



Injury severity in pediatric all-terrain vehicle-related trauma in Nova Scotia☆☆☆☆



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ABSTRACT

Background/Purpose: In 2004–2005, legislation restricting all-terrain vehicle (ATV) use by children and an extensive social marketing campaign intended to reduce pediatric ATV-related morbidity. The frequency, nature, and severity of pediatric ATV-associated trauma were compared before and after such interventions.

Methods: A retrospective cohort study was performed for all pediatric ATV-related injuries that presented to the provincial level 1 pediatric trauma center from 1998 to 2014. National databases were queried for ATV-related injury hospitalizations ($n = 258$), trauma center emergency department visits ($n = 342$), and admissions ($n = 136$) in Nova Scotia from 2002 to 2014. Admissions between 1998 and 2003 ($n = 68$) and 2006–2014 ($n = 60$) were compared using chi square analysis for age and gender distribution, length of stay, critical care admission, helmet use, mechanism, and severity of injury.

Results: Admissions, trauma center emergency room visits and admissions initially decreased following legislative and social marketing interventions and subsequently gradually increased. Interventions resulted in no significant difference in age or gender distribution, length of hospital stay, critical care admission, helmet use, and mechanism of injury. There was a significantly higher proportion of severe injuries post interventions. **Conclusions:** Legislation and social marketing interventions had a short-term decrease on the frequency of ATV-related injuries and no sustained effect on the frequency, nature, and severity of ATV-related injuries.

Level of evidence: Level IV

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Riding all-terrain vehicles (ATVs) have become increasingly popular as a recreational activity for both adults and children [1]. However, fatalities from off-road vehicles (ATVs and dirt bikes combined) more than doubled from 1990 to 2010 in Canada, begging the question of their safety as a recreational product [1].

In 2004, a report was published on the frequency, nature and severity of ATV-related injuries in children in Nova Scotia [2]. Since then, two key events in ATV safety occurred. The first was a provincial task force leading to new provincial legislation restricting the use of ATVs to individuals 14 years or older, with those aged 14–15 years allowed to operate an ATV only after the successful completion of safety training, and using an engine size recommended by the manufacturer for the age of participant [3]. Those younger than 14 would only be permitted to operate an ATV on a closed course under very strict conditions; since that time, however, this has since been revised to

allow these younger children to ride on private property with supervision using industry-recommended age-appropriate vehicles [4]. The resultant public reaction, both for and against these restrictions, resulted in such substantial media coverage and public debate, that it formed the second key event: a social marketing “campaign” that increased the awareness of the public of the safety concerns about ATV use by children.

We aimed to determine if these legislative changes and public awareness were associated with a decrease in numbers and frequency of ATV-related injuries in children, patterns of injury and/or safety behaviors, ATV popularity and use of health care resources. The secondary objective was to determine if this effect differed for youth ages 14 and up compared to younger children.

1. Methods

1.1. Study design

A retrospective cohort study was performed querying the Discharge Abstract Database (DAD) from the provincial government's Department of Health and Wellness and the National Ambulatory Care Reporting System (NACRS) from the Izaak Walton Killam (IWK) Health Centre for patients aged 0–16 in Nova Scotia with ATV-related injuries between 2002 and 2014. The DAD provides information on all patients

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hospitalized in the province of Nova Scotia. NACRS represents all patients seen in the emergency department (ED) of the IWK Health Centre, regardless of their admission status. The IWK Health Centre is the maritime's only level I pediatric trauma centre and treats minor injuries from the local population as well as major injuries from most of the maritime region. Injuries were identified through ICD-10 external cause of injury codes reflecting injuries secondary to occupying a special all-terrain or other off-road motor vehicle: V86.08, V86.18, V86.2, V86.38, V86.4, V86.58, V86.68, V86.7 and V86.98. These codes also include injuries secondary to dirt bikes operated in an off-road area and are recognized limitations of this administrative dataset [5]. In addition, a retrospective chart review of all patients aged 0–16 admitted to the IWK Health Centre with a diagnosis of an ATV-related injury between January 1998 and December 2014 was performed to provide more detail of the nature of these injuries. Finally, as a proxy measure of exposure to ATVs, ATV sales in the province were queried from the National Motorcycle, Scooter and All-Terrain Vehicle Annual Industry Report population [6] and population statistics were obtained through Statistics Canada [7].

1.2. Outcome variable collected

Outpatient data from the IWK NACRS database provided simple counts of patients seen in the ED with ATV-related injuries, the proportion admitted to hospital and the average age of patient per year between 2002 and 2014.

From the DAD, demographics recorded included age and gender, length of stay (LOS) in hospital and admission to a critical care unit.

From the IWK Health Centre chart review, demographics recorded included age, gender, and year of injury. Specific injury characteristics recorded included presence of a helmet (yes vs. no), mechanism of injury (roll over vs. other), injury severity score, LOS in hospital and admission to a critical care unit.

Injury Severity Score (ISS) was the measure of trauma severity for our study. It is defined by assigning each injury an Abbreviated Injury Scale score (AIS) (1990 version, Association for Advancement of Automotive Medicine) and is allocated to one of six body regions (head, face, chest, abdomen, extremities). The highest AIS for each body region is squared, and the top three severely injured body region scores are summed to produce the ISS score [8]. Total length of stay in hospital and admission to a critical care unit were employed as metrics of resource utilization. Rates of helmet use and rollover versus other mechanism of injury were examined for measures of behavioral change, using the latter to reflect ability to control and handle the heavy weight of the vehicle.

All metrics were compared between two time periods straddling the 2-year period of the task force, public debate and legislative change (2004–2005, inclusive): 1998–2003, inclusive versus 2006–2014. A subsequent subgroup analysis in patients aged <14 years versus 14–15 was performed as the legislation change created very tight restrictions for the younger age group which should have severely limited their access to ATVs.

1.3. Statistical analysis

Univariate analyses were used to determine associations between the variables collected and the outcomes of interest. Student's *t*-test was used to compare means of normally distributed variables and the Kruskal–Wallis test used to compare medians of variables with non-parametric distributions. Continuous variables were dichotomized at the level of the upper or lower quartile. Unadjusted odds ratios (OR) of associations were determined using chi-square or Fisher's exact test as appropriate. ORs, with 95% confidence intervals (CI) not spanning 1.0 and *p*-values <0.05 were ultimately considered statistically significant. All analyses were performed using SAS statistical software, version 8.2, Cary, NC, USA. This study was reviewed and approved by

the Research Ethics Board of the IWK Health Centre (unique identifier number 1002324) and external funding was employed.

2. Results

From 2002 to 2014, 258 pediatric patients with an off-road vehicle-related injury were admitted to a hospital in Nova Scotia, 136 of these were admitted to the IWK Health Centre with a definitive ATV-related injury, and 342 visited the pediatric trauma centre emergency department with a definitive ATV-related injury. As seen on Fig. 1, the time period following the social marketing and legislation change saw a decrease in trauma centre emergency room visits and admissions as well as provincial hospitalizations for ATV-related injury until 2008. This effect, however, was not sustained and a distinct upward trend is noticed for the years 2009–2014. Of particular note, these trends follow the same pattern as ATV sales in the province.

Table 1 displays the demographics and injury-related features of children admitted to our level I pediatric trauma centre obtained from the IWK Health Centre chart review. 128 cases were examined, 68 from the time period 1998–2003 and 60 from 2006 to 2014. Between the time periods straddling the period of legislative change and public debate (2004–2005), we observed no statistically significant difference in sex, percentage over 14 years old, length of stay, special unit hours or reported helmet use or proportion of rollovers. There was statistically higher proportion of severe injuries in the later time period.

Our subgroup analysis of patients younger than 14 versus 14 and older is shown in Table 2. As displayed the statistically significant increase in rollovers and severe injuries were observed in the older age group. The younger age group had a significant decrease in helmet use, however it should be noted that this metric was not uniformly recorded in the chart.

3. Discussion

Our ATV injury demographics, including average age and gender distribution are similar to previous literature [9–11]. Interestingly, our data show a subjective decrease in incidence of ATV-related injuries in the years immediately following the social marketing campaign and legislative change, associated with a decrease in ATV sales. This however is not sustained and rates of hospitalizations steadily climb thereafter. Our results echo the findings of Neiberg et al. who did not find a significant decrease in ATV-related traumatic injuries in children after similar legislative changes [12]. Similarly, Beidler et al. studied patterns of ATV-associated injuries 6 months pre- and post-legislation change. Although they found statistically significant reduction in injuries in patients younger than 8, the results did not reach significance for ages 8–15, helmet use patterns and head injuries [13].

These findings are contrasted with Helmkamp et al. which found significantly decrease death rates in ATV-related trauma in states with safety legislation [14]. Helmkamp et al. study differs significantly from ours however in that they explored adult data and deaths only, whereas our study was specific to the pediatric population. Furthermore, their study compared different populations within the same time period as opposed to the same population pre- and post-intervention. A follow-up study demonstrated a three-fold increase in ATV-related mortality comparing 1990–1998 vs. 2000–2007 in the US [15]. Although some regulations were introduced in between both time periods, these were not uniformly adopted across all states. Furthermore, ATV sales dramatically increased across both time periods.

Helmet use patterns did not change across our timelines. Keenan et al. compared states with and without mandatory helmet legislation and found increase helmet use in ATV users with associated legislation [16]. It should be noted however that the change in legislation did not affect the regulations of helmets when operating an ATV, which have always been mandatory in Nova Scotia. In the pediatric bicycling realm, helmet legislation has led to increased helmet use [17] and decreased injury and mortality [18,19].

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