Ten Years of All-Terrain Vehicle Injury, Mortality, and Healthcare Costs

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Background: All-terrain vehicles (ATVs) are increasing in popularity worldwide. The province of Alberta accounts for 25% of Canadian ATV sales. This study describes the epidemiology, outcomes, and associated healthcare costs for a decade of ATV traumatic injury incidents.

Methods: This is a retrospective population based cohort study using two provincial databases: the Alberta Trauma Registry and the Office of the Chief Medical Examiner of Alberta. Data for individuals aged 18 years or older with Injury Severity Score 12 or deaths between April 1, 1998, and March 31, 2008 were included. Healthcare costs were extrapolated using figures from a Level I trauma center.

Results: ATV incidents resulted in 459 serious trauma cases, 395 trauma center admissions (a total of 4,117 days), and a 17% mortality rate. Postdischarge care was required for nearly 30% of patients. Male patients aged 18 years to 19 years had the highest incidence (6.5 of 100,000 people). Head, neck, and cervical spine injuries were most common (59%) and predictive of mortality (relative risk [RR], 2.19; interquartile range [IQR], 1.35□3.54; p 0.001). Vehicle rollovers (RR, 2.75; IQR, 1.13□6.70; p 0.01), vehicle ejection (RR, 4.18; IQR, 1.70□10.32; p 0.000), alcohol intake (RR, 2.33; IQR, 1.52□3.56; p 0.000), helmet use (RR, 1.82; IQR, 1.11□3.02; p 0.01), and incident location were predictive of mortality.

Conclusions: Increasing rates of ATV-related serious trauma and death are described in young males riding without helmets after consuming alcohol. Serious injuries contributed to healthcare costs in excess of $6.5 million USD. Predictors of mortality include rider behaviors and mechanical factors. Prevention should include rider education and industry measures to improve ATV stability.

Key Words: All-terrain vehicle, Off-road highway vehicle, Trauma, Wounds and injuries, Mortality.

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All-terrain vehicles (ATVs), defined as four-wheeled off-highway motor vehicles, have increased in popularity in many countries worldwide in the recent years. Associated with their increased use has been several reports of severe injury.[1□4] Many reports have illustrated differing pictures of the ATV trauma population and their injuries, including data on rider populations on a closed-circuit recreational course with an enforced helmet rule[2] to rural Australian farmers using ATVs primarily for work.[4] These findings are in contrast to the extensive literature, primarily from the United States, illustrating a young male population with injuries sustained during recreational use; suffering commonly head and neck injuries with poor rates of helmet use. The literature from the United States has also emphasized high rates of alcohol intoxication and its contribution to ATV crashes.[5,6] Helmkamp et al.[7] reported that ATV trauma in the United States resulted in national hospitalization costs exceeding $1.1 billion from 2000 to 2004, a significant burden of injury.

Most studies on ATV trauma have included injured persons who presented to a major trauma center[8□14] or who survived injury.[15] By restricting studies to patients presented to trauma center, the most severely injured people were excluded and significant predictors of severe injury or mortality may be missed. Only one study outlined adult ATV mortality including deaths at the scene but did not characterize multisystem injury, concentrating only on the single injury most likely to cause death.[5] A study including trauma center admissions and deaths at the scene may provide incident and injury features that are predictors of mortality.

In Canada, the province of Alberta leads the country in ATV sales and use, with an increase in yearly sales of 50% over the last 8 years, accounting for 25% of all ATVs sold nationally.[16] Alberta Traffic Collision Statistics illustrate a nearly threefold increase in ATV collisions since 2001.[17] In recent years, a larger number of patients with severe injuries from ATV use have been admitted to the trauma service at a Level I trauma center in southern Alberta. Despite the increase in popularity of ATVs and the increase in incidence of ATV collisions, information in the trauma literature on Canadian ATV-related injury including mortality is limited to pediatric populations.[18,19]

The limitations of the worldwide and Canadian literature mean that despite increasing use of ATVs, a clear picture of the extent of adult ATV trauma and mortality, its contributing factors, and associated healthcare costs is not available to inform public policy-makers. Therefore, the objective of this study was to define the adult incidence and mortality rates, describe the injuries and costs associated with major ATV injuries, and assess changes over a 10-year period in the province of Alberta, Canada.

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MATERIALS AND METHODS

This study used a population-based retrospective cohort design. Ethics approval was obtained from the Conjoint Health Research Ethics Board at University of Calgary. All adults (aged 18 years) suffering major trauma or death directly caused by a four-wheeled ATV in the Province of Alberta from April 1, 1998, to March 31, 2008, were included. Study subjects were identified, and data were obtained using two independent provincial databases: the Alberta Trauma Registry and the Office of the Chief Medical Examiner (ME) database. The Alberta Trauma Registry database registers all patients aged 18 years who suffer trauma with an Injury Severity Score (ISS) 12 and present to one of the three major Level I and Level II trauma centers in Alberta. The database of the Office of the Chief ME of Alberta was used for data on all individuals aged 18 years who died before presenting to a major trauma center.

After identification of cases through the source databases, specific data were abstracted. This abstraction included detailed demographic data (age and gender), injury geographic location (urban or rural defined as areas with 50,000 population), terrain or environment descriptors including streets or fields, mechanism of collision, ATV use for work or recreation, injury demographics (number of fatalities and number of injured persons), injury type (blunt or penetrating trauma), and injury date and time. Whether the patient was a driver or passenger on the ATV, alcohol levels if measured, and helmet use were also collected. Injury severity among hospitalized patients was assessed using the ISS. Injuries were grouped into six body systems (head and neck, face, chest, abdominal and pelvic, extremities, and external) according to the Maximum Abbreviated Injury Scale classification system for ease of analysis.[20] The Alberta Trauma Registry included the ISS coding; however, the data from the Office of the Chief ME could not be coded by ISS because of the limitations of the data descriptors. The ME data were grouped into body system categories. Hospital stay information included duration of hospital stay, intensive care unit (ICU) admissions and duration of stay, number of operating room procedures, and discharge destination (home, hospital, or rehabilitation center).

All statistical analyses were performed using Stata statistical software version 11 (Stata, College Station, TX). For description, continuous variables were expressed as median with interquartile ranges (IQRs) when nonnormally distributed and were compared using the Mann-Whitney *U* test. Categorical data were compared using the Fisher's exact *t* test. Incidence rates were calculated using population data from the Alberta Health Registry. Overall all-cause case-fatality rates were calculated by dividing the number of deaths by the total number of ATV trauma cases.

Estimated provincial hospital costs for ATV-related trauma patients were calculated using figures from one of the study's Level I trauma centers, Foothills Medical Centre, for the years 2002 to 2006. Foothills Medical Centre patients admitted for ATV-related injuries between 2002 and 2006 were considered a representative sample of the provincial ATV trauma population. Individual patient costs were obtained by matching their trauma number to the former Calgary Health Region corporate database. The average daily cost of inhospital care was then calculated and applied to the overall study cohort. For all comparisons, a p value of 0.05 was determined to represent statistical significance. Costs included both direct and indirect costs of nursing, laboratory, diagnostic, surgical, surgical supplies, medications, and support staff.[21] The costs associated with repeat hospital admissions or the provision of healthcare services after discharge from a Level I trauma center acute care setting were not assessed.

RESULTS

Population

During the 10-year study period, a total of 459 cases of severe trauma involving ATVs were identified: 395 (86%) through the Alberta Trauma Registry and 64 by the Office of the Chief ME of Alberta. Eighty-seven percent (n 401) were male, and the median age for the entire study population was 36 years (IQR, 24□50 years). The median ISS (n 395) was 19 (IQR, 16□25). Of the 459 cases, there were 79 deaths either prehospital or before discharge for an all cause case-fatality rate of 17%.

Incidence

The overall annual incidence of ATV associated severe trauma was 2.0 per 100,000 population. Overall incidence of severe ATV trauma increased yearly during the study period, and this was attributable to dramatic increases in the number of male victims as shown in Figure 1. Overall, male subjects were at a much higher risk than females (3.5 vs. 0.5 per 100,000; incidence rate ratio, 7.1; 95% confidence interval, 5.3□9.5; p 0.0001) with this risk differential between the genders most pronounced in the more recent years of the study (Fig. 1). The incidence of severe ATV trauma incidents decreased with advancing age (Fig. 2).

Event Description

Events resulting in severe injury or mortality involved ATV drivers (94%, 427 of 459), riding for recreational purposes (92%, 423 of 459) in rural areas (87%, 363 of 417).

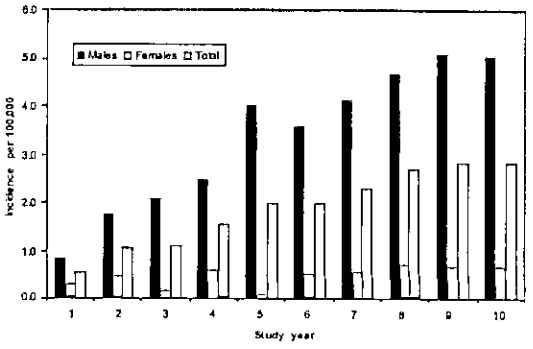

Figure 1. Yearly incidence of major ATV injury in the province of Alberta, Canada.

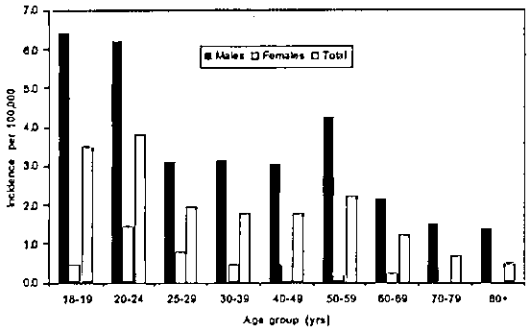

Figure 2. Age- and gender-related incidence of severe ATV trauma in Alberta, Canada.

These incidents commonly occurred on weekends (54%, 249 of 459) in the summer months of June through August (41%, 187 of 459). Helmet use was reported in only 35% (144 of 408) of those where information was recorded.

The most common mechanism of injury was blunt trauma (98%, 448 of 459) sustained in a vehicle rollover (78%, 307 of 395) or when ejected from the vehicle (67%, 261 of 391). The most common locations for an ATV injury incident were the street or highway (18%, 81 of 459) and defined recreational areas (12%, 57 of 459). ATV injury incidents frequently occurred on farms (9%, 39 of 459).

Positive blood alcohol levels were reported in 45% (n 132) of 292 available cases. Although, in the majority of cases, alcohol levels were not tested or available, positive alcohol levels were significantly associated with ATV incidents on the street or highway (39 of 132, 30%, vs. 27 of 160, 17%; p 0.01) and with reduced helmet use (23 of 122, 19%, vs. 62 of 142, 44%; p 0.000). Positive blood alcohol levels were also associated with recreational use of ATVs compared with ATV use for work (129 of 132, 98%, vs. 146 of 160, 91%; p 0.02).

Because of the high incidence of ATV trauma in persons younger than 30 years, we chose to compare event factors between 18-year and 30-year olds and those older than 30 years (Table 1). Both groups showed comparable rates of weekend recreational use in rural areas and had similar rates of helmet use. People younger than 30 years were more likely to have been injured as passengers on an ATV. Collisions with stationary objects were more common among riders younger than 30 years and may suggest a lack of familiarity with the riding environment or with the operation of the ATV. Rollover single-vehicle collisions were more commonly reported for people aged 30 or older as were ATV incidents on farms. Although only approaching significance,

TABLE 1. Descriptive Factors of ATV Events by Total Study Population and Age Category

Factor	Total Study Population, n (%)	Age <30 yr, Rate (%)	Age > 30 yr, Rate (%)	p
Mean ISS (IQR)	19 (16–25)	20 (16–29)	19 (16–25)	0.10
Male	401/459 (87.4)	135/162 (83.3)	266/297 (89.6)	0.06
Rural	363/417 (87.1)	131/137 (95.6)	232/242 (95.9)	1.00
Urban	16/471 (3.4)	6/137 (4.4)	10/242 (4.1)	1.00
Out of province	38/471 (8.1)	13/162 (8.0)	26/297 (8.8)	0.86
Weekend	249/459 (54.3)	87/162 (53.7)	162/297 (54.5)	0.92
Driver	427/456 (93.6)	143/159 (89.9)	284/297 (95.6)	0.03*
Passenger	25/456 (5.5)	14/159 (8.8)	11/297 (3.7)	0.03*
Other rider	4/456 (0.9)	2/159 (1.3)	2/297 (0.7)	0.61
Recreational use	423/459 (92.2)	152/162 (93.8)	271/297 (91.2)	0.37
Wearing helmet	144/408 (35.3); 144/459 (31.4)	56/148 (37.8)	88/260 (33.8)	0.45
Alcohol intake	132/292 (45.2); 132/459 (28.8)	55/105 (52.4)	77/187 (41.2)	0.07
Rollover	307/395 (77.7)	94/134 (70.1)	213/261 (81.6)	0.01*
Ejected	261/391 (66.8)	99/141 (70.2)	162/250 (64.8)	0.32
Stationary collision	61/395 (15.4)	29/134 (21.6)	32/261 (12.3)	0.02*
Moving collision	26/395 (6.6)	11/134 (8.2)	15/261 (5.7)	0.39
Location street	81/459 (17.7)	36/162 (22.2)	45/297 (15.2)	0.07
Recreational area	57/459 (12.4)	23/162 (14.2)	34/297 (11.4)	0.46
Location industry	9/459 (2.0)	2/162 (1.2)	7/297 (2.4)	0.50
Location mine	4/459 (0.9)	1/162 (0.6)	3/297 (1.0)	1.00
Location farm	39/459 (8.5)	8/162 (4.9)	31/297 (10.4)	0.05*
Location home	9/459 (2.0)	1/162 (0.6)	8/297 (2.7)	0.17
Winter (December–February)	35/459 (7.6)	11/162 (6.8)	24/297 (8.1)	0.72
Spring (March–May)	112/459 (24.4)	45/162 (27.8)	67/297 (22.6)	0.21
Summer (June–August)	187/459 (40.7)	66/162 (40.7)	121/297 (40.7)	1.00
Autumn (September–November)	125/459 (27.2)	40/162 (24.7)	85/297 (28.6)	0.38

Other rider includes behind ATV; Stationary collision includes trees, fences, and boulders.
* Significant at 0.05 level.

there is a trend toward more female riders, more incidents on streets or highways, and increased rates of confirmed alcohol consumption in the group younger than 30 years.

Injury

ATV trauma resulted in 4,117 total admission days. The median total length of stay per patient was 7 days (IQR, 4–13 days). Thirty percent (120 of 395) of patients required admission to the ICU for a median 6-day (IQR, 2–11 days) length of stay. Among the survivors to hospital discharge, nearly 30% (n 110, 28%) of patients required direct transfer to an alternate acute care facility (17%), a rehabilitation center (11%), or a chronic care facility (n 1) after the acute care admission.

Injuries organized by body system are included in Table 2. Head, neck, and cervical spine (c-spine) injuries were the most common injuries among fatal ATV incidents and incidents resulting in major trauma center admission. These injuries were identified in nearly 60% of the study population and were frequently classified as serious, severe, and critical among hospitalized patients. Helmet use was associated with a significantly lower rate of head, neck, and c-spine injuries (63 of 144, 44%, vs. 184 of 264, 70%; p 0.000). Patients with these injuries were more likely to require ICU admission (91 of 224, 40%, vs. 29 of 170, 17%; p 0.001), intubations (71 of 224, 32%, vs. 10 of 170, 6%; p 0.001), or a surgical procedure (115 of 246, 47%, vs. 66 of 170, 39%; p 0.02) and were less likely to be discharged home (136 of 224, 61%, vs. 120 of 170, 71%; p 0.04). Patients with these injuries were often discharged to a rehabilitation center after their stay at the major trauma center (35 of 224, 16%, vs. 7 of 170, 4%; p 0.000).

Injuries to the chest and T-spine occurred in nearly 60% of the study population (275 of 459). Although the chest and T-spine injuries were commonly categorized as serious and severe, they were not associated with an increased likelihood of ICU admission, intubation, or requiring further care on discharge. These patients were less likely to require an operating room procedure (95 of 246, 39%, vs. 86 of 149, 58%; p 0.000).

Mortality

Of the 79 patients who died, 43 died on scene (54%), 15 died at a major trauma center (19%), and 21 died at a peripheral rural hospital (27%). Case-fatality rates are provided in Table 3 outlining the relative risk (RR) of death for various incident factors. A significantly increased risk of mortality was observed in ATV incidents of rollover or ejection from the vehicle (RR, 2.75 [IQR, 1.13–6.70]; p 0.01, and RR, 4.18 [IQR, 1.7–10.32]; p 0.000, respectively). ATV incidents occurring at designated recreational areas and on streets or highways had a significantly increased RR of mortality (RR, 3.66 [IQR, 2.52–5.32]; p 0.000, and RR, 2.56 [IQR, 1.73–3.80]; p 0.000, respectively).

Factors representing rider behaviors also showed a significantly increased risk of mortality in ATV trauma. These factors included the consumption of alcohol with a RR of mortality of 2.33 (IQR, 1.52–3.56; p 0.000). An individual's choice not to wear a helmet was significantly linked to an increased risk of death (1.82 [IQR, 1.11–3.02]; p 0.008). Use of ATVs for work, despite being a smaller proportion of the injured population, also had a significantly increased risk for mortality at RR of 2.10 (IQR, 1.26–3.51; p 0.008).

Two injury classes were associated with significantly increased predictive risk of mortality. These were head injuries (2.19 [IQR, 1.35–3.54]; p 0.001) and face injuries (RR, 1.59 [IQR, 1.05–2.39]; p 0.03). A large number of crush injuries to the head and face were observed during the chart review of files from the ME.

Although not statistically significant, many additional factors may increase the risk of mortality. Injuries occurring at home had a RR of mortality of 1.97 (IQR, 0.77–5.09). The ME charts revealed that the majority of events at home occurred during the loading of an ATV for transport. The increased risk of mortality, although not statistically significant, emphasizes the importance of public safety training and protective measures not only during ATV operation but also in ATV storage and transport.

The ME chart review identified a common theme associated with a lack of knowledge and familiarity with the terrain chosen for travel on the ATV resulting in death. Many incidents were related to sudden unexpected falls off cliffs, down embankments, into rivers resulting in drowning, or collisions with stationary objects (e.g., trees, rocks, and fences). Because of the speculative nature of the observations contained in these charts, quantification for further analysis was not possible.

TABLE 2. Injuries Sustained in ATV Trauma Described by Body System

	Head and Neck Including C-Spine	Face	Chest Including T-Spine	Abdomen and Pelvic Content Including L-Spine	Upper and Lower Extremities	External
Total, n (%)	271 (59.04)	118 (25.71)	275 (59.91)	118 (25.71)	200 (43.57)	118 (29.9)
ME cases	46	20	21	8	17	*
MAIS severity code						
Minor		10	7	1	4	116
Moderate	57	51	24	56	103	2
Serious	60	33	98	30	73	
Severe	51	1	98	17	2	
Critical	56		19	6	1	
Maximum	1					

MAIS, Maximum Abbreviated Injury Scale.
* External injuries not reported for Office of the Chief ME cases.

TABLE 3. Case Fatality Rates and the Relative Risk of Mortality by ATV Event Descriptive Factors

Factor	Mortality With Factor, n (%)	Mortality Without Factor (%)	Relative Risk (95% CI)	p
Ejected	42/261 (16.1)	5/130 (3.8)	4.18 (1.70–10.32)	0.000*
Recreational area	27/57 (47.4)	52/402 (12.9)	3.66 (2.52–5.32)	0.000*
Rural	78/363 (21.5)	1/16 (6.3)	3.44 (0.51–23.17)	
Rollover	48/307 (15.6)	5/88 (5.7)	2.75 (1.13–6.70)	0.01*
Location street	28/81 (34.6)	51/378 (13.5)	2.56 (1.73–3.80)	0.000*
Penetrating injury	2/5 (40.0)	77/454 (17.0)	2.36 (0.79–7.03)	
Alcohol intake	48/132 (36.4)	25/160 (15.6)	2.33 (1.52–3.56)	0.000*
Head injury	60/271 (22.1)	19/188 (10.1)	2.19 (1.35–3.54)	0.001*
Work-related use	12/36 (33.3)	67/423 (15.8)	2.10 (1.26–3.51)	0.008*
Location home	3/9 (33.3)	76/450 (16.9)	1.97 (0.77–5.09)	
No helmet	57/264 (21.6)	17/144 (11.8)	1.82 (1.11–3.02)	0.01*
Face injury	28/118 (23.7)	51/341 (15.0)	1.59 (1.05–2.39)	0.03*
Location mine	1/4 (25.0)	78/455 (17.1)	1.46 (0.26–8.06)	
Winter (December–February)	8/35 (22.9)	71/424 (16.7)	1.36 (0.72–2.60)	
Spring (March–May)	24/112 (21.4)	55/347 (15.9)	1.35 (0.88–2.08)	
Male	71/401 (17.7)	8/58 (13.8)	1.28 (0.65–2.52)	
Location farm	8/39 (20.5)	71/420 (16.9)	1.21 (0.63–2.33)	
Age 30 yr	31/162 (19.1)	48/297 (16.2)	1.18 (0.79–1.78)	
Moving collision	4/26 (15.4)	49/369 (13.3)	1.16 (0.45–2.96)	
Weekend	43/206 (20.9)	36/174 (20.7)	1.01 (0.67–1.51)	
Summer (January–August)	31/187 (16.6)	48/272 (17.6)	0.94 (0.62–1.42)	
Autumn (September–November)	16/125 (12.8)	63/334 (18.9)	0.67 (0.41–1.13)	
Location industry	1/9 (11.1)	78/450 (17.3)	0.64 (0.10–4.11)	
Extremity injury	23/200 (11.5)	56/259 (21.6)	0.53 (0.34–0.83)	0.006*
Chest injury	34/275 (12.4)	45/184 (24.5)	0.51 (0.34–0.76)	0.001*
Recreational use	67/423 (15.8)	12/36 (33.3)	0.48 (0.28–0.79)	0.02*
Abdominal injury	8/118 (6.8)	71/341 (20.8)	0.33 (0.16–0.66)	0.000*
Blunt	71/448 (15.8)	8/11 (72.7)	0.22 (0.14–0.33)	0.000*
Stationary collision	1/61 (1.6)	52/334 (15.6)	0.11 (0.01–0.75)	0.002*

CI, confidence interval.
* Significant at 0.05 level.

Hospital Costs

The median cost per admission day for an ATV trauma patient was calculated as $1,460.50 per day in 2009 Canadian dollars[22] (median, $1,460.50; IQR, $1,177,98–$2,103 .05). Extrapolated to 4,117 trauma center admission days over 10 years in the province of Alberta, ATV trauma has cost the provincial healthcare system an estimated 6 million Canadian dollars in acute care costs ($6,012,878.50 in 2009 Canadian dollars). This translates to over $6.5 million US dollars ($6,510,143.55 in 2009 USD using an exchange rate of 1.0827 on June 1, 2009, obtained from the Bank of Canada).

DISCUSSION

ATVs are increasingly involved in major trauma in the province of Alberta. In our study, ATV mortality accounted for 17% of the population with severe injuries. Recently, Monk et al.[23] compared motorcycle trauma with motor-vehicle trauma in the province of Alberta and reported a 29% and 46% mortality rate, respectively. Expressed as a mortality rate per number of registered vehicles, motorcycles were deemed more dangerous with an 11-year mortality rate of 0.128% compared with motor vehicles at 0.038%. From the current ATV study, the 10-year mortality rate for ATVs adjusted to the number of registered vehicles is 0.029%. However, the yearly mortality rate adjusted for the number of registered vehicles surpassed that of motor vehicles in 2001 to a maximum of 0.058% in 2006 and continues to exceed that for motor vehicles.[24] Even though ATVs are increasing in popularity, the increase in mortality is out of proportion to the increase in registered ATVs.

The increasing mortality rate in ATV trauma is paralleled by increasing injury rates and corresponding hospital costs. During the 10-year period, we estimated that $6.5 million USD (in 2009 US dollars) was spent on ATV trauma for the acute trauma center stay alone. The estimated costs in this study do not include the cost of rehabilitation, extended peripheral hospital stay, repeat hospital admissions, total years of life lost, or cost of quality of life years lost. The figures underestimate the overall inhospital costs of ATV injury because patients with an ISS 12 and those younger than 18 years were excluded from the study. Helmkamp et al.[7] estimated that total hospital costs for ATV trauma in the United States from 2000 to 2004 alone exceeded $1.1 billion, 20% of these costs were paid by public funds. The difference

between the two studies is likely because of both the population size and the public provision and organization of healthcare in Canada. The current study has identified a substantial burden and impact of ATV trauma on the healthcare system associated with the need for increased access to acute care hospital beds, resource utilization across the system, and postdischarge support requirements resulting in high overall financial costs.

Common factors are associated with ATV injury and mortality. Previous studies have reported risk factors for ATV mortality including the population descriptors of male, younger than 25 years, and living in rural areas.[25] In the current study, the majority of ATV events occurred in rural areas and involved male drivers. However, the factors that increased mortality were consistent across genders and age categories and included use of an ATV on a highway or street, use in a recreational area, consumption of alcohol before or when operating or riding on an ATV, and not wearing appropriate protective equipment (i.e., helmets). These findings are consistent with Hall et al.[6] who reported ATV mortality associated with low rates of helmet use, high alcohol consumption at intoxicating levels, serious head injuries on street collisions, and chest and abdomen compression injuries in rural areas.

This study reports an increase in the incidence of ATV rollovers among the population older than 30 years. Anticipating that ATV drivers older than 30 years are more likely to be experienced drivers, the high incidence of rollover in this age category may suggest an inherent instability of the ATV contributing more to ATV trauma incidents rather than rider inexperience. It has also been previously suggested in the literature that increased ATV power and relaxed manufacturing regulations may contribute to ATV rollovers and subsequent injuries.[12] It is apparent that improvements in ATV safety require both public education campaigns and appropriate legislation and discussions with industry to improve ATV stability and safety. The consistency of unsafe behaviors across genders and age categories supports the importance of basic and wide-reaching public health campaigns and training. Messages should include the importance of safe ATV use including loading and transport, prevention of drinking and driving, promotion of helmet use, the cautious operation of ATVs on highways, streets, and busy recreational areas, and the danger of driving ATVs in unfamiliar terrain. The message is clear: ATV-related injuries and mortality are predictable, preventable, and costly.

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