Variations in injury among Canadian adolescents by urban-rural geographic status

Xuran Jiang, Dongguang Li, William Boyce and William Pickett

Abstract

Injuries are the leading cause of morbidity and mortality among Canadian adolescents. Rural adolescents may be disproportionally affected by these traumatic events. Differences in risk for injury between rural and urban adolescents remain understudied. We compared adolescent reports of medically attended injury by urban-rural geographic status using a representative national sample of Canadian adolescents. The study involved an analysis of a national sample of Canadian adolescents aged 11 to 15 years (N = 7,235) from the 2001-2002 WHO/Health Behaviour in School-aged Children survey. Respondents were classified into five geographic categories according to school addresses. Several differences in risk for injury were documented by urban-rural geographic status. Adolescents from rural regions were more likely to report medically treated injury compared with the reference population from large metropolitan areas. These patterns of medically attended injury suggest that prevention and intervention programs could be better targeted to the needs of specific geographic populations of Canadian youth.

Key words: *adolescent, geography, injury, urban-rural*

Introduction

Childhood injury is an important yet understudied issue in Canada. While annual age-standardized mortality rates due to injury among Canadian adolescents decreased substantially from 1979 to 2002 (20.9 per 100,000 to 8.1 per 100,000),[1] injuries still account for approximately 56% of all observed adolescent deaths, or more deaths than from all other causes combined in this group.[2] Children and adolescents living in rural areas may be disproportionately affected. Traumas from motor vehicle crashes,[3] bicycle-related injuries,[4] firearm injuries,[5] agricultural work-related injury[6-7] and suicide[8] all increase with increasing rurality and remoteness. Injuries are also associated with substantial costs in terms of lost potential, disability, treatment and rehabilitation.[9] In rural areas, consequences of injury tend to be more severe due to more challenging living environments,[10-11] lack of access to medical care services[12] and differences in behavioural norms.[13-14]

In Canada, few studies have specifically examined the more general injury experiences of rural adolescents. Most existing epidemiological research focuses solely on fatal injuries[5] or has been confined to a single province.[3,8] Patterns in risk for injury by degree of rurality have not been characterized. We therefore used Canadian records from the 2001-2002 World Health Organization/Health Behaviour in School-aged Children (WHO/HBSC) survey, along with a specially constructed, fixed geographic code (the modified Beale urban-rural code) to study this issue. Our focus was on examining adolescent injury patterns by urban-rural geographic status to ultimately inform preventive efforts.

Methods

Study population and procedures

The HBSC is a World Health Organization collaborative, multinational, cross-sectional survey which was designed to provide information on the health outcomes and health behaviours of young people.[15] Canadian records (N = 7,235) analyzed here were collected in 2002 by the Social Program Evaluation Group at Queen's University in partnership with the Public Health Agency of Canada. The cross-national HBSC research protocol was followed.[15] A cluster sample design was used, with the school class being the basic cluster.[15-16] The survey was conducted in school classes and teachers were asked to administer the questionnaire. The time frame for filling out the questionnaire was one school class session (about 45 minutes). Within each province, samples were selected to represent distributions of schools by size, geographic location (urban and rural), language and religion.[15,17] The Canadian sample is representative of students in grades 6-10 and the sample was designed to be self-weighting. Ethics approval was obtained from the Queen's University General Research Ethics Board and subject consent was obtained at the school board, parent and student levels.

Author References

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Measurements

Variables used in this study were obtained from the 2002 HBSC self-report questionnaire containing 122 core questions about health behaviour (e.g., substance use, bullying, sexual health), demographics (e.g., age, gender, socioeconomic status) and other relevant health outcome variables (e.g., injury).[15]

Injuries

The Canadian version of the HBSC asked questions about injuries that occurred during the "twelve months prior to the survey, and were treated by a doctor or nurse." Response options were "I wasn't...", "1 time", "2 times", "3 times", "4 times or more." Examples of medical attention included being admitted to hospital, requiring a visit to an emergency department or receiving medical care in a doctor's office. Limitation of the study of injury reports to medically treated events is a widely accepted and frequently used approach.[15] Self-reports of injuries have also been found to be reliable and comprehensive indicators of the incidence of injury among 11- to 15-year-old adolescents.[18] The one-year period of recall was used to be consistent with past research practice and to maximize levels of recall.[19]

Students who reported at least one medically treated injury were asked to identify their most important injury event and describe the nature of this injury (medical sequelae), injury type (e.g., sports or fighting related), treatments administered and whether it led to at least one day lost from school or other normal activities.[15] In subsequent analyses that excluded non-severe injury events, analyses were based on "serious injuries", defined in this study using a version of the Modified Abbreviated Injury Score (MAIS) developed by HBSC researchers.[20] These included injuries that resulted in 1) treatment for the injury and hospital admission overnight; 2) the student missing at least one full day of school or usual activities; or 3) an operation due to an internal injury.

Geographic status

A standard geographic classification system commonly called the "Beale urban-rural coding system" was used to group respondents according to urban-rural geographic status.[21] Beale codes for each census division are made available for research purposes from Statistics Canada. In the HBSC database, the postal code for each participating school was linked to a specific census division (CD). These CDs were subsequently coded into one of the five following geographic categories: 1) *large metropolitan regions* are "a central and most populous census division of a census metropolitan area (CMA) with a population greater than one million, or remaining CDs within or partially within a CMA with a population greater than one million;" 2) *medium metropolitan regions* are "CDs containing, within or partially within a CMA with a population between 250,000 and 999,999;" 3) *small metropolitan regions* are "CDs containing, within or partially within a CMA/Census Agglomeration (CA) with a population between 50,000 and 249,999;" 4) *non-metro-adjacent regions* are "CDs that share a boundary with a CMA/CA that has a population greater than 50,000;" 5) *rural regions* are "CDs that do not share a boundary with a CMA/CA that has a population greater than 50,000."

The cities of Montreal, Toronto and Vancouver are examples of large metropolitan regions. Medium metropolitan areas include cities like Winnipeg, Halifax and Calgary. Small metropolitan areas include smaller cities (e.g., Regina, Kingston); non-metro-adjacent regions include smaller towns (e.g., Lanark ON; Duncan BC); and rural areas include communities such as Bishop Falls NF, Chandler QC and The Pas MB.

The Beale urban-rural coding system was originally developed by the United States Department of Agriculture to classify the location of counties within an urban-rural continuum.[21] This system has been used to examine urban-rural differences for a range of health indicators including injury,[22-23] cancer[24] and physical activity.[25] This system has been adapted to be compatible to the Canadian context by using census divisions, which are roughly equivalent to counties in the United States.[21,26] Unlike other definitions of "rural" used by Statistics Canada, which have an emphasis on population size and density, this classification system contains both hierarchical (size) and settlement context components. Though the original U.S. classification scheme had eleven categories, the system for Canada uses six.[21] In the present study, the original six Canadian categories were collapsed into five in order for sufficient cell sizes to generate stable estimates.

Covariates

Additional variables considered in this analysis included age, sex and socioeconomic status (SES). Age and sex are standard demographic factors and are also risk factors for injury. SES is a fundamental determinant of health for both individuals and communities.[16] Low SES levels are related to a variety of negative health outcomes, including injury.[27] Prior Canadian studies reported that rural students were more likely than urban ones to be from families with lower SES backgrounds.

Analysis

Statistical analyses were conducted using SAS, version 8.2 [SAS Institute Inc., Cary, NC]. Prevalence rates of medically treated injury were calculated along with associated 95% confidence intervals. A design effect of 1.2 (i.e., standard errors for estimates were multiplied by 1.2) was used to account for the clustered nature of the data.[15,17] All analyses were stratified by the five geographic categories (large metro, medium metro, small metro, non-metro-adjacent and rural). Sub-analyses were conducted by gender and three age groups in years (i.e., <13; 13 to <15; ≥ 15). Medically treated injuries and serious injury were further described by injury type, nature of injury and their immediate treatments. Rates of medically treated injury by geographic categories were compared using the Cochran-Armitage trend test[28] and the chi-square test.

TABLE 1
Study population characteristics by Beale geographic categories

	Geographic categories										*p*-value
	Large metro N=1,066		Medium metro N=1,654		Small metro N=1,757		Non-metro-adjacent N=1,213		Rural N=1,545		
	N	%	N	%	N	%	N	%	N	%	
Age groups (years)											< 0.0001
< 13	424	39.8	592	35.8	698	39.7	540	44.5	544	35.2	
13 to < 15	362	34.0	573	34.6	645	36.7	443	36.5	649	42.0	
≥ 15	280	26.3	489	29.6	414	23.6	230	19.0	352	22.8	
Sex											0.21
Boys	477	44.8	767	46.4	843	48.0	537	44.3	733	47.4	
Girls	589	55.2	887	53.6	914	52.0	676	55.7	812	52.6	

Data source: WHO/Health Behaviour in School-aged Children survey for Canada, 2001-2002.

Results

Sample

A total of 7,235 students (3,357 boys and 3,878 girls) from 171 schools participated in the 2001-2002 Canadian HBSC survey. Table 1 displays the demographic characteristics of respondents by degree of rurality (1,066 from large metro; 1,654 from medium metro; 1,757 from small metro; 1,213 from non-metro-adjacent; and 1,545 from rural regions). While there was little variation in the proportions of respondents by sex, the distribution by age group was significantly different ($p < 0.0001$) across the five Beale groupings.

Medically treated injuries

Over half of the study population reported one or more medically treated injury by a doctor or nurse during the 12 months prior to the survey (Table 2). Annual rates of injury were statistically higher in boys than in girls (59.1% versus 50.1%; $p < 0.001$); this was true in all three age groups included in this study ($p < 0.001$). Approximately 54% of the injured youth reported multiple injuries (two or more during the year). Medically treated injury rates were consistently higher in rural, non-metro-adjacent, small metro and medium metro areas, compared with large metro areas. Statistically significant differences in injury risk were observed by geographic status within the two sexes and three age groups (data not shown).

Serious injuries

Approximately 27% of the respondents reported serious injuries according to the HBSC Modified Abbreviated Injury Score criteria.[20] Overall, annual reported rates of reporting serious injury were higher in rural (i.e., rural and non-metro-adjacent) areas than in the urban (i.e., large metro and medium metro) areas (Table 2). Statistically significant urban-rural differences in injury risk were identified for the two sexes and three age groups (data not shown).

TABLE 2
Annual rate (R) and 95% confidence interval (CI) of medically treated and serious injuries in Canadian adolescents, by Beale geographic categories

	Geographic categories										*p*-value
	Large metro N=1,066		Medium metro N=1,654		Small metro N=1,757		Non-metro-adjacent N=1,213		Rural N=1,545		
	N	R (CI)	N	R (CI)	N	R (CI)	N	R (CI)	N	R (CI)	
Medically treated injuries											
Any injury	507	48 (44,52)	899	55 (52,58)	992	57 (54,60)	671	56 (52,59)	836	54 (51,57)	**0.01*** **(0.0002**)**
2 times or more	279	26 (23,30)	479	29 (27,32)	553	32 (29,34)	347	29 (26,32)	455	30 (27,32)	0.21* (0.06**)
3 times or more	136	13 (10,15)	238	14 (12,17)	299	17 (15,19)	185	15 (13,18)	226	15 (13,17)	0.25* (0.03**)
Serious injuries	224	21 (18,24)	433	26 (24,29)	527	30 (28,33)	328	27 (24,30)	421	27 (25,30)	**0.004*** **(<0.0001**)**

* Trend test

**Chi-square test

Data source: WHO/Health Behaviour in School-aged Children survey for Canada, 2001-2002

TABLE 3
Annual rate (R) and 95% confidence interval (CI) of serious injuries in Canadian adolescents, by key descriptors and Beale geographic categories

	Geographic categories										*p*-value
	Large metro N=1,066		Medium metro N=1,654		Small metro N=1,757		Non-metro-adjacent N=1,213		Rural N=1,545		
	R	(CI)	R	(CI)	R	(CI)	R	(CI)	R	(CI)	
Location											
Sports area	12	(10,15)	18	(16,20)	15	(13,17)	14	(12,16)	14	(12,17)	0.61* (0.002**)
Home	9	(7,11)	10	(9,12)	11	(10,13)	15	(13,18)	13	(11,15)	**<0.0001* (<0.0001**)**
School, education area	11	(8,13)	10	(8,12)	10	(8,12)	10	(8,12)	10	(8,11)	0.56* (0.91**)
Activity											
Sports, organized or other	25	(22,28)	29	(27,32)	26	(24,29)	26	(24,29)	25	(23,28)	0.41* (0.06**)
Transportation	7	(5,9)	8	(6,9)	8	(7,10)	9	(7,11)	9	(7,11)	**0.03*** (0.03**)
Fighting	2	(1,2)	1	(1,2)	2	(1,3)	1	(1,2)	2	(1,3)	0.70* (0.80**)
Nature of injury											
Broken bone or dislocation	9	(7,11)	13	(11,15)	16	(14,19)	16	(13,18)	15	(13,17)	**<0.0001* (0.0001**)**
Sprain or strain	26	(23,30)	32	(29,35)	31	(29,34)	31	(28,35)	30	(27,33)	0.25* (0.03**)
Laceration	17	(15,20)	18	(16,20)	19	(17,22)	21	(18,23)	17	(14,19)	0.95* (0.06**)
Head or neck injury	6	(4,7)	8	(7,10)	10	(8,12)	10	(8,12)	9	(7,11)	**0.005* (0.0008**)**
Immediate treatment											
Doctor's office/clinic	22	(19,25)	25	(22,27)	20	(18,23)	22	(19,25)	25	(23,28)	0.21* (0.004**)
Emergency room	8	(6,10)	12	(10,14)	18	(16,21)	15	(12,17)	12	(10,14)	**0.007* (<0.0001**)**
Hospital overnight	3	(1,4)	3	(2,5)	5	(3,6)	3	(2,5)	3	(2,4)	0.64* (0.06**)

* Trend test

**Chi-square test

Data source: WHO/Health Behaviour in School-aged Children survey for Canada, 2001-2002

Location, activity, nature of injury and treatment

Table 3 presents annual rates of adolescent most serious injury by location, activity, nature and treatment. Sports-related injuries were prominent in both sexes and all five geographic areas (ranging from 19% to 36%). Sports areas were the most common location of injury for both boys (17%) and girls (13%), followed by home (11% for boys and 12% for girls) and school or education areas (10%). Youth from more rural (i.e., rural and non-metro-adjacent) areas were more likely to be injured at home compared to those from the most urban (i.e., large metro and medium metro) areas for both males ($p = 0.002$) and females ($p < 0.0001$). Sprains and strains (31%); lacerations (18%); broken bones or dislocations (15%); and head or neck injuries (9%) were the leading natures of injuries reported. In general, these injuries were more commonly reported by adolescents from more rural areas. Approximately 22% of females and 24% of males visited doctor offices or clinics; 12% of females and 15% of males went to an emergency room; and 2% of females and 5% of males required an overnight hospital stay for the injury. Adolescents from more rural areas reported proportionally higher occurrences of emergency room visits, with the highest occurrences reported in small metropolitan areas (21% for females in these areas). Statistically significant differences were identified for emergency room visits in comparisons between males ($p = 0.007$) and between females ($p = 0.0006$) from the five geographic areas.

Discussion

Our analysis identified disparities in injury rates and patterns among Canadian adolescents by geographic status. Overall, living in more rural areas was associated with higher risks for injury. Statistically significant differences in risk for injury by urban-rural status were found for both medically treated injuries and serious injury events. Interestingly, while males reported proportionally higher occurrences

of both medically treated and serious injuries compared with females, a generally wider geographic disparity in injury rates was observed among females.

The finding of an increased risk for injury among youth living outside metropolitan centers is consistent with earlier studies conducted in Canada,[3-4] the United States[22,29,30] and other countries.[10] With few exceptions[4,22,29] most of these studies have examined "urban" and "rural" populations as dichotomies, and thus did not fully capture geographic patterns in injury risk. Studies that have examined the urban-rural continuum reported that children living in the most rural and remote regions experienced the highest risks for injury and serious injury.[4,22,29]

In the present study, while prevalence of injury was generally higher in more rural areas compared with large metropolitan areas, the highest risks for injury were not always observed among adolescents residing in the former. In fact, adolescents from small metro areas reported the proportionally highest occurrences of any medically treated injury, serious injury and emergency room visits, although there is overlap between these 95% confidence intervals and those from other areas. This discrepancy may reflect differential injury patterns or may be due to differences in nature of injury,[22] definitions used for the terms "injury" and "serious injury", geographic classification systems[4] or composition of the study population.[4,29] An alternative explanation is that though people living in the most rural areas may be at higher risk, these populations also have limited access to medical care facilities and must travel long distances to reach health services. Therefore, the prevalence of medically treated injuries appears to be artificially lower among rural Canadian populations than it actually is.

A number of methodological issues warrant consideration. Urban-rural comparisons such as ours are useful in drawing attention to particular types of communities or locations that may be associated with health problems, although geographic studies in general have limited ability to shed light on critical determinants and how they operate to affect youth health. Variations in injury risks, for example, may in fact be due to underlying cultural differences in risk taking,[31] poverty,[32] care-seeking behaviours[33] or service availability.[33] To identify specific place and health determinants, comparisons between similar locations (for example, between small urban areas) would be useful. For example, increased density of traffic in suburban areas can lead to injury risk for young pedestrians.[34] Similarly, crime and violence in large urban areas are associated with increased fighting injuries.[35-36] However, these studies also assume that aggregate behaviours or characteristics at the area level are equally important for residents of those areas. This assumption is obviously not always valid.

Our study had a number of strengths. First, this research is original in that it examines injury patterns among Canadian adolescents by geographic status. We did this by using a large and nationally representative sample of Canadian adolescents. Most Canadian studies on this topic have a provincial or regional focus.[3,8] Second, the use of the modified Beale urban-rural classification provides us with an improved perspective on geographical influences on school-aged children health in Canada. Third, this survey was administered according to a standard protocol, and names and other personal identifiers were not collected in order to improve data accuracy as well as to ensure confidentiality. Past validation efforts have shown this approach to the collection of health data results in higher rates of participation and better and more accurate self-reported data.[37] Finally, the fact that all data were compiled as part of a general health survey (i.e., no focused questions/hypotheses were provided to the participants) limited the potential for information bias.[37]

Several limitations of the study should also be noted. First, the present study was based on self-reported measurements of injury, which is subject to errors in recall.[19] However, self-reports are a common and accepted method of measuring injuries, and adolescents aged 11 to 15 years have been shown to provide accurate reports of personal injury experiences.[18] Second, since data were collected on a single day, students absent from school were unable to participate. Those who may have missed school due to injury (especially serious injury) were therefore not represented. This would result in underestimates of injury rates. Third, only the most serious injury from the 12 months preceding the study was considered in some analyses. This too resulted in an underestimation of the number of injuries that actually occurred. Fourth, use of school-level data to infer urban-rural status of students may lead to misclassification of the urban-rural status since rural children and youth attending urban schools will be classified as "urban students" and vice versa. Many students classified as "urban" come from rural areas and are bused to urban schools. This misclassification of urban-rural status may bias the results towards no effect. Fifth, the cross-sectional nature of the study obviously limits exploration of causal pathways. Finally, our analysis included multiple comparisons and so statistically significant results should be interpreted with caution.

The urban-rural gradients in risk for injury identified in this study indicate potential inequalities in adolescent health. If these risk disparities are confirmed in other populations, the next obvious step is to identify underlying causes of these inequalities. This should include focused study of injury-related risk factors as well as injury treatment patterns by geographic status. With respect to prevention, while rural adolescents are at significantly higher risk for injury compared to their urban counterparts, very few injury prevention strategies have been designed specifically to meet the needs of these most disadvantaged populations.[38] There is a need for prevention initiatives to be targeted specially at the needs and social context of non-urban adolescent populations. These strategies need to be informed by the injury patterns observed here, as well as

by the acute and underlying determinants of injury that are most prevalent in these adolescent cultures.

Conclusions

This study represents one of the first attempts, to our knowledge, to compare patterns of medically treated injury from all causes among Canadian school-aged adolescents by urban-rural geographic status. Higher risks of injury were observed among adolescents from more rural areas when compared to those from large metropolitan areas. Adolescents from small metro areas reported the proportionally highest occurrences of both medically treated injury and serious injury. These findings emphasize the importance of conceptualizing the term "rurality" as a continuum instead of a dichotomy. Studies focusing on the health of adolescents in small metro areas and rural areas are needed to fully understand these patterns. As ours is the first population-based study that has examined these issues in a nationally representative sample of Canadian adolescents, replication of our analyses in different settings or contexts is also warranted.

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