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The Epidemiology of All-Terrain Vehicle and Snowmobile-Related Injuries in Ontario

Report

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Contents

Executive Summary

All-Terrain Vehicles (ATVs) and snowmobiles are popular transport and recreational devices; however, there is a risk of serious injury with their use. In the 2014 and 2015 calendar years, there were 13,590 emergency room (ER) visits and 1,288 hospitalizations related to the use of ATVs and snowmobiles in Ontario. Males and children under the age of 16 have been identified as being at particularly high risk for injuries related to the use of ATVs and snowmobiles. In Ontario, legislation prohibits the use of ATVs and snowmobiles by children under the age of 16 on highway roads and for children under the age of 12 on private property unless supervised by an adult.

Despite the dangers associated with ATV and snowmobiles, there is limited data specific to the province of Ontario on the burden of injury related to the use of these vehicles. Therefore, the objectives of this study were as follows:

(1) To describe the frequency, type, location and mechanism of injuries and fatalities resulting from (i) ATV and (ii) snowmobile use in Ontario, including injuries by age and sex.

(2) To describe the rates of injury and fatality associated with ATV and snowmobile use by Ontario Public Health Unit (PHU).

In order to assess the burden of injury in Ontario, we conducted a descriptive study of both ATV and snowmobile-related injuries and behaviours using health administrative data (i.e., emergency room visits, hospitalizations and fatalities), select questions from the 2013 Canadian Community Health Survey and surveillance data from the Canadian Hospitals Injury Reporting and Prevention Program.

We found that the number of ER visits and hospitalizations related to ATV and snowmobile use are high, with over 11,000 ATV-related and 2,900 snowmobile-related ER visits in 2015 – 2016. Children under the age of 16 and males represented a large proportion of these injuries. Individuals who presented to the emergency room and were hospitalized from injuries related to ATV and snowmobile use were reported more often as being the driver and were driving off-road at the time of the injury. The most common type of injury requiring hospitalization was fractures and the most common mechanism of injury was falling off or being ejected from the vehicle, followed closely by the vehicle rolling over for both snowmobiles and ATVs. The rate of ATV and snowmobile-related injuries vary across PHUs; units categorized as mainly rural appear to have higher rates of injury compared to units categorized as non-rural.

At a population level, the predictable and preventable nature of ATV and snowmobile injuries provides an opportunity for public health action. In addition, off-road vehicle safety is included as a topic of consideration in the 2018 Ontario Public Health Standards. PHUs can use the information in this report to inform prevention planning.

Introduction

Off-road vehicles (ORVs) are popular recreational vehicles in Ontario; however, there is a risk of serious injury with their use.[1,2] The two types of ORVs that are most used by Ontarians are all-terrain vehicles (ATVs) and snowmobiles.

ATVs, also known as quad or farm bikes, are motorized vehicles designed for off-road use.[3] They weigh up to 600 lbs and can travel more than 90 km/h.[4] As the use of ATVs grows in Canada,[5] the number of associated injuries has risen accordingly. From 1995 to 2010, there was a 150% overall increase in the rate of serious injuries and an 85.7% increase in the rate of fatalities related to ATVs and dirt bikes in Canada.[6] Although some research has indicated that the rate of ATV injury is decreasing in parts of the United States,[7] the recent trends in Ontario are unknown.

Snowmobiles are heavy motorized vehicles, which can weigh over 600 lbs and reach speeds over 100 km/h.[8] Although there has been a general downward trend in reported snowmobile injuries (38.0% decrease) and fatalities (34.9% decrease) over time in Canada,[6] snowmobile injuries continue to be a significant cause of injury and death, with 181 snowmobilers seriously injured in 2010.

Trends in Ontario

According to the 2018 Ontario Injury Data Report, there were 13,590 emergency room visits and 1,288 hospital visits related to ATVs, snowmobiles and other off-road vehicles in the 2014–15 fiscal years (April 1, 2014 to March 31, 2016).[9] This translates into a crude rate of 49.5 per 100,000 population and 4.7 per 100,000 population, respectively.[9] The age group with the highest rate of emergency room and hospital visits were those ages 15 to 19 years, followed by 20 to 24 year olds and 10 to 14 years old. In total, there were 204 fatalities resulting from ATVs, snowmobiles and other all-terrain vehicles use in Ontario from 2008–2012, with 20 to 24 year olds representing the highest rate of fatality, although the fatality rate across all age groups is low.[9] The relative contribution of the different types of off-road vehicles is unknown.

Risk Factors

A number of risk factors for ATV-related injuries have been identified in previous literature, including young age, male gender, having multiple passengers, driving age-inappropriate vehicles, engaging in risky behaviours and lack of protective equipment.[10]

Pediatric Population

A large majority of the research on ATV and snowmobile-related injuries has been conducted in the pediatric population, as children under the age of 16 have been identified as being at a disproportionately high risk for injury with the use of these vehicles.[1,4,9–11] One study reported that children under the age of 16 were four times more likely to require treatment in an emergency room due to ATV use compared to

older riders.[7] Although children represent only 12% to 15% of ATV ridership, they account for 27% to 35% of all ATV-related fatalities.[12] Numerous studies have shown that the mean age for children admitted to the hospital ranged between 9 to 13 years old, but it is not uncommon for children under the age of 6 to be affected by ATV injuries.[7] Youth have been found to drive ATVs larger and more powerful than safe use guidelines recommend.[7] The Canadian Pediatric Association recommends that children under the age of 16 should be restricted from operating ATVs or snowmobiles.[1,4,11]

Lack of Protective Equipment

Helmets have been shown to reduce the odds of suffering a head injury, including traumatic brain injuries, intracranial hemorrhages, loss of consciousness and mortality when involved in a collision with an ATV or snowmobile.[5,11,13–18] One study showed that the use of helmets reduced the risk of head injury by 64%.[19] Despite this, it is estimated that the use of helmets on recreational vehicles is quite low. One study showed that helmet use ranged from 0% to 44% among injured children, depending on age and geographic location.[7] In the adult population, helmet use was reported between 7% to 50%,[10,13,18,20] with less use on ATVs compared to motorcycles.[12] For snowmobile injuries, helmet use was estimated to be 50% to 70%.[8,14,16]

Risky Behaviours

Numerous studies have shown that there are a number of ATV related behaviours that are associated with a higher risk of injury, including the use of ATVs for recreation instead of work purposes, the use of alcohol and drugs while driving, driving at night, having multiple passengers and engaging in risky driving, such as making jumps or driving at high speeds.[7]

Sex

Males have consistently been found to be overrepresented in recreational vehicle-related injuries. It has been speculated that this is related to an increased exposure to ATVs and snowmobiles, including a higher frequency of riding.[1,6,21,22] Nevertheless, one study found that females were more likely to report engaging in risky behaviours, such as riding in the dark and riding without protective gear.[22]

Injury Type, Location and Mechanism

The most common type of injury for both ATV and snowmobile related hospitalizations in both pediatric and adult populations is reported to be orthopedic injuries.[2,6,7,23–25] In both ATV and snowmobiles, the most common cause of death was due to head and neck injuries.[8,26]

A report of ORV injuries in Canada found that the primary mechanism of injury for ATVs and snowmobiles is ejection from the vehicle, followed by rolling/tipping for ATVs and crashing into a fixed structure for snowmobiles.[2,7,8,25]

The type and mechanism of injury has been shown to depend on age.[25] For example, youth under the age of 16 are more likely to present with a fracture or head injury compared to adolescents and adults over the

age of 16 and more than twice as likely to sustain crush injuries.[10] Conversely, older adolescents and adults are more likely to sustain spinal injuries.[27,28]

In Ontario, most fatalities related to ATVs were caused by injury/blunt force trauma and the most common fatal injury location was the head and neck.[1] Males and individuals between the ages of 15 and 29 had the highest fatality rate.[1] This is consistent with literature from the United States and Australia.[8,15]

Legislation in Ontario

In Ontario, there are three legislative acts that govern the use of recreational vehicles, including the *Highway Traffic Act*, the *Off-Road Vehicles Act* and the *Motorized Snow Vehicles Act*.

Regarding minimum age for use, children under the age of 12 are restricted from operating ATVs, except on private property or if closely supervised by an adult (*Off-Road Vehicle Act*, R.S.O. 1990, c. O.4, s. 4). To drive across or along a highway or public road, children must be at least 16 years old with a valid driver's licence. Moreover, children must be at least 8 years old to ride as a passenger on the highway or public road (*Highway Traffic Act*, O.Reg 135/15).

To drive a snowmobile along trails, a person must be at least 12 years old and hold a drivers or motorized snow vehicle operator's licence (*Motorized Snow Vehicles Act*, R.S.O. 1990, c. M.44). Similar to ATVs, to drive across or along a highway or public road on snowmobile, riders must be at least 16 years old and hold a valid driver's or motorized snow vehicle operator's licence (*Motorized Snow Vehicles Act*, R.S.O. 1990, c. M.44).

All riders, including drivers and passengers on both ATVs and snowmobiles, are required to wear approved helmets on and off-road at any age (*Highway Traffic Act*, O.Reg 135/15).

Rationale

Despite the risk of injuries and fatalities related to ATVs and snowmobiles, there is limited information on injuries occurring with the use of either ATVs or snowmobiles in Ontario. Specifically, there is little Ontario data on the geographic, age or sex distribution of these injuries, as well as rates and mechanisms of injury by vehicle type. Jurisdiction- and vehicle-specific injury data are important since there are differences in the population at risk based on rider activity (e.g., occupational versus recreational use) and the specific crash environment.[29]

Objectives

Primary Objective: To describe the frequency, type, location and mechanism of injuries and fatalities resulting from (i) ATV and (ii) snowmobile use in Ontario, including injuries by age and sex.

Secondary Objective: To describe the rate of injury and fatality associated with ATV and snowmobile use by Ontario PHUs.

Methods

Data Sources and Procedures

IntelliHEALTH

To examine counts of injuries and fatalities related to (i) ATVs and (ii) snowmobiles in Ontario, inpatient discharge data (i.e., hospitalization) from the Discharge Abstract Database (DAD), ambulatory visits (i.e., emergency room visits) data from the National Ambulatory Care Reporting System (NACRS) and fatalities data from the Vital Statistics – Death database were extracted for the calendar years 2005–16. Two years (or more) of data were used for the calculation of rates to reduce the number of cells where data would need to be supressed due to small cell sizes. Where estimates are presented, the number of years that were used in the numerators and denominators are specified. All data were accessed through the IntelliHEALTH database, which is a web-based data abstraction tool housed by the Ontario Ministry of Health and Long Term Care.

Emergency room visits, hospitalizations and fatalities related to ATVs and snowmobile use were identified using the International Statistical Classification of Diseases 10th edition, Canada (ICD-10-CA) codes V86 (5 digits) and U99.032. V86 codes identify that the patient was an 'occupant of a special all-terrain or other motor vehicle designed primarily for off-road use, injured in a transport accident,' and the U99.032 code is a provisional code representing an ATV-related injury. These codes provide information about the vehicle type, location of injury and seating position (Appendix A). It is important to note that V86 codes specify the vehicle as either (1) snowmobile or (2) all-terrain or other off road motor vehicle. This means that ATV injuries may include other ORVs, such as dune buggies or golf carts; we will refer to all injuries related to "all-terrain and other off road motor vehicles" as ATV injuries for the purposes of this report.

Individual visits to the emergency room and hospitalizations were identified using the NACRS and DAD key, respectively. NACRS and DAD keys represent one visit to the emergency room or hospital, not a particular individual; therefore one individual may visit the emergency room or hospital multiple times and will receive a new NACRS and/or DAD key for each visit. Unique DAD and NACRS keys could be linked to one or multiple ICD-10-CA codes; those with multiple V86 or U99 codes were recoded to have one primary code, with V86 codes prioritized over U99 codes. A number of individual visits were double coded; in these instances, rules were followed in terms of which codes were prioritized.

Rates for ATV and snowmobile-related emergency room visits, hospitalizations and fatalities were calculated using population estimates produced by Public Health Ontario (PHO). Rates of ATV and snowmobile-related emergency room visits, hospitalizations and deaths are presented from 2005–2016. Rates were also calculated and presented by Statistics Canada Peer Group and for each PHU.

PHUs were also grouped by Statistics Canada Peer Groups, which are 10 groups of health units that are similar in terms of social and economic characteristics. Peer groupings were used to explore one known risk factor for injury, socioeconomic status based on the use of proxy measures, including income inequality, immigrant and Aboriginal status. The numerators and denominators from each included PHU were pooled and a Peer Group emergency room and hospitalization rate for both ATVs and snowmobiles were calculated. The principle characteristics for each Peer Group created by Statistics Canada are listed in Table 1.

The use of 2014 Statistics Canada Peer Groups provides an overall rate of injuries related to ATVs and snowmobiles for 'similar' groups of PHUs. This allows for the comparison of rates between Statistics Canada Peer Groups. Use of these groups also allows within group comparisons, whereby PHUs may assess the burden of ATV and snowmobile-related injuries in their unit compared to similar units in their Peer Group. Those that have high rates may choose to collaborate with similar units to identify population specific strategies for reducing rates of injury related to ATVs and snowmobiles.

Table 1. Summary table of 2014 Statistics Canada Peer Groups and principle characteristics

Peer group	Principle characteristics
A	Urban-rural mix from coast to coast Average percentage of Aboriginal population Average percentage of immigrant population
B	Mainly urban centres in Ontario and Alberta with moderately high population density Low percentage of Aboriginal population Very high employment rate Higher than average percentage of immigrant population
C	Sparsely populated urban-rural mix in Eastern and Central provinces Average percentage of Aboriginal population Average employment rate Low percentage of immigrant population
D	Mainly rural regions from Quebec to British Columbia Average percentage of Aboriginal population High employment rate

Peer group	Principle characteristics
E	Mainly rural and remote regions in the Western provinces and the Territories High proportion of Aboriginal population Average percentage of immigrant population
F	Northern and remote regions Very high proportion of Aboriginal population Very low employment rate Low proportion of immigrants
G	Largest metro centres with an average population density of 4,065 people per square kilometre Very low proportion of Aboriginal population Average employment rate Very high proportion of immigrant population
H	Mainly population centres in Ontario and British Columbia with high population density Very high percentage of visible minority population Low Aboriginal population

Source: Statistics Canada.

More information on Statistics Canada Peer Groups.

The number of ATV and snowmobile-related emergency room visits and hospitalizations in 2015–16 were stratified by age and sex, seating position and location of injury. Age groups selected were as follows: 0 to 11, 12 to 15, 16 to 24, 25 to 35, 36+ years. These groupings were selected based on the age cut-offs included in Ontario legislation, described above. These age groups are used consistently throughout this report. Seating position is derived from the V86 codes where seating positions for ATV and snowmobile riders includes driver, passenger, unspecified, as well as boarding or being outside of the vehicle for ATV riders. Similarly, location of injury is derived from the V86 codes and includes on-road (i.e., on a highway), off-road (i.e., not on the highway) and unspecified.

To assess the injuries resulting from (i) ATVs and (ii) snowmobiles, ICD-10 Codes for injuries (first three digits in the S-Section and T-Section; Appendix B) were extracted for all visits identified as being related to (i) ATVs and (ii) snowmobiles (V86 and U99.032) in the NACRS and DAD Databases. Since each NACRS or DAD key was associated with one or more injury codes, the count of injury codes represents a single

injury, not necessarily a single patient or a single visit. Injury codes were collapsed into body region (head/neck, trunk, upper, lower and other/unspecified) and type of injury (fracture, amputation, open wound/superficial, blood vessel/nerve, ligament/muscle, other).

Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP)

The Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP) is Canada's injury and poisoning surveillance system housed by the Public Health Agency of Canada. CHIRPP collects injury data on injuries sustained by individuals seen at emergency rooms in 17 hospitals across Canada. Information collected includes what the individual was doing when the injury happened, what went wrong and where the injury occurred. In Ontario, there are six participating hospitals, including four pediatric hospitals and two general hospitals. Cases were identified through keyword search and only data from Ontario hospitals were included.

We extracted information on the type of injury, mechanism of injury and events leading up to injury related to ATVs and snowmobiles from the CHIRPP database. Data was aggregated across hospital sites and stratified by risk factors (e.g., substance use, helmet use, day of the week and recreational use). Mechanism of injury was coded from narrative descriptions of the event and frequency and proportions of mechanism of injury was presented (Appendix C). The mechanism of injury was also stratified by age group.

2013 Canadian Community Health Survey (CCHS)

In order to characterize individuals using (i) ATVs and (ii) snowmobiles, we used self-reported data from the 2013 Canadian Community Health Survey (CCHS), which is a population-based, weighted survey conducted by Statistics Canada for Canadians ages 12 and up (Appendix D). Variables used included age and sex, as well as indicators for self-report use of snowmobiles and/or ATVs, helmet use and driver alcohol use (DRV_Q11A- DRV_Q14B). We estimated the frequency of each indicator in the Ontario population using survey weights created by Statistics Canada and used a bootstrapping procedure to estimate 95% confidence intervals. More information on the use of survey weights and bootstrapping can be found on the Statistics Canada website. We stratified self-reported ATV and snowmobile use by sex and age group (0 to 11, 12 to 15, 16 to 24, 25 to 35, 36+).

Statistical Analysis

All analyses were performed using SAS and R Statistical software. Rates represent the number of new injuries per 100,000 persons in the population over a specified period of time. Numerators for rates (ER visits, hospitalizations, deaths) were calculated using NACRS, DAD and Vital Statistics data, respectively.

Rates are calculated as follows:

$$rate\ per\ 100{,}000 = \left(\frac{\begin{array}{c} number\ of\ ER\ visits/hospitalizations/deaths \\ over\ reported\ period\ of\ time \end{array}}{\begin{array}{c} Ontario\ population \\ over\ reported\ period\ of\ time \end{array}} \right) \times 100{,}000$$

Proportions represent the number of individuals affected by a specified condition over the total number of individuals in the group.

$$proportion\ = \frac{number\ with\ a\ particular\ characteristic}{total\ persons\ which\ the\ numerator\ is\ a\ subset}$$

Proportions are described as the percentage of the group that had that particular characteristic. Percentages are calculated as follows:

$$percentage\ = proportion\ \times 100$$

Confidence intervals are calculated to communicate the level of uncertainty in an estimate. In this report, we calculated 95% confidence intervals for the rates and proportions of injury. A 95% confidence interval is interpreted as the range of variability in the estimate (rate, proportion, odds ratio) calculated. If we were to conduct a particular study an infinite number of times 95% of the time, the range would contain the true estimate.

Results

Trends of ATV and Snowmobile-Related Presentations in Ontario

Figure 1. Annual rates of all-terrain vehicle- (ATV) and snowmobile-related emergency room visits, hospitalizations and fatalities per 100,000 population from 2005–2016 (NACRS, DAD, and Vital Statistics data shown)

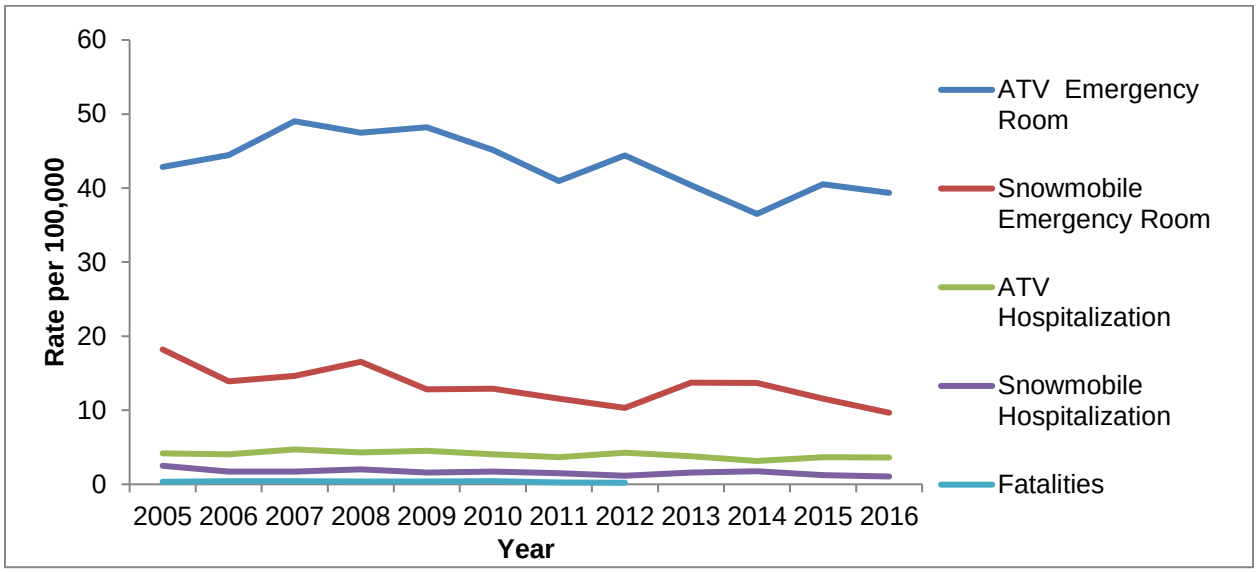

Figure 1 features the rates of ATV and snowmobile-related presentations. The rate of ATV emergency room visits peaked in 2007, with 49 visits per 100,000 population, then dropped to the lowest rate in 2014 at 36.5 per 100,000 population. Similarly, hospitalizations peaked in 2007 at 4.7 per 100,000 population and bottomed in 2014 at 3.1 per 100,000 population. In 2016, the rate of emergency room visits was 39.3 per 100,000 population (total of 5,500) and the rate of hospitalizations was 3.6 per 100,000 population (total of 1,351).

Snowmobile injuries followed a similar pattern, peaking in 2005 with 18.2 emergency room visits per 100,000 population and 2.5 hospitalizations per 100,000 population, dropping with the lowest rate in 2016 with 9.66 emergency room visits per 100,000 (total of 506) and 1.05 hospitalizations per 100,000 (total of 147).

Fatality data for both snowmobiles and ATVs is presented up to the last reporting year in 2012. The annual rate peaked in 2007 and 2010 with 0.4 deaths per 100,000 population (52 deaths each year) and was the lowest in 2012 at 0.2 deaths per 100,000 population (29 deaths).

Emergency Room Visits and Hospitalizations

Table 2. Number of emergency room (ER) visits and hospitalizations for all-terrain vehicle- (ATV) and snowmobile-related injuries in 2015 and 2016, by age and sex

Age Group	ATV ER Visits # total (% male)	ATV Hospitalizations # total (% male)	Snowmobile ER Visits # total (% male)	Snowmobile Hospitalizations # total (% male)
0-11	960 (69%)	74 (70%)	95 (63%)	9 (78%)
12-15	1,345 (73%)	105 (90%)	172 (69%)	18 (78%)
16-24	3,221 (75%)	228 (82%)	694 (74%)	48 (81%)
25-35	2,266 (79%)	191 (85%)	686 (79%)	69 (81%)
36+	3,299 (80%)	413 (83%)	1,297 (79%)	(83%)
Total	11,091 (77%)	1,011 (83%)	2,944 (77%)	317 (82%)

Source: NACRS, DAD

Emergency room visits and hospitalizations in 2015 and 2016 were stratified by age group and sex (Table 2). Males represented the largest proportion of ATV and snowmobile emergency room and hospital visits (63%-90%). Males made up a larger proportion of hospitalizations compared to emergency room visits for both ATV (83% versus 77%) and snowmobiles (82% versus 77%).

Table 3. Rates of emergency room (ER) visits and hospitalizations per 100,000 population for all-terrain vehicle- (ATV) and snowmobile-related injuries in 2015 and 2016, by age group

Age Group	ATV ER Visits	ATV Hospitalizations	Snowmobile ER Visits	Snowmobile Hospitalizations
0-11	27.2	2.1	2.7	0.3
12-15	112.3	8.8	14.4	1.5
16-24	96.4	6.8	20.8	1.4
25-35	54.4	4.6	16.5	1.7
36+	21.2	2.7	8.3	1.1

Source: NACRS, DAD

The rate of emergency room visits and hospitalizations related to ATVs were highest in the 12- to 15-year-old age group. The rate of emergency room visits related to snowmobiles was highest in the 16- to 24-year-old age group and rate of hospitalizations related to snowmobiles were highest in the 25- to 35-year-old age group (Table 3).

Self-Reported ATV and Snowmobile Use

Table 4A. Self-reported off-road vehicle use (all-terrain vehicle) in Ontario by age group (≥ 12 years) and sex in 2013

Age Group	Weighted Frequency Responded Yes (% male)	% of age group responded Yes	95% CI
12-15	112,953 (59.6%)	20.7%	17.5 - 23.0
16-24	250,025 (64.5%)	15.7%	13.7- 17.7
25-35	225,864 (59.4%)	11.75%	10.1 - 13.4

Age Group	Weighted Frequency Responded Yes (% male)	% of age group responded Yes	95% CI
36+	558,768 (69.4%)	7.8%	7.2 - 8.5
Total	1,147,610 (65.4%)	10.3%	9.7 - 10.9

Table 4B. Self-reported off-road vehicle use (snowmobile, motorboat or Sea-Doo) in Ontario by age group (≥ 12 years) and sex in 2013

Age Group	Weighted Frequency Responded Yes (% male)	% of age group responded Yes	95% CI
12-15	156,977 (54.7%)	28.8%	24.7 - 32.8
16-24	373,392 (60.2%)	23.4%	21.1 - 25.8
25-35	438,613 (58.2%)	22.8%	20.4 - 25.2
36+	1,322,642 (59.0%)	18.5%	17.4 - 19.7
Total	2,291,624 (58.7%)	20.5%	19.5 - 21.4

Source: Canadian Community Health Survey 2013. Estimates calculated using population weights. Confidence intervals using bootstrapping procedure = 500.

According to our analysis of the 2013 CCHS, it was estimated that approximately 10% of the population in Ontario ages 12 years and older rode an ATV within the last year and approximately 20% rode a snowmobile, motorboat or Sea-Doo (Table 4B). The youngest age group had the highest proportion of individuals that self-reported using an ATV or using a snowmobile, motorboat or Sea-Doo within the last year. As age increased, the proportion of individuals who reported using at least one of these vehicles decreased. Males represented a larger proportion of individuals who self-reported using at least one of these vehicles within the last year.

Seating Position

Table 5. Number and percentage* of emergency room (ER) visits for all-terrain vehicle- (ATV) and snowmobile-related injuries by seating position and age group in 2015 and 2016

Vehicle	Seating Position	0-11 years	12-15 years	16-24 years	25-35 years	36+ years	Total
ATV	Driver	503 (52.4%)	861 (64.0%)	2,109 (65.5%)	1,510 (66.6%)	2,118 (64.2%)	7,101 (64.0%)
	Passenger	173 (18.0%)	113 (8.4%)	247 (7.7%)	120 (5.3)	184 (5.6%)	837 (7.5%)
	Unspecified	261 (27.2%)	348 (25.9%)	799 (24.8%)	581 (25.6%)	898 (27.2%)	2,887 (26.0%)
	Boarding	<5	<5	15 (0.5%)	15 (0.7%)	36 (1.1%)	71(0.6%)
	Outside	22 (2.3%)	19 (1.4%)	52 (1.6%)	40 (1.8%)	62 (1.9%)	195 (1.8%)
Snowmobile	Driver	30 (31.6%)	92 (53.5%)	418 (60.2%)	442 (64.4%)	852 (65.7%)	1,834 (62.3%)
	Passenger	30 (31.6%)	21 (12.2%)	55 (7.9%)	46 (6.7%)	58 (4.5%)	210 (7.1%)
	Unspecified	35 (36.8%)	59 (34.3%)	221 (31.8%)	198 (28.9%)	387 (29.8%)	900 (30.6%)

Source: NACRS; Where cell sizes <5, data not presented; *column totals.

Emergency room visits were stratified by age group and seating position (Table 5). Drivers were the most represented in all age groups for both ATV and snowmobile-related injuries. Importantly, 52% of injured ATV riders ages 0 to 11 and 64% of injured ATV riders ages 12 to 15 were reported to be driving at the time of the injury. This is compared to 32% of injured snowmobile riders ages 0 to 11 and 53% of injured snowmobile riders ages 12 to 15.

Table 6. Number and percentage* of hospitalizations for all-terrain vehicle- (ATV) and snowmobile-related injuries by seating position and age group in 2015 and 2016

Vehicle	Seating Position	0-11 years	12-15 years	16-24 years	25-35 years	36+ years	Total
ATV	Driver	43 (59.0%)	82 (78.1%)	163 (71.5%)	141 (73.8%)	326 (78.9%)	755 (74.8%)
	Passenger	20 (27.4%)	13 (12.4%)	29 (12.7%)	18 (9.4%)	28 (6.8%)	108 (10.7%)
	Unspecified	7 (9.6%)	9 (8.6%)	32 (14.0%)	27 (14.1%)	49 (11.9%)	124 (12.3%)
	Boarding	0	0	0	<5	<5	<5
	Outside	<5	<5	<5	<5	9 (2.2%)	21 (2.1%)
Snowmobile	Driver	<5	10 (55.5%)	41 (85.4%)	55 (79.7%)	154 (89.0%)	260 (82.5%)
	Passenger	5	<5	<5	7 (10.1%)	6 (3.5%)	25 (7.9%)
	Unspecified	<5	5 (27.8%)	<5	7 (10.1%)	13 (7.5%)	30 (9.5%)

Source: DAD; Where cell sizes <5, data not presented; *column totals.

A higher proportion of injured riders who were hospitalized were reported as drivers for both ATVs and snowmobiles, with the exception of snowmobile riders under the age of 12 (Table 6).

Location of Injury

Table 7. Number of emergency room (ER) visits and hospitalizations for all-terrain vehicle- (ATV) and snowmobile-related injuries by location in 2015 and 2016

Vehicle	ER Visits/Hospitalizations	Highway # (%)	Non-Highway # (%)	Unspecified # (%)	Total #
ATV	ER Visits	647 (5.8%)	10,329 (93.1%)	116 (1.0%)	11,092
	Hospitalizations	88 (8.7%)	919 (90.9%)	<5	1,007

Vehicle	ER Visits/Hospitalizations	Highway # (%)	Non-Highway # (%)	Unspecified # (%)	Total #
Snowmobile	ER Visits	330 (11.2%)	2,614 (88.8%)	<5	2,944
	Hospitalizations	45 (14.2%)	272 (85.8%)	<5	317

Source: NACRS, DAD; Where cell sizes <5, data not presented.

Emergency room visits and hospitalizations were stratified by the location that the injury took place (Table 7). More emergency room visits and hospitalizations were related to injuries sustained in non-highway environments (e.g., private property, recreational trails, etc.) compared to injuries sustained on the highway (i.e., a public road; Table 7). A slightly higher proportion of emergency room visits and hospitalizations related to ATVs took place on non-highway roads (93% and 91%, respectively) compared to emergency room visits and hospitalizations related to snowmobiles (89% and 86%, respectively).

Type of Injury

Table 8. Number of emergency room (ER) visits and hospitalizations by body region and type of injury sustained by all-terrain vehicle (ATV) and snowmobile users in 2015 and 2016

Body Region	Injury Type	ATV ER Visits # (% of injuries)	ATV Hospitalizations # (% of injuries)	Snowmobile ER Visits # (% of injuries)	Snowmobile Hospitalizations # (% of injuries)
Head/Neck	Superficial/Open Wound	770 (5.5%)	66 (3.4%)	156 (4.3%)	18 (2.9%)
	Fracture	275 (2.0%)	128 (6.7%)	79 (2.2%)	40 (6.5%)
	Ligament/Muscle	148 (1.1%)	7 (0.4%)	61 (1.7%)	<5
	Nerve/Vessel	51 (0.4%)	22 (1.1%)	17 (0.5%)	14 (2.3%)
	Crushing/ Amputation	<5	<5	0 (0.0%)	0 (0.0%)
	Intracranial	618 (4.4%)	113 (5.9%)	149	34 (5.5%)

Body Region	Injury Type	ATV ER Visits # (% of injuries)	ATV Hospitalizations # (% of injuries)	Snowmobile ER Visits # (% of injuries)	Snowmobile Hospitalizations # (% of injuries)
				(4.1%)	
	Other	599 (4.3%)	17 (0.9%)	148 (4.1%)	5 (0.8%)
Trunk	Superficial/Open Wound	918 (6.6%)	40 (2.1%)	266 (7.3%)	10 (1.6%)
	Fracture	888 (6.4%)	333 (17.4%)	308 (8.5%)	119 (19.3%)
	Ligament/Muscle	94 (0.7%)	7 (0.4%)	41 (1.1%)	<5
	Nerve/Vessel	19 (0.1%)	11 (0.6%)	10 (0.3%)	7 (1.1%)
	Crushing/ Amputation	7 (0.1%)	<5	0 (0.0%)	0 (0.0%)
	Internal organ	379 (2.7%)	266 (13.9%)	128 (3.5%)	94 (15.2%)
	Other	447 (3.2%)	14 (0.7%)	132 (3.6%)	<5
Upper	Superficial/Open Wound	1,138 (8.1%)	26 (1.4%)	227 (6.2%)	0 (0.0%)
	Fracture	2,103 (15.0%)	313 (16.3%)	491 (13.5%)	72 (11.7%)
	Ligament/Muscle	809 (5.8%)	39 (2.0%)	274 (7.5%)	11 (1.8%)
	Nerve/Vessel	16 (0.1%)	10 (0.5%)	5 (0.1%)	<5
	Crushing/ Amputation	29 (0.2%)	<5	<5	0 (0.0%)

Body Region	Injury Type	ATV ER Visits # (% of injuries)	ATV Hospitalizations # (% of injuries)	Snowmobile ER Visits # (% of injuries)	Snowmobile Hospitalizations # (% of injuries)
	Other	472 (3.4%)	6 (0.3%)	110 (3.0%)	0 (0.0%)
Lower	Superficial/Open Wound	1,450 (10.4%)	55 (2.9%)	312 (8.6%)	13 (2.1%)
	Fracture	938 (6.7%)	333 (17.4%)	281 (7.7%)	126 (20.4%)
	Ligament/Muscle	673 (4.8%)	54 (2.8%)	202 (5.6%)	27 (4.4%)
	Nerve/Vessel	9 (0.1%)	8 (0.4%)	5 (0.1%)	7 (1.1%)
	Crushing/ Amputation	30 (0.2%)	<5	6 (0.2%)	<5
	Other	437 (3.1%)	6 (0.3%)	132 (3.6%)	<5
Multiple	Superficial/Open Wound	428 (3.1%)	12 (0.6%)	38 (1.0%)	<5
	Fracture	10 (0.1%)	6 (0.3%)	<5	<5
	Ligament/Muscle	9 (0.1%)	<5	<5	0 (0.0%)
	Nerve/Vessel	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
	Crushing/ Amputation	<5	0 (0.0%)	0 (0.0%)	<5
	Other/Unspecified	73 (0.5%)	12 (0.6%)	16 (0.4%)	0 (0.0%)
Unspecified	Unspecified	134 (1.0%)	<5	35 (1.0%)	0 (0.0%)
Total	N/A	13975	1915	3636	618

Source: NACRS, DAD; Where cell sizes <5, data not presented.

The injuries sustained by ATV and snowmobile riders seen at the emergency room and hospital were stratified by body region and type of injury (Table 8). The most common injury for ATV-related emergency room visits was superficial/open wounds (n=4,704, 33.7%), followed closely by fractures (n=4,214, 30.2%). Fractures were the most common injury found in ATV-related hospitalizations (n=1,113, 58.2%), followed by superficial/open wounds (n=199, 10.4%). Fractures were the most common snowmobile injury related to both emergency room visits (n=1,162, 32%) and hospitalizations (n=357, 58%).

The most common body region injured in ATV and snowmobile-related injuries seen in the emergency room was the upper extremity (i.e., arms and shoulders; 32.7% and 30.5% respectively) followed by the lower extremity (i.e., hips, legs and feet; 25.3% and 25.8% respectively). The most common region injured in ATV and snowmobile-related injuries seen in hospital was the trunk (i.e., abdomen, thorax, spine, pelvis and lower back, 35.2% and 38.4% respectively) followed by the lower extremity (24% and 28.8% respectively).

Combining ATV and snowmobile-related emergency room visits, the most common injury was upper body fractures (15% and 13.5%) and the most common injury for hospitalizations was lower body fractures (17.4% and 20.5%) and trunk fractures (17.4% and 19.3% respectively). Approximately 4% of all emergency room visits and 6% of all hospitalizations related to both ATVs and snowmobiles were intracranial injuries.

Table 9. Percentage of injuries presented to emergency room (ER) related to all-terrain vehicles (ATVs) and snowmobiles by body region and age group in 2015 and 2016

Vehicle	Body Region	0-11 years	12-15 years	16-24 years	25-35 years	36+ years
ATVs	Head/Neck	23%	18%	19%	17%	15%
	Lower Extremity	21%	29%	28%	25%	22%
	Upper Extremity	40%	39%	33%	31%	29%
	Multiple Regions	3%	3%	4%	4%	3%
	Trunk	11%	10%	14%	22%	30%
	Unspecified	2%	1%	1%	1%	1%
Snowmobile	Head/Neck	22%	19%	19%	19%	14%
	Lower Extremity	20%	28%	29%	27%	24%
	Upper Extremity	35%	39%	32%	28%	30%
	Multiple Regions	2%	2%	3%	2%	1%
	Trunk	13%	12%	17%	23%	31%
	Unspecified	8%	0%	1%	1%	1%

Source: NACRS

Table 10. Total injuries per age group stratified by body region (percentage) in hospitalizations related to all-terrain vehicles (ATVs) and snowmobiles in 2015 and 2016

Vehicle	Body Region	0-11 years	12-15 years	16-24 years	25-35 years	36+ years
ATVs	Head/Neck	17%	19%	20%	22%	16%
	Lower Extremity	27%	32%	34%	22%	18%
	Upper Extremity	35%	28%	19%	17%	19%
	Multiple Regions	2%	1%	2%	2%	1%
	Trunk	19%	19%	25%	38%	45%

Vehicle	Body Region	0-11 years	12-15 years	16-24 years	25-35 years	36+ years
	Unspecified	0%	0%	0%	0%	0%
Snowmobile	Head/Neck	54%	23%	21%	23%	14%
	Lower Extremity	15%	27%	34%	26%	29%
	Upper Extremity	15%	13%	16%	11%	15%
	Multiple Regions	0%	3%	3%	0%	0%
	Trunk	15%	33%	26%	40%	42%

Source: DAD

The injuries sustained by ATV and snowmobile riders seen at the emergency room and hospital were also stratified by age group (Table 9 and 10, respectively). Of emergency room visit injuries related to ATVs and snowmobiles, upper body and head injuries were more represented in the youngest age groups, while trunk injuries were more represented in the oldest age groups (Table 9); however, for more serious injuries resulting in hospitalization, there was a high proportion of upper extremity injury in the youngest ATV riders group and head and neck injuries in the youngest age group of snowmobile riders (Table 10).

Mechanism of Injury

Table 11. Mechanism of injury for all-terrain vehicle- (ATV) and snowmobile-related emergency room (ER) visits in 2015 and 2016

Mechanism	ATV # (% of ER visits)	Snowmobile # (% of ER visits)
Rollover	93 (32.1%)	15 (22.7%)
Fell off vehicle	77 (26.6%)	14 (21.2%)
Ejection	29 (10.0%)	16 (24.2%)
Collision with stationary object	15 (5.2%)	6 (9.1%)
Injury on vehicle	23 (7.9%)	<5
Injury outside of vehicle	11 (3.8%)	<5

Mechanism	ATV # (% of ER visits)	Snowmobile # (% of ER visits)
Boarding	7 (2.4%)	<5
Collision with other vehicle	7 (2.4%)	<5
Injury related to trailer	8 (2.8%)	<5
Pedestrian hit by vehicle	5 (1.7%)	<5
Foot caught under vehicle	6 (2.1%)	<5
Unknown	7 (2.4%)	<5
Other	<5	<5
Total	**290**	**66**

Source: Canadian Hospitals Injury Reporting and Prevention Program; Where cell sizes <5, data not presented.

The mechanism of injury for ATV and snowmobile-related emergency room visits from 2015-2016 was extracted from the CHIRPP surveillance data (Table 11). The most common mechanism of injury for both ATV and snowmobile use was the vehicle rolling over, followed by falling off the vehicle.

Table 12. Percentage of injuries attributable to mechanism within each age strata for all-terrain vehicle (ATV) and snowmobile-related emergency room visits stratified by age group in 2015 and 2016

Vehicle	Mechanism	0-11 years	12-15 years	16-24 years	25-35 years	36+ years
ATV	Ejected	6.8%	9.8%	8.1%	14.6%	11.9%
	Fell off ORV	39.0%	32.8%	30.6%	9.8%	16.4%
	Rollover	28.8%	27.9%	25.8%	41.5%	38.8%
	All others	25.4%	29.5%	35.5%	34.1%	32.9%
Snowmobile	Ejected	0.0%	18.8%	18.2%	20.0%	47.1%
	Fell off ORV	14.3%	25.0%	9.1%	26.7%	23.5%
	Rollover	28.6%	12.5%	27.3%	26.7%	23.5%

Vehicle	Mechanism	0-11 years	12-15 years	16-24 years	25-35 years	36+ years
	All others	57.1%	43.7%	45.4%	26.6%	5.9%

Source: Canadian Hospitals Injury Reporting and Prevention Program

The mechanism of injury amongst ATV related emergency room visits varied by age (Table 12). In the younger age groups (0 to 11 and 12 to 15 years), falling off the ATV accounted for the highest proportion of injuries whereas in the older age groups (25 to 35 and 36+ years), the highest proportions of injuries resulted from rollovers. The trend in mechanism of injury between age groups for snowmobile users was less consistent.

Self-Reported Risk Behaviours

Table 13. Self-reported risk behaviours associated with all-terrain vehicle (ATV) and snowmobile use in Ontario in 2013, age ≥ 12 years

Question	Response	Estimated Frequency	% Yes
How often do you wear a helmet when on an ATV?	Always/Most of the Time	887,213	77.3%
	Rarely/Never	260,265	22.7%
In the past 12 months, have you been a passenger on [a snowmobile, motor boat, Sea-Doo or ATV/a snowmobile, motor boat or Sea-Doo/an ATV] with a driver who had two or more drinks in the hour before driving?	No	2,489,748	93.11%
	Yes	184,259	6.9%
	Avg. # times	3.6	
In the past 12 months, have you driven [a snowmobile, motor boat, Sea-Doo or ATV/a snowmobile, motor boat or Sea-Doo/an ATV] after having two or more drinks in the hour before you drove?	No	2,144,243	93.3%
	Yes	154,733	6.7%
	Avg. # times	4.1	

Source: Canadian Community Health Survey (2013). Excluded individuals that did not know, refused to answer, not stated or not applicable.

Self-reported risk behaviours related to snowmobile, motorboat, Sea-Doo and ATV use was captured by the 2013 Canadian Community Health Survey (Table 13). Of the 10.3% of Ontarians who self-reported using an ATV within the last year (Table 4A), 77.5% reported that they either always wore a helmet or

wore a helmet most of the time, while only 22.7% reported that they either rarely wore a helmet or never wore a helmet while driving an ATV (Table 13). When stratified by age group, 12 to 15 year-olds reported the highest use of helmets (87.3%) followed by 25 to 35 year-olds (78.4%), 36+ (75.7%) and 16 to 24 year-olds (75.4%). Males and females self-reported similar use of helmets (77.8% and 76.4% respectively). Data on helmet use was not collected for snowmobiles.

Out of all individuals who responded that they had rode a snowmobile, motorboat or Sea-Doo and/or ATV within the past year (Table 4A & 4B), almost 7% of individuals reported that they were a passenger when the driver had two or more drinks within the hour before driving and almost 7% have reported that they have been the driver in the same situation (Table 13). For those who answered yes to having been a passenger, the majority of respondents report that this has happened once or twice (38.1% and 27.1%, respectively). A further 34.8% of respondents reported that it happened three or more times and 11.9% report that it happened 10 or more times. For drivers, approximately half reported that it happened only once or twice (23.8% and 30.7% respectively), with 45.5% reporting three or more times and 14.1% reporting 10 or more times. A larger proportion of males compared to females reported being a passenger while the driver had been drinking (8% versus 6%) and a larger proportion of males compared to females reported that they had been drinking before driving (11% versus 1%).

Risk Factors among Injured ATV and Snowmobile Riders

Table 14. Risk factors among injured all-terrain vehicle (ATV) and snowmobile riders in 2015 and 2016

Risk Factor	Level	ATV # (% of Injured Riders)	Snowmobiles # (% of Injured Riders)
Sex	Male	211 (72.8%)	50 (75.8%)
	Female	78 (26.9%)	16 (24.2%)
	Unknown	<5	0 (0.0%)
Age category	0-11	59 (20.3%)	7 (10.6%)
	12-15	61 (21.0%)	16 (24.2%)
	16-24	62 (21.4%)	11 (16.7%)
	25-35	41 (14.1%)	15 (22.7%)
	36+	67 (23.1%)	17 (25.8%)
Substance use	Yes	21 (7.2%)	<5
	Suspected	<5	0 (0.0%)
	Unknown	30 (10.3%)	7 (10.6%)
	No	237 (81.7%)	55 (83.3%)
Substance type	Alcohol	18 (6.2%)	<5
	Illicit Drugs	<5	0 (0.0%)
	Both	<5	0 (0.0%)
Protective equipment	Helmet Only	129 (44.5%)	34 (51.5%)

Risk Factor	Level	ATV # (% of Injured Riders)	Snowmobiles # (% of Injured Riders)
	Helmet + Other	24 (8.3%)	10 (15.2%)
	Other Only	6 (2.1%)	0 (0.0%)
	Unknown	131 (45.2%)	22 (33.3%)
Weekday	Fri - Sun	190 (65.5%)	37 (56.1%)
	Mon - Thurs	100 (34.5%)	29 (43.9%)
Used for work-related tasks	Yes	<5	0 (0.0%)
	No	289 (99.7%)	66 (100.0%)

Source: Canadian Hospitals Injury Reporting and Prevention Program; Where cell sizes <5, data not presented.

Amongst emergency room visits related to ATVs and snowmobiles captured by the CHIRPP surveillance system, less than 10% of ATV and snowmobile-related emergency room visits involved substance use (Table 14). The most common substance used was alcohol.

Of injured riders seen at the emergency room, 52.8% ATV and 66.7% of snowmobile riders reported wearing helmets and 2.1% of ATV riders were wearing only protective devices other than a helmet. No protective devices were noted for the remainder of riders, although it is unknown whether this accurately captures the extent of device use among injured riders.

The majority of ATV and snowmobile-related emergency room visits occurred on the weekend days (Friday to Sunday) and almost all were related to recreational use of ATVs or snowmobiles.

Rates of Injury by Public Health Unit

Table 15. Number and annual rate of all-terrain vehicle- (ATV) and snowmobile-related emergency room (ER) visits and hospitalizations stratified by Statistics Canada Peer Group* and Ontario PHUs in 2015 and 2016

Peer Group	Public Health Unit	ATV ER Visits Count (Rate/100,000)	ATV Hospitalizations Count (Rate/100,000)	Snowmobile ER Visits Count (Rate/100,000)	Snowmobile Hospitalizations Count (Rate/100,000)
A	Brant	131 (44.7)	22 (7.51)	26 (8.88)	<5
	Hamilton	274 (24.5)	27 (2.42)	39 (3.49)	5 (0.45)
	Middlesex-London	305 (32.3)	35 (3.70)	66 (6.98)	11 (1.16)
	Niagara	534 (59.1)	37 (4.09)	88 (9.73)	13 (1.44)
	Windsor-Essex	216 (26.6)	26 (3.20)	34 (4.19)	6 (0.74)
B	Durham	521 (39.1)	36 (2.70)	105 (7.87)	11 (0.82)

Peer Group	Public Health Unit	ATV ER Visits Count (Rate/100,000)	ATV Hospitalizations Count (Rate/100,000)	Snowmobile ER Visits Count (Rate/100,000)	Snowmobile Hospitalizations Count (Rate/100,000)
	Halton	251 (22.3)	25 (2.2)	41 (3.6)	<5
	Ottawa	304 (15.8)	36 (1.9)	95 (4.9)	11 (0.6)
	Simcoe Muskoka	765 (69.2)	69 (6.2)	303 (27.4)	37 (3.3)
	Waterloo	290 (26.6)	23 (2.1)	70 (6.4)	9 (0.8)
	Wellington-Dufferin-Guelph	460 (79.9)	33 (5.7)	88 (15.3)	8 (1.4)
C	Elgin-St. Thomas	187 (102.8)	6 (3.3)	28 (15.4)	<5
	Hastings-Prince Edward County	398 (121.6)	32 (9.8)	46 (14.1)	8 (2.4)
	Kingston-Frontenac-Lennox & Addington	283 (69.8)	27 (6.7)	46 (11.3)	5 (1.2)
	Lambton	196 (75.5)	12 (4.6)	37 (14.3)	8 (3.1)
	North Bay-Perry Sound	246 (96.2)	24 (9.4)	121 (47.3)	13 (5.1)
	Northwestern	163 (100.1)	20 (12.3)	117 (71.8)	7 (4.3)
	Peterborough	209 (74.1)	16 (5.7)	48 (17.0)	9 (3.2)
	Porcupine	332 (194.6)	26 (15.2)	185 (108.5)	17 (10.0)
	Sudbury	411 (103.1)	43 (10.8)	170 (42.6)	17 (4.3)
	Thunder Bay	324 (105.3)	31 (10.1)	111 (36.1)	11 (3.6)
	Timiskaming	82 (121.0)	15 (22.1)	51 (75.3)	5 (7.4)
D	Grey Bruce	471 (143.4)	41 (12.5)	84 (25.6)	9 (2.7)
	Haldimand-Norfolk	376 (169.3)	43 (19.4)	44 (19.8)	<5
	Huron	195 (164.6)	16 (13.5)	64 (54.0)	<5
	Haliburton-Kawartha-Pine Ridge	493 (136.2)	48 (13.3)	119 (32.9)	6 (1.7)
	Leeds-Grenville-Lanark	318 (93.9)	37 (10.9)	67 (19.8)	5 (1.5)
	Oxford	196 (87.5)	8 (3.6)	42 (18.8)	<5
	Perth	145 (92.3)	9 (5.7)	53 (33.7)	<5
	Renfrew	262 (123.2)	21 (9.9)	88 (41.4)	13 (6.1)
	Eastern Ontario	333 (81.0)	29 (7.0)	104 (25.3)	10 (2.4)
E	Algoma	290 (125.7)	31 (13.4)	109 (47.2)	11 (4.8)
	Chatham-Kent	231 (109.6)	29 (13.8)	44 (20.9)	7 (3.3)

Peer Group	Public Health Unit	ATV ER Visits Count (Rate/100,000)	ATV Hospitalizations Count (Rate/100,000)	Snowmobile ER Visits Count (Rate/100,000)	Snowmobile Hospitalizations Count (Rate/100,000)
G	Toronto	321 (5.6)	33 (0.6)	75 (1.3)	8 (0.1)
H	Peel	256 (8.8)	17 (0.6)	49 (1.7)	6 (0.2)
	York Region	323 (14.1)	28 (1.2)	87 (3.8)	7 (0.3)

Source: NACRS, DAD; Where cell sizes <5, data not presented; *Note, the province of Ontario does not have a Peer Group F.

Emergency room visits and hospitalizations were stratified by Statistics Canada Peer Groups and PHU (Table 15). The highest rate of emergency room visits and hospitalizations related to snowmobiles was in Porcupine. The highest rate of emergency room visits related to ATVs was in Porcupine, but the highest rate of ATV-related hospitalizations was in Timiskaming.

Rates of Injury by Statistics Canada Peer Groups

Table 16. Average rates of all-terrain vehicle- (ATV) and snowmobile-related emergency room (ER) visits and hospitalizations by Statistics Canada Peer Groups in 2015 and 2016

Peer Group	ATV ER Visits Rate per 100,000 (min-max value*)	ATV Hospitalizations Rate per 100,000 (min-max value)	Snowmobile ER Visits Rate per 100,000 (min-max value)	Snowmobile Hospitalizations Rate per 100,000 (min-max value)
A	35.87 (24.55-59.07)	3.61 (2.42-7.51)	6.22 (3.49-9.73)	0.93 (N/A)
B	36.16 (15.75-79.87)	3.10 (1.86-6.24)	9.80 (3.63-27.39)	1.12 (N/A)
C	100.41 (69.82-121.05)	8.94 (3.30-22.14)	34.05 (11.35-108.47)	3.65 (N/A)
D	117.47 (80.99-169.28)	10.61 (3.57-19.36)	28.01 (18.75-54.02)	2.40 (N/A)
E**	118.00 (109.6-125.67)	13.59 (13.43-13.76)	34.65 (20.88-47.23)	4.08 (3.32-4.77)
G***	5.63	0.58	1.32	0.14
H**	11.12 (8.80-14.07)	0.86 (0.58-1.22)	2.61 (1.68-3.79)	0.25 (0.21-0.30)

Source: NACRS, DAD; *Represents the rate range (lowest to highest)/100,000 population from each peer group; **Peer group with only two PHUs; ***Peer group with one PHU (City of Toronto); N/A: range not given due to small cell sizes.

When grouped by Statistics Canada Peer Groups (Table 16), Peer Groups D, E and C have the highest rates of emergency room and hospitalizations related to both ATVs and snowmobiles, whereas Peer Group G and H have the lowest rates. There is considerable variation in rates within groups. For example, in Peer Group D, the lowest rate of ATV injury was 80.99 per 100,000 population, whereas the highest rate was 169.28 per 100,000. Peer Group C also demonstrated a considerable range in injury rates, both for ATV hospitalizations and ER visits due to use of snowmobiles (Table 16). These injury rates should be interpreted in the context of their calculation with population-based denominators in the absence of exposure-based denominators.

Discussion

The rates of emergency room visits and hospitalizations in Ontario due to injuries from ATV and snowmobile use are high. This study found over two years, over 15,000 injuries presented to a hospital from an injury related to ATV and snowmobile use.

Consistent with previous literature,[9,16] males represented the largest proportion of individuals who presented to the emergency room and hospital for ATV-related injuries (77% and 83% respectively) and snowmobile-related injuries (77% and 82% respectively). This data also suggests that males may be more likely to have more severe injuries, requiring hospitalization. Literature in this area suggests that injury rates in males may be higher due to the overrepresentation of males from increased exposure, including frequency of exposure.[1,6,21] Males represent a higher proportion of emergency room visits and hospitalizations compared to self-reported ridership for snowmobiles, motorboats and Sea-Doo (61%) and ATVs (65%); however, we are unable to determine the frequency of ridership or what proportion were injured while using motorboats or Sea-Doos from the CCHS data which may account for this difference.

Also consistent with previous literature, the highest rate of injuries was reported in the younger age groups. Children ages 12 to 15 years had the highest rates of ATV-related ER visits and hospitalizations, which is consistent with literature that suggested children under the age of 16 are at a higher risk of injury from ATV use. Evidence suggests the higher risk of injury and differing injury patterns demonstrated in the pediatric population may be due to latency in cognitive skill development, decreased upper and lower body strength, experience using the vehicles, vehicle to child size differential and increased tendency to engage in risky behaviours.[12] Some authors suggest that safe ATV use requires active riding techniques, where riders must shift their weight, movement and strength to ensure stability and control; children do not have the cognitive skills nor weight and strength to engage in these active riding techniques.[3]

A larger proportion of emergency room patients were drivers compared to passengers for both ATV and snowmobile-related injuries. The proportion of drivers compared to passengers was smaller in the younger age groups compared to the older age groups amongst all ATV and snowmobile-related emergency room visits and hospitalizations. This is expected, as legislation stipulates children under the age of 8 should not be passengers on the highway and children under the age of 12 should not be driving ATVs or snowmobiles unless on private property or supervised by an adult. Of concern, there were 503 ATV and 30 snowmobile-related emergency room visits where a child under the age of 12 was the driver and an additional 861 ATV and 92 snowmobile-related emergency room visits where children ages 12 to 15 were reported as being the driver.

Overall, the type of injuries sustained amongst ATV and snowmobile users was similar. Consistent with previous literature,[2,6,23] the most common type of injury related to hospitalizations was fractures. These estimates were similar to the proportions of injuries resulting from ATVs and snowmobiles from the CHIRPP data collected across Canada published in 2015.[6] When stratifying the body region of injury by age group for ATV and snowmobile-related emergency room visits, it is shown that head and neck

injuries, as well as upper body extremity injuries account for a higher proportion of injuries among the younger age groups, where the proportion decreases as age groups increase. The opposite pattern exists for trunk injuries where older age groups have higher proportions of trunk injuries compared to younger age groups. This may indicate the way children are getting injured on ATVs or snowmobiles may be different compared to adults; where children riding adult-sized ATVs or snowmobiles may sustain injuries to their head/neck from impact with the handlebars whereas adults would sustain a trunk-related injury given the same mechanism of impact. What is concerning is the high proportion of head/neck injuries in young children, particularly given the known short and long-term risks associated with minor and major head injuries.

We also noted a difference in the mechanism of injury for children and youth, with a greater proportion of younger children falling off ATVs and older adults being ejected or rolling the ATV over. The mechanism of injury for ATVs and snowmobiles reported here contrasts with previous literature. Previous literature in this area demonstrated that a higher proportion of injuries resulting from collisions than from falling off or being ejected from the vehicle.[5,8,15,22,30–33] This is likely related to our coding strategy, where coded mechanism of injury and not mechanism of collision. This strategy was chosen to better understand the injury-causing mechanism over the circumstances that caused the collision.

We found a higher proportion ATV riders who presented to the emergency room were wearing helmets (44.5%) compared to ATV review literature;[7] however, this proportion was much lower than the self-reported use of helmets reported in the CCHS (77.5%). The relatively low proportion of reported use is concerning given helmet legislation in Ontario that is applicable to all riders and that head injuries are the most common cause of death related to ATVs in Ontario.[1] The proportion of snowmobile riders who presented to the emergency room and had been wearing helmets was consistent with previous literature.[8,14,16]

The proportion of individuals who self-reported consuming alcoholic beverages before driving an ATV or snowmobile, motorboat or Sea-Doo was similar to the proportion of emergency room visits involving substance use for both snowmobiles and ATVs. Due to limitations in the data, discussed later, this is likely an underrepresentation of actual substance use with ATV and snowmobiles.

When stratified by Statistics Canada Peer groups, Peer Group D and E had the highest rates of injury. These Peer Groups represent mainly rural regions, defined as having a low percentage of visible minorities and an average percentage of Aboriginal population, in addition to having low employment rates. Peer Groups G and H had the lowest rates of emergency room visits and hospitalizations related to ATVs and snowmobiles. These Peer Groups represent the largest population centres with a high population density. In Ontario, the only PHU that falls under peer group G is Toronto and Peer Group H includes only Peel and York Region, which are both in the Greater Toronto Area. A higher proportion of injuries in rural areas, compared to more urban areas is consistent with previous literature,[16,34] likely due to the higher prevalence and use of ATVs and snowmobiles.

The Statistics Canada Peer Groupings, however, provide a limited understanding of the true relationship between off-road vehicle injury and socioeconomic status. In addition, the groupings do not necessarily

best represent areas in Ontario as a measure of socioeconomic status. As shown in Table 16, there appear to be as many intra-peer group rate differences as inter-peer group differences. To better understand socioeconomic differences as an independent risk factor for off-road injuries, a study would have to look at specific summary measures of socioeconomic status, controlling for known risk factors such as age, sex and exposure. In addition, the use of Peer Groups does not provide perspective into what injury rates are in northern PHUs, as northern units are represented in multiple Peer Groups. It is hypothesized that northern units would see a greater injury rate with ATV and snowmobile use, given the increased exposure; however, we do not have access to ATV and snowmobile exposure data.

Roles for Public Health Practice

ATV-related morbidity and mortality in children and youth is a significant public health issue amenable to primary prevention.[35] Public health is well positioned to reduce the number and risk of injuries related to ATVs and snowmobiles. This may be done through increasing awareness of the risk of injury related to ORV use and supporting the implementation of interventions to address the reduction of injury through policies around ATV and snowmobile safety.

The data provided in this report can be used by PHUs to facilitate PHU, intra-provincial and cross-provincial comparisons. PHUs may compare the number and rate of injuries to similar PHUs and share public health approaches to mitigating ATV and snowmobile-related injury.

While legislation is a highly effective intervention used to reduce injuries related to motor vehicles, particularly in children and youth,[36] its effectiveness for preventing ATV and snowmobile-related injuries is less clear. One study in the US demonstrated the implementation of minimum age restrictions was effective in reducing the number and rate of recreational vehicle-related injuries.[37] It found a 33% to 50% reduction in the rate of emergency department and inpatient discharges when comparing injury rates over the same time period to adults. The net impact of legislation, however, is not only its content, but also its enforcement by local officials. Organizations such as the Canadian Pediatric Society (CPS) have recommended children under the age of 16 should not ride nor operate either ATVs or snowmobiles.[4]

Mandatory helmet use is another effective strategy to reduce the risk of recreational vehicle-related head injuries. There are several studies that have demonstrated a reduction in morbidity and mortality of recreational vehicle riders with helmet use;[18,38–40] however, helmets only provide a protective effect when riders wear them and wear them correctly. Other interventions such as educational programs manufacturer warnings or public attention to the dangers of ATV use to reduce injury in both ATV and snowmobile use come with mixed findings in the literature.[7,37,41] Some authors have suggested the role of brief behavioural interventions in the medical setting, peer-to-peer interventions and interventions targeting parents of children and youth who ride recreational vehicles may play an important role in the reduction of ATV and/or snowmobile related injuries.[7]

Study Strengths and Limitations

This is the first study to examine non-fatal and fatal ATV and snowmobile-related injuries across the province of Ontario.[1,42,43] It provides information on all emergency department, hospitalizations and fatalities related to ATVs and snowmobiles, as well as provides an understanding of the type and mechanism of injuries related to recreational vehicle use in Ontario. Additionally, this report provides PHU and Statistics Canada Peer Group specific rates on ATV and snowmobile-related injuries; however, this study has several limitations, particular to each dataset used.

IntelliHealth

IntelliHEALTH databases capture all emergency room visits, hospitalizations and fatalities in Ontario; however, they underrepresent the true burden of ATV and snowmobile injuries due to the exclusion of cases that do not present to hospital. Therefore, they do not include any injuries where the injured individual did not seek medical care or sought medical attention outside of the hospital setting. In some cases, where one individual presented to the ER and was later transferred as an inpatient, the same injury would be coded twice as both an ER visit, and a hospitalization.

We were also unable to present injury rates on the most recent year(s) due to restraints in administrative data. Data from the NACRS and DAD databases were only available up to 2016 and data from the Vital Stats death databases are only available up to 2012.

There are also several limitations with the use of ICD-10 codes. The V86 codes include the use of (i) snowmobiles and (ii) all-terrain vehicles and other off-road vehicles, including dirt bikes, golf carts, etc. Therefore, the rates presented for ATVs may also include other forms of off-road vehicles.

We also stratified data from the NACRS and DAD by PHU and Statistics Canada Peer Groups. In these datasets, the individual injuries were assigned to PHUs and Peer Groups based on home location, not where the injury took place (e.g., if an individual's residence is in Toronto, but they were injured outside of Toronto, the injury count would still be counted towards the Toronto Public Health Unit and the Peer Group assigned to Toronto). Therefore, when interpreting the rates by PHU and Peer Group, they do not necessarily reflect the burden of injury in that particular PHU or Peer Group, but rather the burden of the injury amongst individuals who reside in that area. It is estimated that despite this categorization of injuries, the greatest exposure to ATV and snowmobile use would correspond with the location of reported injuries.

Data was stratified by Statistical Canada Peer Groups in order to gain an understanding of the potential differences in injury rates between PHUs. Although these rates provide a high level understanding of the differences between groups categorized by Statistics Canada based on socioeconomic factors, rurality and demographic profiles, individual PHUs represent large areas and there may be a large range in ATV and snowmobile use and the presence of other risk factors, by specific region. Therefore, a more

granular approach is necessary to determine the effect, if any, on socioeconomic factors or measures of equity, on the risk of ATV and snowmobile-related injuries.

Lastly, we are unable to use exposure data (e.g. frequency and/or duration of ridership); therefore, we are unable to determine to risk of injury for those exposed to ATVs and snowmobiles. There is a need for reliable denominator-based surveillance data to estimate the risk of ATV and snowmobile injury in Ontario.

Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP)

CHIRPP is not representative of all injuries in Ontario, as data is only collected from four pediatric hospitals and two general hospitals. In addition, CHIRPP data is likely to over represent injuries in children and underrepresent less severe injuries in Aboriginal and other people who live in rural and remote areas.

It is also possible that the reported use of substances, helmets and protective gear, as well as mechanisms of injury differ between the individuals captured in the CHIRPP database and individuals with ATV and snowmobile-related injuries in areas not captured by CHIRPP. Thus, caution should be exercised in generalizing these findings to the entire Ontario population.

Lastly, the data collected from CHIRPP has a substantial amount of missing data regarding substance use (10%) and protective gear; (45%) therefore, the proportions presented may be conservative.

Canadian Community Health Survey (CCHS)

The CCHS administered questions regarding the proportion of Ontarians that ride off-road vehicles in the 2003, 2009, 2010 and 2013 CCHS cycles. There are a number of limitations of the CCHS. This data collection method does not systematically capture ATV and snowmobile exposure, including the actual number of hours of use over ATV and snowmobile seasons, as well as the limitations of collecting data in each survey cycle. CCHS also only collects data on children and adults ages 12+, which excludes the 0 to 11 age group. Therefore, we do not have any self-reported data on the use of ATVs and snowmobiles in this important age group, which was shown to represent a large proportion of injuries.

While CCHS collects ATVspecific use information, it groups snowmobile use with other vehicles, such as Sea-Doos and motorboats. Since is it not possible to determine the use of snowmobiles separate from Sea-Doos and motorboats, we are limited in our understanding of the extent of snowmobile use in Ontario.

As with many self-reported surveys, the CCHS is also susceptible to social desirability bias. Individuals may be uncomfortable answering questions that they perceive to be as socially undesirable, such as the consumption of alcohol before riding an ORV, which could lead to an underestimation of this behaviour. Respondents may also over-report the use of protective equipment for the same reason. Surveys are also susceptible to response bias, whereby there may be a difference between those who choose to

respond to the survey or not and recall bias, whereby participants may be unable to accurately recall the answer to the question.

Lastly, the CCHS has a relatively small sample size (n=20,451) compared to administrative databases and does not include residents on reserves, health care institutions and some remote areas, as well as full-time members of the Canadian Forces.

Overall, we have found that the rates of emergency room visits and hospitalizations related to ATV and snowmobile use are high. Males, children under the age of 16 and drivers represent a large proportion of these injuries. The most common type of injury requiring hospitalization was fractures and the most common mechanism of injury was falling off or being ejected from the vehicle, followed closely by the vehicle rolling over. The rate of ATV and snowmobile related injuries vary across PHUs; units categorized as mainly rural appear to have higher rates of injury compared to units categorized as non-rural.

Off-road vehicle safety is a topic for consideration in the 2018 Ontario Public Health Standards. Understanding the rates of injury by PHU, as well as the common injury types, location and mechanisms of injury can be used to inform prevention planning. In addition, the predictable and preventable nature of ATV and snowmobile injuries provides an opportunity for public health action given the number of potentially effective interventions, including implementation and enforcement of minimum age restrictions and mandatory helmet use that apply to on and off-road ATV and snowmobile use.

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Appendix A: ICD-10 Codes – ORVs

- V86.0 - Driver of all-terrain or other off road motor vehicle injured in traffic accident
- V86.00 - Driver of snowmobile injured in traffic accident
- V86.08 - Driver of other all-terrain or other off road motor vehicle injured in traffic accident
- V86.1 - Passenger of all-terrain or other off road motor vehicle injured in traffic accident
- V86.10 - Passenger of snowmobile injured in traffic accident
- V86.18 - Passenger of other all-terrain or other off road motor vehicle injured in traffic accident
- V86.2 - Person on outside of all-terrain or other off-road motor vehicle injured in traffic accident
- V86.3 - Unspecified occupant of all-terrain or other off road motor vehicle injured in traffic accident
- V86.30 - Unspecified occupant of snowmobile injured in traffic accident
- V86.38 - Unspecified occupant of other all-terrain or other off road motor vehicle injured in traffic accident
- V86.4 - Person injured while boarding or alighting from all-terrain or other off-road motor vehicle
- V86.5 - Driver of all-terrain or other off road motor vehicle injured in non-traffic accident
- V86.50 - Driver of snowmobile injured in non-traffic land accident
- V86.51 - Driver of snowmobile injured in non-traffic accident, falling through ice
- V86.58 - Driver of other all-terrain or other off road motor vehicle injured in non-traffic accident
- V86.6 - Passenger of all-terrain or other off road motor vehicle injured in non-traffic accident
- V86.60 - Passenger of snowmobile injured in non-traffic land accident
- V86.61 - Passenger of snowmobile injured in non-traffic accident, falling through ice
- V86.68 - Passenger of other all-terrain or other off road motor vehicle injured in non-traffic accident
- V86.7 - Person on outside of all-terrain or other off-road motor vehicle injured in non-traffic accident

- V86.9 - Unspecified occupant of all-terrain or other off road motor vehicle injured in non-traffic accident. Includes:
    - All-terrain motor-vehicle accident NOS
    - Off-road motor-vehicle accident NOS
- V86.90 - Unspecified occupant of snowmobile injured in non-traffic land accident
- V86.91 - Unspecified occupant of snowmobile injured in non-traffic accident, falling through ice
- V86.98 - Unspecified occupant of other all-terrain or other off road motor vehicle injured in non-traffic accident
- U99.032 – All-terrain vehicle (ATV) sports

Vehicle Codes

Vehicle	Code
ATV	"V8608" "V8658" "V8618" "V8668" "V864" "V862" “V867" “V8638" "V8698" "U99"
Snowmobile	"V8600" "V8650” "V8651" "V8610" "V8660" "V8661"

Vehicle	Code
	"V8630"
	"V8690"
	"V8691"

Seating Position

Vehicle	Seating Position	Code
ATV	Driver	"V8608" "V8658"
	Passenger	"V8618" "V8668"
	Boarding	"V864"
	Outside	"V862" "V867"
	Unspecified	“V8638" "V8698 "U99"
Snowmobile	Driver	"V8600" "V8650" "V8651"
	Passenger	"V8610" "V8660 "V8661"
	Unspecified	"V8630" "V8690" "V8691”

Double coding rules:

- V86 codes > U99 Codes
- Codes with seating position (i.e., driver/passenger) > codes without seating position (i.e., boarding or outside of the vehicle) > codes with unspecified seating position
- Codes with conflicting seating positions (i.e., driver + passenger) recoded to unspecified seating position

Injury Location

Vehicle	Location	Code
ATV	Highway	"V8608" "V8618" "V8638" "V862"
	Non-Highway	"V8658" "V8668" "V8698" "V867"
	Other	"V864" "U99"
Snowmobile	Highway	"V8600" “V8610” "V8630"
	Non-Highway	“V8650" "V8651" "V8660" "V8661" "V8690” "V8691"

Double Coding rules:

- V86 codes > U99 Codes
- Codes with location of injury (i.e., highway or non-highway) > other
- Codes with conflicting locations (i.e., highway versus non-highway) recoded as other

Appendix B: ICD-10 Codes – Injuries

	Head/Neck	Trunk	Upper Body	Lower Body	Multiple
Superficial/Wound	S00	S20	S40	S70	T00
	S01	S21	S41	S71	T01
	S10	S30	S50	S80	
	S11	S31	S51	S81	
			S60	S90	
			S61	S91	
Fracture	S02	S22	S42	S72	T02
	S12	S32	S52	S82	
		T08	S62	S92	
			T10	T12	
Ligament/Muscle	S03	S23	S43	S73	T03
	S13	S33	S46	S76	
	S16		S53	S83	
			S56	S86	
			S63	S93	
			S66	S96	
Nerve/Vessel	S04	S24	S44	S74	
	S05	S25	S45	S75	
	S14	S34	S54	S84	
	S15	S35	S55	S85	
			S64	S94	
			S65	S95	
Crush/Amputation	S07	S28	S47	S77	T04
	S17	S38	S48	S87	T05
	S08		S57	S78	

	Head/Neck	Trunk	Upper Body	Lower Body	Multiple
	S18		S67	S88	
			S58	S97	
			S68	S98	
Intracranial	S06				
Internal organ		S26			
		S27			
		S36			
		S37			
Other	S09	S29	S49	S79	T06
	S19	S39	S59	S89	
		T09	S69	S99	
			T11	T13	
Unspecified					T07

Appendix C: CHIRPP Narrative Coding Strategy

Mechanism	Narrative
Injury outside of ORV	Lifting or performing maintenance on ORV
Boarding	Mounting or dismounting the ORV
Collision with Stationary Object	Collided with a stationary object Injury was caused by impact with the stationary object while remaining on ORV If patient collided with a stationary object causing the patient to be ejected/fall of the ORV and the injury was caused by ejection/falling off the ORV, the mechanism of injury was considered 'Fell Off ORV' or 'Ejection'
Collision with Vehicle	Collided with another ORV Collided with another Motor Vehicle
Fell off ORV	Patient fell off the ORV Injury was caused by impact with the ground/surrounding environment (e.g., tree, rock, ice, etc.)
Ejection	Was 'thrown' or 'ejected' or 'flew' from the ORV Injury was caused by impact with the ground or impact with the ORV (e.g., hit body part on snowmobile while being ejected)
Injured on ORV	
Rollover	The ORV rolled over or tipped over The injury is a result of the ORV crushing the patient or the impact of the patient on the group/surrounding environment while the ORV rolled/tipped
Pedestrian	Patient struck by an ORV Pedestrian or bystander
Trailer	Riding an ORV and struck by the trailer/sled Riding on a trailer and being towed by an ORV
Other/Unknown	Frostbite

Mechanism	Narrative
	Hit by an animal
	Unknown - Not enough information provided

Appendix D: Canadian Community Health Survey

DRV_Q11A
In the past 12 months, have you been the driver of, or a passenger in, a snowmobile, motor boat or Sea-Doo?

Coded	Yes	No	Other Responses
Responses	1: Yes	2: No	6: Not Applicable 7: Don't know 8: Refusal 9: Not Stated

DRV_Q11B
In the past 12 months, have you been the driver of, or a passenger in, an all-terrain vehicle (ATV)?

Coded	Yes	No	Other Responses
Responses	1: Yes	2: No	6: Not Applicable 7: Don't know 8: Refusal 9: Not Stated

DRV_Q12
How often do you wear a helmet when on an ATV?

Coded	Always/Most of the Time	Rarely/Never	Other Responses
Responses	1: Always 2: Most of the time	3: Rarely 4: Never	6: Not Applicable 7: Don't know 9: Not Stated

DRV_Q13A
In the past 12 months, have you been a passenger on [a snowmobile, motor boat, Sea-Doo or ATV/a snowmobile, motor boat or Sea-Doo/an ATV] with a driver who had two or more drinks in the hour before driving?

Coded	Yes	No	Other Responses
Responses	1: Yes	2: No	6: Not Applicable 7: Don't know 8: Refusal 9: Not Stated

DRV_Q13B
How many times (in the past 12 months)?

Coded	Number of Times (Continuous)	Other Responses
Responses	Min = 1; Max = 95	6: Not Applicable 7: Don't know 8: Refusal 9: Not Stated

DRV_Q14A
In the past 12 months, have you driven [a snowmobile, motor boat, Sea-Doo or ATV/a snowmobile, motor boat or Sea-Doo/an ATV] after having two or more drinks in the hour before you drove?

Coded	Yes	No	Other Responses
Responses	1: Yes	2: No	6: Not Applicable 7: Don't know 8: Refusal 9: Not Stated

DRV_Q14B
How many times (in the past 12 months)?

Coded	Number of Times (Continuous)	Other Responses
Responses	Min = 1; Max = 95	6: Not Applicable 7: Don't know 8: Refusal 9: Not Stated

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