| 4 | 0.8 | 0.7 | 0.9 | | 1.2 | 1.1 | 1.3 | | 0.4* | 0.4 | 0.5 | | 0.6 | 0.5 | 0.7 | | 1.0 | 0.9 | 1.1 | |
| 5 (highest) | 0.7 | 0.6 | 0.8 | | 1.1 | 1.0 | 1.2 | | 0.3 | 0.2 | 0.4 | | 0.6 | 0.5 | 0.7 | | 0.9 | 0.8 | 1.0 | |
| **Natural environment** | | | | | | | | | | | | | | | | | | | | |
| Total | 0.7 | 0.7 | 0.8 | -0.1 | 0.8 | 0.7 | 0.8 | -0.1 | 0.7 | 0.6 | 0.7 | 0.0 | 1.1 | 1.0 | 1.1 | 0.0 | 0.4 | 0.4 | 0.5 | -0.1 |
| 1 (lowest) | 0.8* | 0.7 | 0.9 | | 0.9* | 0.8 | 1.0 | | 0.7 | 0.6 | 0.8 | | 1.1* | 1.0 | 1.2 | | 0.5* | 0.4 | 0.6 | |
| 2 | 0.7* | 0.6 | 0.8 | | 0.7 | 0.6 | 0.8 | | 0.7 | 0.6 | 0.8 | | 1.1 | 0.9 | 1.2 | | 0.4 | 0.3 | 0.5 | |
| 3 | 0.8* | 0.8 | 0.9 | | 0.9* | 0.8 | 1.0 | | 0.8 | 0.7 | 0.9 | | 1.2* | 1.0 | 1.3 | | 0.5* | 0.5 | 0.6 | |
| 4 | 0.7 | 0.6 | 0.8 | | 0.8* | 0.7 | 0.9 | | 0.6 | 0.5 | 0.7 | | 1.1* | 1.0 | 1.2 | | 0.4 | 0.3 | 0.4 | |
| 5 (highest) | 0.6 | 0.5 | 0.7 | | 0.6 | 0.5 | 0.7 | | 0.6 | 0.6 | 0.8 | | 0.9 | 0.8 | 1.0 | | 0.4 | 0.3 | 0.4 | |
| **Fire** | | | | | | | | | | | | | | | | | | | | |
| Total | 0.7 | 0.7 | 0.8 | -0.17* | 0.9 | 0.8 | 0.9 | -0.15* | 0.6 | 0.5 | 0.6 | -0.21* | 1.1 | 1.0 | 1.2 | -0.19* | 0.4 | 0.3 | 0.4 | -0.12* |
| 1 (lowest) | 1.0* | 1.0 | 1.1 | | 1.2* | 1.1 | 1.3 | | 0.9* | 0.8 | 1.0 | | 1.7* | 1.5 | 1.8 | | 0.5* | 0.4 | 0.6 | |
| 2 | 0.8* | 0.7 | 0.9 | | 1.0* | 0.8 | 1.1 | | 0.7* | 0.6 | 0.8 | | 1.3* | 1.1 | 1.4 | | 0.4* | 0.3 | 0.5 | |
| 3 | 0.6* | 0.6 | 0.7 | | 0.9* | 0.8 | 1.0 | | 0.4 | 0.3 | 0.5 | | 0.9 | 0.8 | 1.1 | | 0.4 | 0.3 | 0.5 | |
| 4 | 0.6 | 0.5 | 0.6 | | 0.7 | 0.6 | 0.8 | | 0.5 | 0.4 | 0.5 | | 0.9 | 0.7 | 1.0 | | 0.3 | 0.3 | 0.4 | |
| 5 (highest) | 0.5 | 0.5 | 0.6 | | 0.7 | 0.6 | 0.8 | | 0.4 | 0.3 | 0.5 | | 0.8 | 0.7 | 0.9 | | 0.3 | 0.2 | 0.4 | |
| **Drowning/Suffocation** | | | | | | | | | | | | | | | | | | | | |
| Total | 0.4 | 0.4 | 0.4 | -0.07* | 0.5 | 0.5 | 0.6 | -0.1 | 0.3 | 0.3 | 0.3 | -0.1 | 0.7 | 0.7 | 0.8 | -0.06* | 0.1 | 0.1 | 0.2 | -0.1 |
| 1 (lowest) | 0.5* | 0.4 | 0.5 | | 0.6 | 0.5 | 0.7 | | 0.3* | 0.3 | 0.4 | | 0.8* | 0.7 | 0.9 | | 0.2* | 0.2 | 0.3 | |
| 2 | 0.4 | 0.4 | 0.5 | | 0.5 | 0.5 | 0.6 | | 0.3* | 0.3 | 0.4 | | 0.7 | 0.6 | 0.9 | | 0.2 | 0.1 | 0.2 | |
| 3 | 0.4 | 0.3 | 0.4 | | 0.5 | 0.4 | 0.6 | | 0.3 | 0.2 | 0.4 | | 0.7 | 0.6 | 0.8 | | 0.1 | 0.1 | 0.2 | |
| 4 | 0.4 | 0.3 | 0.4 | | 0.5 | 0.4 | 0.5 | | 0.3* | 0.3 | 0.4 | | 0.7 | 0.6 | 0.8 | | 0.2 | 0.1 | 0.2 | |
| 5 (highest) | 0.4 | 0.3 | 0.4 | | 0.5 | 0.4 | 0.6 | | 0.2 | 0.2 | 0.3 | | 0.6 | 0.5 | 0.7 | | 0.1 | 0.1 | 0.2 | |
| **Other** | | | | | | | | | | | | | | | | | | | | |
| Total | 3.7 | 3.6 | 3.8 | -0.02* | 4.6 | 4.5 | 4.7 | 0.0 | 2.7 | 2.6 | 2.8 | 0.0 | 3.3 | 3.2 | 3.4 | -0.06* | 4.0 | 3.9 | 4.2 | 0.0 |
| 1 (lowest) | 3.9* | 3.7 | 4.0 | | 5.1* | 4.8 | 5.4 | | 2.6 | 2.4 | 2.8 | | 3.7* | 3.5 | 4.0 | | 4.0 | 3.7 | 4.3 | |
| 2 | 3.7* | 3.5 | 3.9 | | 4.5 | 4.2 | 4.8 | | 2.9* | 2.7 | 3.1 | | 3.5* | 3.2 | 3.7 | | 3.9 | 3.7 | 4.2 | |
| 3 | 3.8* | 3.6 | 4.0 | | 4.8* | 4.5 | 5.1 | | 2.7 | 2.5 | 3.0 | | 3.3* | 3.1 | 3.5 | | 4.2 | 4.0 | 4.5 | |
| 4 | 3.6 | 3.4 | 3.7 | | 4.3 | 4.1 | 4.6 | | 2.8 | 2.6 | 3.0 | | 3.1 | 2.9 | 3.3 | | 4.0 | 3.8 | 4.3 | |
| 5 (highest) | 3.5 | 3.3 | 3.6 | | 4.3 | 4.1 | 4.6 | | 2.6 | 2.4 | 2.8 | | 2.9 | 2.7 | 3.1 | | 4.0 | 3.8 | 4.2 | |

† LTT=linear trend test coefficient

* significantly different from highest quintile ($p<0.05$)

**Source:** 2001/2002 to 2004/2005 Hospital Morbidity Database.

10,000 person-years at risk in the highest (Figure 2). This pattern applied to males and females and to children aged 0 to 9. However, among 10- to 19-year-olds, associations between neighbourhood income and injury hospitalizations were not statistically significant.

## Low neighbourhood income/High hospitalization rates

For several causes of unintentional injury, children and teens in low-income neighbourhoods were more likely to be hospitalized than were their counterparts in high-income neighbourhoods (Table 2, Appendix Table B). Age-standardized rates of hospitalization due to *poisoning* and to being *cut/pierced* were significantly higher in the three lowest neighbourhood income quintiles than among those in the highest. Confirming this, the LTT was significant overall, by sex, and by age group. Similarly, rates of hospitalization due to *fires* tended to rise as neighbourhood income decreased. The LTT across the five income quintiles was significant for all age and sex groups.

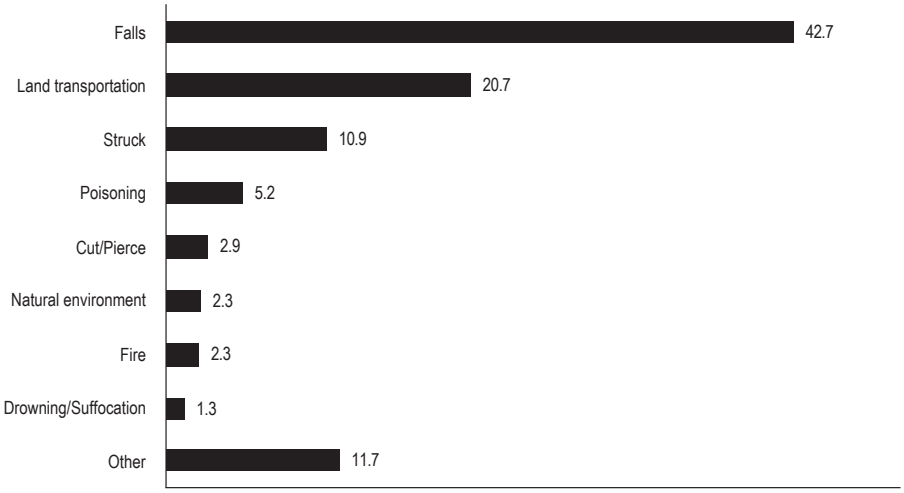
For a number of other causes, hospitalization rates were higher in lower-income neighbourhoods among children, but not teens. For instance, while children and teenagers in the lower-income neighbourhoods had signficantly higher rates of hospitalization for *drowning/ suffocation*, for *land transportation*, and for *other* causes than did those in the highest, the LTT was significant only among children aged 0 to 9.

Children aged 0 to 9 in the lowest-income neighbourhoods had significantly higher rates of hospitalization for *falls* than did those in the highest income quintile. By contrast, 10- to 19-year-olds in such neighbourhoods actually had a siginficantly lower rate of hospitalization for falls than did those in the highest-income neigbourhoods.

## High neighbourhood income/High hospitalization rates

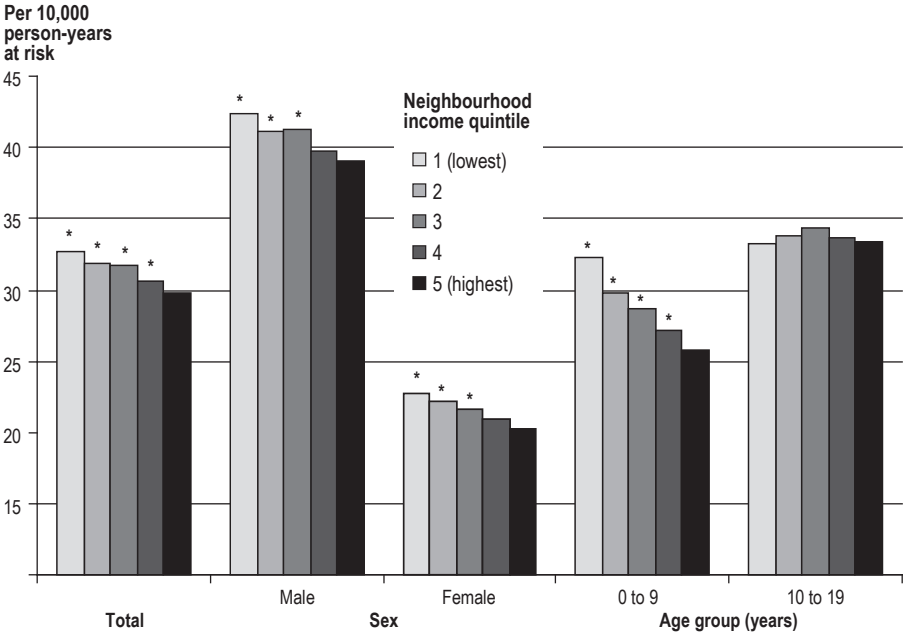
At ages 10 to 19, age-standardized rates of hospitalization due to being *struck* tended to rise with neighbourhood income

**Figure 1**
**Percentage distribution of unintentional injury hospitalizations, by category, urban population aged 0 to 19, Canada, 2001/2002 to 2004/2005**




**Source:** 2001/2002 to 2004/2005 Hospital Morbidity Database.

**Figure 2**
**Rate of unintentional injury hospitalizations per 10,000 person-years at risk, by sex, age group and neighbourhood income quintile, urban population aged 0 to 19, Canada, 2001/2002 to 2004/2005**




* significantly different from highest quintile ($p < 0.05$)
**Source:** 2001/2002 to 2004/2005 Hospital Morbidity Database.

quintile. The LTT was significant for the 10-to-19 age group, but not for children aged 0 to 9.

### No gradient

For injuries due to the *natural environment,* no gradient by neighbourhood income was evident in hospitalization rates. For example, young people from middle-income neighbourhoods (quintile 3) had higher natural environment injury hospitalization rates than did those from the lowest neighbourhood income quintile.

## Discussion

As has been found in other studies,[14,15,22,34,40] this analysis shows that rates of unintentional injury hospitalization among Canadian children and teenagers generally increased with neighbourhood disadvantage. The pattern was consistent for most types of unintentional injuries suggesting that they are related to the level of income in the neighbourhood where children live.

Rates of hospitalization for poisoning, being cut/pierced and fire were higher among children and teens in lower-income neighbourhoods. As well, for children aged 0 to 9 (but not 10- to 19-year-olds), associations between low neighbourhood income and hospitalizations for injuries related to falls and other unintentional causes were signficant.

However, hospitalization rates for all injury categories were not invariably higher for children in lower-income neighbourhoods. In fact, rates for injuries due to being struck were significantly higher among 10- to 19-year-olds in higher-income neighbourhoods. A possible explanation is that this category includes sports injuries, which may be more common in higher-income neighbourhoods. A study in England, Scotland and Wales found that rates of childhood sports-related fractures increased with area affluence.[41] A preliminary analysis of ICD codes for the causes of hospitalization in this study supported this theory: 29% of the struck injuries in the highest-income neighbourhoods were sports-related, compared with 24% of the struck injuries in the lowest income neighbourhoods.

Similar to findings reported in some,[42-44] but not all, [18,22] studies, children aged 0 to 9 in the lowest-income neighbourhoods had a higher rate of hospitalization for falls than did those in the highest-income neighbourhoods, but for 10- to 19-year-olds, the rate was lower in the lowest-income neighbourhoods. It is possible that the circumstances surrounding falls differ among younger and older children. For instance, hazards such as a lack of baby gates may expose young children to fall-related hospitalizations.

### Strengths and limitations

Canadian studies of associations between neighbourhood income and childhood injury have typically used self-reported survey data, which do not provide information on diagnoses,[30-32] or administrative data that pertain only to a single city or hospital.[22,35] By contrast, the present analysis uses four years of population-based hospitalization data for children in urban Canada to produce rates by age and sex. Moreover, the rates in this article are likely conservative, because injury hospitalizations occurring outside the individual's province of residence were excluded, as were injuries to children and teenagers who died before hospital admission. And by design, individuals presenting only to emergency rooms, doctors offices or clinics were not included.

This study has several limitations. Because Quebec provides only the first three digits of the postal code, the assignment of neighbourhood income quintile was less precise than that in other provinces.

Research suggests that neighbourhood has independent effects on childhood injury even when controlling for individual and family factors.[45] Even so, the lack of information about family characteristics or children's behaviours that can influence injury risk[32,46] meant that the relative contributions of individual, family and neighbourhood factors could not be ascertained in this analysis.

This is an ecological study—associations observed at the neighbourhood level do not necessarily apply at the individual level. As well, the findings apply only to urban areas, and do not necessarily hold for rural areas. Data on the geographical location where the injury happened were also not available.

### Implications for research

Childhood injury has been identified as a key policy area in Canada.[1] Results of the current study may be useful in the development of strategies to reduce childhood injury. In addition, the hospitalization rates presented here can be used to examine changes over time. It remains for future research to examine: how social and physical dimensions of the neighbourhood affect childhood injury; the relative influence of individual and

### *What is already known on this subject?*

- In urban Canada, children and teenagers in lower-income neighbourhoods have higher rates of mortality due to unintentional injury.

### *What does this study add?*

- Children and teenagers in lower-income urban neighbourhoods are more likely than those in higher-income neighbourhood to be hospitalized for unintentional injuries.
- The association between living in a lower-income neighbourhood and injury hospitalization was strongest among children aged 0 to 9.
- Injury hospitalization rates due to being struck were higher among 10- to 19-year-olds in higher-income neighbourhoods, compared with those in lower-income neighbourhoods.

neighbourhood factors; and if patterns are similar in rural neighbourhoods.

## Conclusion

Unintentional childhood injury hospitalization in urban Canada varies by neighbourhood income. Hospitalizations due to fire, poisoning, drowning/suffocation, and being cut/pierced rose with decreasing neighbourhood income. Injury hospitalizations due to being struck showed a reverse gradient—increasing neighbourhood income quintile was associated with a higher rate of hospitalization. ■

## Acknowledgements

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# Appendix

**Table A**
**International Classification of Disease versions used, by province and fiscal year**

| Province | Fiscal 2001 | Fiscal 2002 | Fiscal 2003 | Fiscal 2004 |
|---|---|---|---|---|
| Newfoundland and Labrador | ICD-10-CA | ICD-10-CA | ICD-10-CA | ICD-10-CA |
| Prince Edward Island | ICD-10-CA | ICD-10-CA | ICD-10-CA | ICD-10-CA |
| Nova Scotia | ICD-10-CA | ICD-10-CA | ICD-10-CA | ICD-10-CA |
| New Brunswick | ICD-9-CM | ICD-9-CM | ICD-10-CA | ICD-10-CA |
| Quebec | ICD-9 | ICD-9 | ICD-9 | ICD-9 |
| Ontario | ICD-9; ICD-9-CM | ICD-10-CA | ICD-10-CA | ICD-10-CA |
| Manitoba | ICD-9-CM | ICD-9-CM | ICD-9-CM | ICD-10-CA |
| Saskatchewan | ICD-9; ICD-9-CM; ICD-10-CA | ICD-10-CA | ICD-10-CA | ICD-10-CA |
| Alberta | ICD-9-CM | ICD-10-CA | ICD-10-CA | ICD-10-CA |
| British Columbia | ICD-10-CA | ICD-10-CA | ICD-10-CA | ICD-10-CA |

ICD-10-CA= International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, Canadian Adaptation
ICD-9-CM= International Statistical Classification of Diseases, Injuries and Causes of Death, Ninth Revision, Clinical Modification
ICD-9= International Statistical Classification of Diseases, Injuries and Causes of Death, Ninth Revision

**Table B**
**Number of unintentional injury hospitalizations, by injury category, neighbourhood income quintile, sex and age group, urban population aged 0 to 19, Canada, 2001/2002 to 2004/2005**

| Injury category/ Neighbourhood income quintile | Total | Sex | | Age group (years) | |
|---|---|---|---|---|---|
| | | Male | Female | 0 to 9 | 10 to 19 |
| **Total** | | | | | |
| Total | 76,227 | 50,653 | 25,574 | 32,768 | 43,459 |
| 1 (lowest) | 14,806 | 9,679 | 5,127 | 7,396 | 7,410 |
| 2 | 14,346 | 9,448 | 4,898 | 6,435 | 7,911 |
| 3 | 15,401 | 10,282 | 5,119 | 6,491 | 8,910 |
| 4 | 16,139 | 10,772 | 5,367 | 6,595 | 9,544 |
| 5 (highest) | 15,535 | 10,472 | 5,063 | 5,851 | 9,684 |
| **Falls** | | | | | |
| Total | 32,695 | 21,240 | 11,455 | 16,601 | 16,094 |
| 1 (lowest) | 6,119 | 3,895 | 2,224 | 3,441 | 2,678 |
| 2 | 6,126 | 3,957 | 2,169 | 3,214 | 2,912 |
| 3 | 6,484 | 4,196 | 2,288 | 3,277 | 3,207 |
| 4 | 7,011 | 4,616 | 2,395 | 3,419 | 3,592 |
| 5 (highest) | 6,955 | 4,576 | 2,379 | 3,250 | 3,705 |
| **Land transportation** | | | | | |
| Total | 15,880 | 10,896 | 4,984 | 3,753 | 12,127 |
| 1 (lowest) | 2,995 | 2,022 | 973 | 914 | 2,081 |
| 2 | 3,033 | 2,081 | 952 | 743 | 2,290 |
| 3 | 3,447 | 2,365 | 1,082 | 781 | 2,666 |
| 4 | 3,365 | 2,316 | 1,049 | 748 | 2,617 |
| 5 (highest) | 3,040 | 2,112 | 928 | 567 | 2,473 |
| **Struck** | | | | | |
| Total | 8,335 | 6,553 | 1,782 | 2,125 | 6,210 |
| 1 (lowest) | 1,310 | 1,015 | 295 | 443 | 867 |
| 2 | 1,411 | 1,125 | 286 | 397 | 1,014 |
| 3 | 1,620 | 1,295 | 325 | 419 | 1,201 |
| 4 | 1,930 | 1,519 | 411 | 463 | 1,467 |
| 5 (highest) | 2,064 | 1,599 | 465 | 403 | 1,661 |
| **Poisoning** | | | | | |
| Total | 3,953 | 2,161 | 1,792 | 2,622 | 1,331 |
| 1 (lowest) | 1,053 | 590 | 463 | 732 | 321 |
| 2 | 796 | 438 | 358 | 526 | 270 |
| 3 | 752 | 417 | 335 | 510 | 242 |
| 4 | 722 | 369 | 353 | 471 | 251 |
| 5 (highest) | 630 | 347 | 283 | 383 | 247 |
| **Cut/Pierce** | | | | | |
| Total | 2,230 | 1,656 | 574 | 764 | 1,466 |
| 1 (lowest) | 527 | 388 | 139 | 194 | 333 |
| 2 | 464 | 333 | 131 | 149 | 315 |
| 3 | 438 | 319 | 119 | 151 | 287 |
| 4 | 429 | 321 | 108 | 144 | 285 |
| 5 (highest) | 372 | 295 | 77 | 126 | 246 |
| **Natural environment** | | | | | |
| Total | 1,760 | 949 | 811 | 1,208 | 552 |
| 1 (lowest) | 366 | 206 | 160 | 252 | 114 |
| 2 | 324 | 165 | 159 | 231 | 93 |
| 3 | 405 | 226 | 179 | 264 | 141 |
| 4 | 362 | 205 | 157 | 263 | 99 |
| 5 (highest) | 303 | 147 | 156 | 198 | 105 |
| **Fire** | | | | | |
| Total | 1,750 | 1,084 | 666 | 1,268 | 482 |
| 1 (lowest) | 508 | 294 | 214 | 398 | 110 |
| 2 | 380 | 225 | 155 | 283 | 97 |
| 3 | 309 | 217 | 92 | 211 | 98 |
| 4 | 297 | 183 | 114 | 207 | 90 |
| 5 (highest) | 256 | 165 | 91 | 169 | 87 |
| **Drowning/Suffocation** | | | | | |
| Total | 993 | 635 | 358 | 810 | 183 |
| 1 (lowest) | 233 | 151 | 82 | 189 | 44 |
| 2 | 201 | 128 | 73 | 165 | 36 |
| 3 | 187 | 115 | 72 | 160 | 27 |
| 4 | 200 | 119 | 81 | 158 | 42 |
| 5 (highest) | 172 | 122 | 50 | 138 | 34 |
| **Other** | | | | | |
| Total | 8,980 | 5,726 | 3,254 | 3,769 | 5,211 |
| 1 (lowest) | 1,765 | 1,170 | 595 | 870 | 895 |
| 2 | 1,679 | 1,037 | 642 | 760 | 919 |
| 3 | 1,844 | 1,194 | 650 | 746 | 1,098 |
| 4 | 1,889 | 1,171 | 718 | 748 | 1,141 |
| 5 (highest) | 1,803 | 1,154 | 649 | 645 | 1,158 |

**Source:** 2001/2002 to 2004/2005 Hospital Morbidity Database.