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Original quantitative research

The rural–urban gap: differences in injury characteristics

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Abstract

Background: Injuries are among the top 10 leading causes of death in Canada. However, the types and rates of injuries vary between rural versus urban settings. Injury rates increase with rurality, particularly those related to motor vehicle collisions. Factors such as type of work, hazardous environments and longer driving distances contribute to the difference in rural and urban injury rates. Further examination of injuries comparing rural and urban settings with increased granularity in the nature of injuries and severity is needed.

Methods: The study population consisted of records from the electronic Canadian Hospitals Injury Reporting and Prevention Program (eCHIRPP) from between 2011 and July 2017. Rural and urban status was determined based on postal codes as defined by Canada Post. Proportionate injury ratios (PIRs) were calculated to compare rural and urban injury rates by nature and severity of injury and sex, among other factors.

Results: Rural injuries were more likely to involve multiple injuries (PIR = 1.66 for 3 injuries) and crush injuries (PIR = 1.72). More modestly elevated PIRs for rural settings were found for animal bites (1.14), burns (1.22), eye injuries (1.32), fractures (1.20) and muscle or soft tissue injuries (1.11). Injuries in rural areas were more severe, with a higher likelihood of cases being admitted to hospital (1.97), and they were more likely to be due to a motor vehicle collision (2.12).

Conclusion: The nature of injuries in rural settings differ from those in urban settings. This suggests a need to evaluate current injury prevention efforts in rural settings with the aim to close the gap between rural and urban injury rates.

Keywords: *wounds, injuries, injury surveillance, rural, urban, eCHIRPP, epidemiology, sentinel surveillance, surveillance, Canadian Hospitals Injury Reporting and Prevention Program*

Highlights

- Rural injuries were more likely to involve multiple injuries presenting to the emergency department (ED).
- Crush injuries, animal bites, burns, eye injuries, fractures and soft tissue injuries were more likely in rural settings.
- Rural injury cases that present to the ED are more severe than urban injury cases.
- The injury mechanism with the highest proportionate injury ratio (PIR) was motor vehicle collisions involving all-terrain vehicles (ATVs) or snowmobiles.

Introduction

Injuries are among the top 10 leading causes of death and hospitalizations in Canada.[1,2] The total cost of injuries in Canada in 2010 was estimated at $26.8 billion.[3] However, injury types and rates vary between the sexes, age groups, occupations and geographical locations.

Injury rates along the rural–urban continuum were found to increase with increasing rurality.[4-9] Contributing to the difference between urban and rural/remote populations in injury types and rates are access to health care, availability of firearms and access to bodies of water, among others.[9] People living in rural/remote areas were at a higher risk of injury from motor vehicle accidents than their urban counterparts.[6,9,10] Rural motor vehicle accidents were more likely to be single vehicle accidents and to result in more severe injuries than motor vehicle accidents in urban areas. The incidence of bicycle-related injuries among children also increased with increased rurality.[11]

Lifestyle differences also contribute to the differences in injuries between rural and urban populations. First, heavy machinery, such as farming equipment, that may lead to higher rates of injuries due to crushing is more common in rural areas. Second, rural area residents tend to present with injuries at a hospital or physician when their injuries are severe because their greater remoteness affects access to health care. The longer time between sustaining an injury and presenting could also contribute to increased severity of injuries observed at health care centres. In contrast, urban residents are more likely to present to a health care centre or physician for less severe injuries.

In 2015, the differences between urban and rural work settings were significant,

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with rural workers more likely to be unskilled and employed in the agriculture, forestry, and hunting and fishing industries.[12] Several sociodemographic differences may also affect injury rates. Compared with their urban counterparts, rural injury-compensation claimants were more likely to have lower levels of formal education, have blue-collar occupations and have a diagnosed comorbidity.[13] In particular, blue-collar workers have an increased likelihood of injury due to the physical nature of manual labour and the hazardous work environments.[13] Rural compensation claimants have been found to have longer periods of work-related disability than urban claimants.[12,13]

Analyses of injuries comparing rural to urban settings using up-to-date Canadian data are lacking. There is also a need to evaluate the full spectrum of the nature of injuries, specifically drownings, poisonings and minor injuries such as burns, along with contributing factors such as injury severity, intent and location.[6]

The objective of this study was to quantify the differences between rural and urban injuries experienced by Canadians.

Methods

Study population

The electronic Canadian Hospitals Injury Reporting and Prevention Program (eCHIRPP) collects data on injuries from 17 hospitals (11 pediatric and 6 general) across Canada. We used injury records from 2011 to July 2017 as the study population. Records missing age, sex or postal codes (to determine rurality) were ineligible; otherwise, no eligibility criteria based on age or sex were applied.

The final study sample consisted of 783 597 records.

Statistical analysis

Descriptive frequency distributions for categorical variables and means and standard deviations were calculated for continuous variables by demographic and injury characteristics. Proportionate injury ratios (PIRs) and 95% confidence intervals were calculated to compare rural injuries to urban injuries by nature of injury, intent, severity and sex. A PIR of 1 indicates that the proportion of observed cases for a characteristic is the same as the expected number based on the sum of the age-specific proportions of that characteristic.

Statistical analyses were conducted using SAS Enterprise Guide version 5.1 (SAS Institute Inc., Cary, NC, USA) and Microsoft Excel 2010 (Redmond, WA, USA).

Rurality

Rurality was determined based on the first three digits of the postal code for each record. Postal codes with 0 (zero) as the second character are classified as rural delivery areas by Canada Post while the numbers 1 through 9 are urban delivery areas.

Nature of injury

The nature of injury was defined as the most serious/severe injury presented by the patient at the emergency department (ED).

Results

Initially, 788 782 injury records from 2011 to July 2017 were extracted from the eCHIRPP database. Records missing age, sex or postal codes were excluded for a final study sample of 783 597, made up of 65 483 cases from rural settings and 718 114 from urban settings.

Individuals injured in rural settings were on average 9.5 years older than their urban counterparts (Table 1). Fractures, nerve/muscle/soft tissue injuries and open wounds accounted for over 50% of injuries in both settings and were more frequent in rural settings. Unintentional injuries were by far the most common; among intentional injuries, intentional self-harm was more common among females, and maltreatment/assault injuries were more common in males in both urban and rural settings.

Compared to urban settings, crush injuries or amputations (PIR = 1.72), animal bites (1.14), burns or corrosions (1.22), eye injuries (1.32), fractures (1.20) and muscle, tendon, nerve, internal organ or soft tissue injuries (1.11) were more likely in rural settings (Table 2).

Presenting with two or three injuries per case was more likely in rural settings than in urban ones (PIR = 1.07 and 1.66, respectively). Compared to urban settings, injuries in rural settings were more likely to occur at work (1.20) and outdoors (1.17). Rural injuries were also more likely to be more severe than urban injuries, with cases more likely to be observed in the ED and require follow-up (1.07); treated in the ED (1.09); admitted to hospital (1.97); or declared dead on arrival or dying in the ED (1.91).

A sensitivity analysis was performed to determine whether the PIR calculated for multiple injuries was influenced by the severity of injuries. The findings show that urban residents more readily present for injuries, whereas rural residents decide they require medical assistance when their injuries are more severe and are more likely to also have multiple injuries. This sensitivity analysis calculated multiple injury PIRs using only severe injury cases in both rural and urban settings. Rural residents with severe injuries were more likely to experience multiple injuries than urban residents, which is in agreement with the initial findings (results not shown).

Rural injuries were more likely to be due to a motor vehicle collision (PIR = 2.12). Injury risk varied based on vehicle type; all-terrain vehicles (ATVs) / snowmobiles (PIR = 2.29), motorcycles / dirt bikes (1.10) and trucks (1.22) were more likely to be reported as involved in an injury in a rural setting than in an urban one.

Discussion

As expected, crush injuries or amputations were more likely in rural settings than urban ones. This can be attributed to rural settings being more hazardous environments. For instance, more farming equipment and heavy machinery is found in rural settings, increasing the risk of crush injuries. These more hazardous environments may also lead to the higher severity of injury as defined by the level of treatment received by rural cases. The common mechanisms of injury in rural settings are more likely to result in more severe injuries than those found in urban settings. In addition, because of the longer time between an injury occurring and access to health care services, the greater distances to hospitals may contribute to the higher severity of injuries at intake.

Injuries involving a motor vehicle collision were more likely in rural settings. This increased risk could be attributed to

TABLE 1
Characteristics of injury events by rurality and sex, all ages, eCHIRPP, 2011–July 2017

Characteristics	Rural			Urban		
	All	Male	Female	All	Male	Female
Total number, *n* (%)	65 483 (8.36)	38 108 (58.20)	27 375 (41.80)	718 114 (91.64)	406 781 (56.65)	311 333 (43.35)
Age in years, mean (SD)	23.69 (25.73)	23.26 (24.13)	24.30 (27.80)	14.13 (18.82)	13.44 (16.61)	15.03 (21.34)
Nature of injury, *n* (%)						
Animal bite	811 (1.24)	404 (1.06)	407 (1.49)	6 783 (0.94)	3 451 (0.85)	3 332 (1.07)
Burn or corrosion	989 (1.51)	666 (1.75)	323 (1.18)	9 036 (1.26)	5 034 (1.24)	4 002 (1.29)
Crushing or amputation	495 (0.76)	380 (1.00)	115 (0.42)	2 700 (0.38)	1 699 (0.42)	1 001 (0.32)
Drowning or asphyxia	127 (0.19)	75 (0.20)	52 (0.19)	1 398 (0.19)	803 (0.20)	595 (0.19)
Electrical injury	44 (0.07)	32 (0.08)	12 (0.04)	360 (0.05)	218 (0.05)	142 (0.05)
Eye injury	1 791 (2.74)	1 384 (3.63)	407 (1.49)	12 057 (1.68)	7 920 (1.95)	4 137 (1.33)
Foreign body excluding eye	1 616 (2.47)	968 (2.54)	648 (2.37)	21 899 (3.05)	11 820 (2.91)	10 079 (3.24)
Fracture	16 513 (25.22)	9 752 (25.59)	6 761 (24.70)	145 152 (20.21)	83 955 (20.64)	61 197 (19.66)
Frostbite or heat/cold stress or systemic overexertion	42 (0.06)	31 (0.08)	11 (0.04)	315 (0.04)	210 (0.05)	105 (0.03)
Head injury including concussion	7 092 (10.83)	4 132 (10.84)	2 960 (10.81)	99 978 (13.92)	58 746 (14.44)	41 232 (13.24)
Multiple/penetrating/other/dental	688 (1.05)	449 (1.18)	239 (0.87)	8 134 (1.13)	4 988 (1.23)	3 146 (1.01)
Muscle / tendon / internal organ / soft tissue injury / nerve	12 407 (18.95)	6 665 (17.49)	5 742 (20.98)	106 983 (14.90)	57 557 (14.15)	49 426 (15.88)
Nature of injury not specified	1 187 (1.81)	665 (1.75)	522 (1.91)	17 982 (2.50)	10 155 (2.50)	7 827 (2.51)
No injury detected	1 501 (2.29)	800 (2.10)	701 (2.56)	16 882 (2.35)	8 639 (2.12)	8 243 (2.65)
Open wounds	8 828 (13.48)	6 063 (15.91)	2 765 (10.10)	113 565 (15.81)	73 657 (18.11)	39 908 (12.82)
Poisoning	1 174 (1.79)	503 (1.32)	671 (2.45)	14 035 (1.95)	5 815 (1.43)	8 220 (2.64)
Sprains/strains/dislocations	6 830 (10.43)	3 365 (8.83)	3 465 (12.66)	89 285 (12.43)	43 610 (10.72)	45 675 (14.67)
Superficial	3 348 (5.11)	1 774 (4.66)	1 574 (5.75)	51 570 (7.18)	28 504 (7.01)	23 066 (7.41)
Intent						
Intentional self-harm	704 (1.08)	244 (0.64)	460 (1.68)	6 937 (0.97)	1 886 (0.46)	5 051 (1.62)
Maltreatment or assault	775 (1.18)	521 (1.37)	254 (0.93)	6 282 (0.87)	4 283 (1.05)	1 999 (0.64)
Other/Unspecified	243 (0.37)	144 (0.38)	99 (0.36)	2 867 (0.40)	1 611 (0.40)	1 256 (0.40)
Unintentional	63 761 (97.37)	37 199 (97.61)	26 562 (97.03)	702 028 (97.76)	399 001 (98.09)	303 027 (97.33)

Abbreviations: eCHIRPP, electronic Canadian Hospitals Injury Reporting and Prevention Program; SD, standard deviation.

longer driving distances, more time spent driving and higher driving speeds in rural areas compared with urban areas. Specific vehicles such as ATVs/snowmobiles, motorcycles/dirt bikes and trucks were more likely to be involved in a collision in rural areas than in urban areas. This is likely to be due to the abundance of these vehicles in rural areas; in urban settings, buses are more common.

The higher risk of injury while working in rural settings was expected. The increased risk could be attributed to the type of work common to rural areas. Rural work is more likely to be in a primary industry where manual labour and hazardous environments are common and the risk of injury requiring medical attention is higher. In contrast, urban work settings are primarily made up of white-collar occupations where the risk of injury that requires medical attention is quite low.[12] However, due to sampling largely from pediatric hospitals, high-injury-risk urban occupations (e.g. construction workers) may be underrepresented in eCHIRPP.

The results of this study indicate that the differences in the nature of injuries, the severity and potential causes are sizable. As such, there is a need to evaluate existing rural injury prevention programs in an effort to close the gap between rural and urban injury rates.

Strengths and limitations

One of the strengths of this study was that we examined a wide range of injuries regardless of their nature, from minor superficial injuries to severe crush injuries and amputations, rather than focussing on the nature or mechanism of select injuries only. This study addresses the need for studies on minor injuries found by Kim et al.[6] in their systematic review. In addition, the study was able to compare the severity of injuries in rural and urban settings. Many studies have simply compared hospitalization or mortality data in the two settings; in our study, we determined the severity of the injury based on the level of treatment provided at the ED.

The study also has limitations that might have affected the results or the generalizability of the results. The majority of the hospitals that contribute data to eCHIRPP are pediatric hospitals located in cities.

TABLE 2
Age- and sex-adjusted proportionate injury ratios of the nature of rural injuries, by sex, all ages, eCHIRPP, 2011–July 2017

Injury characteristics	Total		Males		Females	
	PIR	95% CI	PIR	95% CI	PIR	95% CI
Nature of injury						
Animal bite	1.14	1.07–1.23	1.13	1.02–1.24	1.16	1.05–1.28
Burn or corrosion	1.22	1.14–1.30	1.41	1.31–1.52	0.95	0.85–1.06
Crush injury or amputation	1.72	1.58–1.88	1.85	1.68–2.05	1.40	1.16–1.68
Drowning or asphyxia	1.09	0.91–1.29	1.04	0.83–1.30	1.17	0.89–1.53
Electrical injury	1.25	0.93–1.68	1.35	0.95–1.90	1.05	0.59–1.84
Eye injury	1.32	1.26–1.39	1.43	1.35–1.50	1.07	0.97–1.18
Foreign body excluding eye	1.03	0.98–1.08	1.08	1.01–1.15	0.96	0.89–1.04
Fracture	1.20	1.18–1.22	1.22	1.20–1.25	1.17	1.14–1.20
Frostbite or heat/cold stress or systemic overexertion	1.24	0.92–1.68	1.31	0.92–1.86	1.08	0.60–1.96
Head injuries including concussion	0.93	0.91–0.95	0.91	0.88–0.94	0.96	0.92–0.99
Multiple/penetrating/dental/other	1.23	1.14–1.33	1.27	1.15–1.39	1.17	1.03–1.33
Muscle/tendon/internal organ/soft tissue injury	1.11	1.09–1.13	1.07	1.04–1.10	1.15	1.12–1.18
Nature of injury not specified	0.80	0.76–0.85	0.76	0.70–0.82	0.86	0.79–0.94
No injury detected	0.91	0.86–0.95	0.91	0.85–0.98	0.90	0.83–0.97
Open wounds	0.87	0.85–0.88	0.88	0.86–0.91	0.83	0.80–0.86
Poisoning	0.91	0.86–0.97	0.89	0.81–0.97	0.93	0.87–1.01
Sprains/strains/dislocations	0.84	0.82–0.86	0.81	0.78–0.84	0.88	0.85–0.91
Superficial	0.71	0.69–0.74	0.67	0.64–0.70	0.77	0.73–0.81
Multiple injuries						
0	0.92	0.79–1.07	0.93	0.76–1.13	0.92	0.73–1.16
1	0.97	0.97–0.98	0.97	0.95–0.98	0.98	0.97–1.00
2	1.07	1.04–1.10	1.08	1.05–1.12	1.05	1.01–1.09
3	1.66	1.60–1.73	1.77	1.69–1.85	1.47	1.37–1.57
Location						
Own home	1.02	1.01–1.04	1.06	1.04–1.08	0.98	0.96–1.00
Other home	1.37	1.34–1.41	1.34	1.30–1.39	1.41	1.36–1.47
Residential institution	0.61	0.55–0.67	0.50	0.42–0.59	0.68	0.60–0.77
School or public office location	0.81	0.79–0.83	0.74	0.72–0.77	0.90	0.87–0.93
Hospital or other health services	0.99	0.89–1.10	0.92	0.78–1.09	1.04	0.91–1.18
Park or sports/rec facility	0.94	0.92–0.96	0.93	0.90–0.95	0.96	0.93–1.00
Street, highway or public road	1.04	1.02–1.07	0.99	0.95–1.03	1.12	1.08–1.17
Trade and service	0.94	0.90–0.99	0.89	0.83–0.95	1.01	0.94–1.08
Other specified	1.88	1.79–1.98	1.92	1.82–2.04	1.77	1.60–1.95
Unspecified	0.99	0.98–1.01	1.01	0.99–1.03	0.96	0.93–0.98
Work						
No	0.99	0.98–1.00	0.98	0.97–0.99	0.99	0.98–1.01
Yes	1.20	1.16–1.23	1.22	1.18–1.26	1.15	1.08–1.21
Treatment/disposition						
Left without being seen or only given advice (no treatment in ED)	0.75	0.74–0.77	0.73	0.71–0.75	0.79	0.76–0.81
Treated in ED with follow-up PRN	0.94	0.93–0.95	0.91	0.90–0.93	0.98	0.96–1.00
Observation in ED, follow-up PRN	0.95	0.91–1.00	0.94	0.89–1.00	0.96	0.90–1.03

Continued on the following page

TABLE 2 (continued)
Age- and sex-adjusted proportionate injury ratios of the nature of rural injuries, by sex, all ages, eCHIRPP, 2011–July 2017

Injury characteristics	Total		Males		Females	
	PIR	95% CI	PIR	95% CI	PIR	95% CI
Treatment/disposition (continued)						
Observation in ED, follow-up required	1.07	1.01–1.14	1.02	0.93–1.10	1.15	1.05–1.25
Treated in ED, follow-up required	1.09	1.07–1.11	1.10	1.08–1.12	1.07	1.05–1.10
Admitted to hospital	1.97	1.93–2.02	2.14	2.09–2.20	1.73	1.66–1.79
Dead on arrival or died in ED	1.91	1.46–2.48	1.83	1.34–2.50	2.12	1.30–3.46
Day of Week						
Friday	1.00	0.98–1.02	1.00	0.97–1.02	1.00	0.97–1.03
Monday	1.00	0.98–1.02	1.01	0.98–1.04	0.99	0.96–1.02
Saturday	1.07	1.05–1.09	1.06	1.04–1.09	1.08	1.05–1.11
Sunday	1.03	1.01–1.05	1.03	1.00–1.06	1.02	0.99–1.06
Thursday	0.96	0.94–0.98	0.94	0.91–0.97	0.98	0.95–1.01
Tuesday	0.97	0.95–0.99	0.98	0.96–1.01	0.96	0.93–0.99
Wednesday	0.97	0.95–0.99	0.97	0.94–0.99	0.96	0.93–0.99
Indoor vs outdoor						
Indoor	0.87	0.86–0.88	0.86	0.84–0.87	1.20	1.18–1.22
Outdoor	1.17	1.16–1.18	1.16	1.14–1.17	0.47	0.46–0.47
Intent						
Intentional self-harm	0.89	0.83–0.96	0.86	0.76–0.97	0.91	0.83–0.99
Maltreatment or assault	0.91	0.85–0.98	0.85	0.78–0.93	1.08	0.96–1.22
Other/unspecified	0.85	0.75–0.97	0.83	0.70–0.98	0.89	0.73–1.08
Unintentional	1.00	1.00–1.01	1.00	0.99–1.01	1.00	0.99–1.01
Vehicle Type						
ATV/snowmobile	2.29	2.16–2.42	2.21	2.07–2.36	2.55	2.28–2.85
Boat including jet ski	0.76	0.63–0.92	0.75	0.59–0.95	0.78	0.58–1.06
Bus	0.53	0.42–0.67	0.58	0.42–0.79	0.48	0.34–0.69
Car/van	0.76	0.73–0.79	0.67	0.63–0.71	0.86	0.81–0.91
Motorcycle/dirt bike	1.10	1.03–1.18	1.08	1.00–1.16	1.27	1.07–1.51
Truck	1.22	1.10–1.35	1.09	0.97–1.24	1.60	1.34–1.90
Unspecified	1.09	0.92–1.30	1.18	0.95–1.45	0.93	0.68–1.29
Motor vehicle collision						
No	0.96	0.95–0.96	0.95	0.94–0.96	0.96	0.95–0.98
Yes	2.12	2.06–2.17	2.29	2.21–2.37	1.89	1.81–1.97

Abbreviations: ATV, all-terrain vehicle; CI, confidence interval; eCHIRPP, electronic Canadian Hospitals Injury Reporting and Prevention Program; ED, emergency department; PIR, proportionate injury ratio.

Note: The PIR measures the deviation between the rate of injuries in rural settings and the rate of injuries in urban settings. A PIR of 1 indicates that the proportion of observed cases for a characteristic is the same as the expected number based on the sum of the age-specific proportions of that characteristic.

This means that older teenagers (18–19 years old), adults, those who present at general hospitals and individuals living in rural and remote areas are underrepresented in the eCHIRPP database. Fatal injuries are also underrepresented.

Referral bias was also a concern. It is likely that rural residents with serious injuries are transferred to urban hospitals.[14] However, eCHIRPP provides details on the nature and mechanism of injury that are not available in more representative provincial datasets.

Similarly, confounding by indication needs to be considered when interpreting the results of the study. Rural cases with serious injuries, particularly children, are more likely to be transferred from rural hospitals to urban hospitals and trauma centres, whereas less severe injuries having occurred in rural settings may not be transferred and therefore may be underrepresented in eCHIRPP. Overall, the data are more likely to capture children with more severe injuries.[14]

The true effect size may be underestimated because the population of interest—rural populations—was underrepresented. In addition, rurality is defined in the eCHIRPP database as those with a rural postal code as assigned by Canada Post. This, however, is not equivalent to the definitions of rural and urban areas established by Statistics Canada[15] used in many studies. This affects the comparability of the results of this study to those conducted based on the Statistics Canada rural area definition. In addition, eCHIRPP sites are not found in some provinces and territories (Saskatchewan, New Brunswick, Prince Edward Island, Northwest Territories or Yukon). This lack of representation also affect the wider generalizability of this study's results.

Conclusion

This study contributes to the body of knowledge regarding rural injuries, giving additional insight to the types and severity of injuries that occur in rural areas. The granular analysis of the nature of injuries provided a necessary comparison of injuries in rural and urban settings. The results of this study show that there is a need to evaluate current injury prevention strategies as a sizable difference remains between rural and urban settings in terms of the nature and rates of injuries.

Conflicts of interest

There are no conflicts of interest to declare.

Authors' contributions and statement

FB, MTD and SM were involved in the design and conceptualization of the project. FB conducted the data analyses and drafted the paper. JC conducted the data extraction and coding. All authors contributed to the interpretation of the results and revisions of the paper.

The content and views expressed in this article are those of the authors and do not necessarily reflect those of the Government of Canada.

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