

A Retrospective Evaluation of Pediatric Major Trauma Related to Sport and Recreational Activities in Nova Scotia

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ABSTRACT

Objectives: A small proportion of pediatric sport- and recreation-related injuries are serious enough to be considered “major trauma.” However, the immediate and long-term consequences in cases of pediatric major trauma are significant and potentially life-threatening. The objective of this study was to describe the incidence and outcomes of pediatric major traumas related to sport and recreational activities in Nova Scotia.

Methods: This study was a retrospective case series. Data on major pediatric traumas related to sport and recreational activities on a provincial scope were extracted from the Nova Scotia Trauma Program Registry between 2000 and 2013. We evaluated frequency, type, severity, and outcomes of major traumas. Outcomes assessed included length of hospital stay, admission to a special care unit (SCU), and mortality.

Results: Overall, 107 children aged three to 18 years sustained a major trauma (mean age 12.5 [SD 3.8]; 84% male). Most injuries were blunt traumas (97%). The greatest proportion were from cycling (59, 53%), followed by hockey (8, 7%), skateboarding (7, 7%) and skiing (7, 7%). The Nova Scotia Pediatric Trauma Team was activated in 27% of cases. Mean in-hospital length of stay was five days (SD 5.6), and nearly half (49%) of patients required SCU admission. Severe traumatic brain injury occurred in 52% of cases, and mortality in five cases.

Conclusions: Over a 13-year period, the highest incidence of pediatric major trauma related to sport and recreational activities was from cycling, followed by hockey. Severe traumatic brain injury occurred in over half of pediatric major trauma patients.

RÉSUMÉ

Objectif: Les blessures liées au sport et aux activités récréatives chez les enfants sont, dans une faible proportion, suffisamment sérieuses pour être considérées comme des « traumatismes graves ». Toutefois, les conséquences immédiates et lointaines de ces traumatismes graves chez les enfants sont importantes et potentiellement mortelles. L'étude visait à

faire état de la fréquence des traumatismes graves liés au sport et aux activités récréatives ainsi que des résultats cliniques chez les enfants en Nouvelle-Écosse.

Méthode: L'étude consistait en une série rétrospective de cas. Les données sur les traumatismes graves liés au sport et aux activités récréatives chez les enfants, à l'échelle provinciale, ont été tirées du Nova Scotia Trauma Program Registry, pour la période de 2000 à 2013. Ont été évalués la fréquence des traumatismes graves, de même que le type, la gravité et les résultats cliniques. Les résultats évalués comprenaient la durée du séjour à l'hôpital, l'admission dans un service de soins spécialisés (SSS) et la mortalité.

Résultats: Dans l'ensemble, 107 enfants, âgés de 3 à 18 ans, ont subi un traumatisme grave (âge moyen: 12,5 [écart type { σ }: 3,8] ans; garçons: 84 %). Dans la plupart des cas, il s'agissait de traumatisme contondant (97 %). Les accidents étaient attribuables, en ordre décroissant, au cyclisme (59; 53 %), au hockey (8; 7 %), à la planche à roulettes (7; 7 %) et au ski (7; 7 %). L'équipe Nova Scotia Pediatric Trauma Team a été mobilisée dans 27 % des cas. La durée moyenne du séjour à l'hôpital était de 5 jours (σ : 5,6) et presque la moitié (49 %) des patients ont dû être admis dans un SSS. Des lésions cérébrales traumatiques graves ont été observées dans 52 % des cas et l'accident s'est soldé par la mort dans 5 cas.

Conclusions: Sur une période de 13 ans, c'est le cyclisme qui s'est révélé la principale cause de traumatismes graves liés au sport et aux activités récréatives chez les enfants, suivi du hockey. Des lésions cérébrales traumatiques importantes ont été observées dans plus de la moitié des traumatismes graves chez les enfants.

Keywords: pediatrics, injuries, sports

INTRODUCTION

The majority of youth sport- and recreation-related injuries are relatively minor and do not require admission to hospital.¹ “Major trauma” in pediatrics is

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commonly defined using an Injury Severity Score (ISS) threshold between 12 to 15, and can result from a variety of injury mechanisms, including falls, being struck by another person, and motor vehicle collisions.^{2,3} Although major traumas account for a small proportion of all sport- and recreation-related injuries, serious immediate and long-term consequences are common.

Hockey has been recognized as a high-risk sport in youth.^{4,5} Injuries to the head are particularly concerning due to the risk of traumatic brain injury (TBI) and its potential long-term consequences. In an effort to reduce pediatric sports injuries, Nova Scotia (NS) recently moved to ban body checking at all levels of peewee hockey (ages 11–12). Previous studies using data from the Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP) have reported that hockey, cycling, and soccer are common causes of pediatric sports injuries seen in Canadian emergency departments (EDs).^{6–9} However, the data used for these studies are not representative of “major traumas,” since the CHIRPP database does not include patients who die before arrival at the ED or who bypass the ED and are directly admitted to hospital.

There is a lack of information available on the overall patterns of sport- and recreation-related major traumas in youth at the population level. The objective of this study was to use data from a provincial trauma registry to describe the overall patterns of pediatric major traumas related to sport and recreational activities that were seen in NS hospitals between 2000 and 2013. With a pediatric population (ages 0–18) of approximately 200,000 in NS, we hypothesized that hockey was the most common cause of sport- and recreation-related major trauma.

METHODS

This retrospective case series study was approved by the Capital Health Research Ethics Board. All patients aged ≤ 18 years that sustained a sport- or recreation-related major trauma between April 1, 2000, and March 31, 2013, were eligible. The Nova Scotia Trauma Program (NSTP) collects detailed information from multiple sources, including all trauma treatment centres in the province, and records it in the Nova Scotia Trauma Registry (NSTR).¹⁰ The NSTP definition for “major trauma” is any injury with an ISS > 12 and an appropriate International Classification of Disease (ICD) External Cause of Injury Code. Penetrating injury cases

with an ISS ≥ 9 are also included in the NSTR, as well as any Trauma Team Activations (TTAs) regardless of ISS. In addition, traumas with an appropriate injury mechanism that resulted in death either at the scene, in the ED, or within 24 hours of admission to a district trauma centre or tertiary trauma centre are included. Excluded are all injuries that do not meet the above criteria, medical errors, and discharges from the ED that were not a TTA.

Using predefined Sport & Recreation Codes developed by the Canadian Institute of Health Information (CIHI),¹¹ we identified all cases of pediatric sport- and recreation-related major trauma from the NSTR during the 13-year study period. Activities involving motorized vehicles (e.g., riding motorcycles, snowmobiles, all-terrain vehicles) are not included in the CIHI Sport & Recreation Codes, and were not considered for this study. Any duplicate records identified were removed. We collected demographic data, type of injury, use of protective equipment, Glasgow Coma Scale (GCS) score at the scene, ISS, Abbreviated Injury Scale (AIS)-90 Head score, ED assessment, admission to a special care unit (SCU), in-hospital length of stay (LOS), discharge disposition, and discharge status (alive or dead). Data on anatomical diagnosis were collected using ICD-9-CM codes prior to April 1, 2001, and using ICD-10-CA codes after April 1, 2001, when these were implemented by the NSTR. Patients with injuries for which no anatomical lesion was described by an ICD-9-CM or ICD-10-CA code were excluded.

The primary outcome of interest was frequency of pediatric sport- and recreation-related major traumas in NS during the study period. We evaluated secondary outcomes that reflected severity of major trauma, including admission to an SCU (Medical Intensive Care Nursing Unit [ICNU], Surgical ICNU, Trauma ICNU, Pediatric ICNU, Step-down Medical Unit, or Step-down Surgical Unit), overall LOS in-hospital, severe TBI (defined as AIS-90 Head score ≥ 3) and mortality.

The following definitions were used for this study, as defined by the NSTR. Type of injury was defined as blunt, penetrating, or drowning/asphyxia. ED assessment included: a) direct admission—bypassed ED and admitted directly to nursing unit or intensive care unit; b) specialty consult—seen by specialist staff member in ED; or c) Pediatric TTA—seen by pediatric trauma team leader, resident pediatric trauma team leader, and multiple specialties/staff. Discharge disposition

included discharge to an acute care facility or rehabilitation facility, or discharge home with/without support services. Seasons were defined as autumn (September 21–December 20), winter (December 21–March 20), spring (March 21–June 20), and summer (June 21–September 20). We defined sport and recreational activities as any activity identifiable in the NSTR using a CIHI Sport & Recreation Code.¹¹

The sample size for this study was dependent on the number of cases of sport- and recreation-related major trauma seen in NS hospitals and captured in the NSTR during the study period. We used descriptive statistics, including proportions, means, and standard deviations. We calculated age-specific rates of major trauma per 100,000 population using estimates of the pediatric population in NS from Statistics Canada.¹² In keeping with the NS Department of Health & Wellness privacy policy, any counts between 1 and 4 are reported as “n < 5.” All analyses were performed using IBM SPSS Statistics (Version 21)¹³ at a confidence level of 95%.

RESULTS

During the 13-year study period, there were 1,177 pediatric major traumas in NS, of which 107 (9%) occurred during a sport or recreational activity (Table 1). The vast majority of injuries were blunt traumas (97%), and most patients were male (90/107, 84%). The majority of traumas occurred during the summer season (41/107, 38%) (Figure 1). In most cases, patients were seen by a specialist staff member in the ED (62/107, 58%). The NS Pediatric Trauma Team was activated in 27% of cases (29/107). Of patients with a GCS score recorded at the scene (58/107, 54%), the mean GCS score was 12.1 (SD 4.1). The overall severity of injuries, as measured by mean ISS, was 17.2 (SD 9.1). Over half of pediatric patients (56/107, 52%) sustained a severe TBI (AIS-90 Head score ≥ 3) and nearly half (52/107, 49%) required admission to an SCU.

Table 2 shows the age-specific rate of major trauma related to sport and recreational activities per 100,000 pediatric population in NS. Males aged 11–14 years had the highest injury rate (11.9), more than eight times greater than the rate for females in the same age group (1.4). The next highest injury rate was in males aged 15–18 years (9.8), which was more than six times greater than the rate for females in the same age group (1.6). Overall, the rate of pediatric major trauma seen in males

Table 1. Demographics and characteristics of pediatric major trauma related to sport and recreation activities

	Major trauma (N = 107)
Age—mean (SD)	12.5 (3.8)
Gender—males, n (%)	90 (84)
Season of injury – n (%)	
Summer (21 Jun – Sep 20)	41 (38)
Spring (21 Mar – 20 Jun)	34 (32)
Winter (21 Dec – 20 Mar)	22 (21)
Autumn (21 Sep – 20 Dec)	10 (9)
Type of injury – n (%)	
Blunt	104 (97)
Penetrating	<5
Drowning/asphyxia	<5
Scene GCS – mean (SD)	12.1 (4.1)
ISS – mean (SD)	17.2 (9.1)
Severe TBI – n (%)	56 (52)
ED assessment – n (%)	
Specialty consult ^a	62 (58)
Pediatric Trauma Team ^b	29 (27)
Direct admission ^c	12 (11)
Emergency staff ^d	<5
Discharge disposition – n (%)	
Home ^e	92 (86)
Acute care/Rehab ^f	8 (8)
Admission to SCU – n (%)	52 (49)
In-hospital LOS – mean days (SD)	5.0 (5.6)
Mortality – n (%)	5 (5)

GCS = Glasgow Coma Scale; ISS = Injury Severity Score; Severe TBI = severe traumatic brain injury, defined as having an Abbreviated Injury Scale 90 Head score ≥ 3 ; SCU = Special care unit (Medical ICNU, Surgical ICNU, Trauma ICNU, Pediatric ICNU, Step-down medical unit, Step-down surgical unit); LOS = length of stay.

^aPatient seen by a specialist staff member in ED (includes patients seen by emergency physicians who are emergency medicine specialists).

^bPediatric Trauma Team includes pediatric trauma team leader, resident pediatric trauma team leader, and multiple specialties and staff members activated together if one or more criteria for Trauma Team Activation are met.

^cPatient bypassed ED and admitted directly to nursing unit or intensive care unit.

^dPatient seen by ED staff.

^ePatient was discharged home with support services in n < 5 cases.

^fPatient discharged to acute care facility or rehabilitation facility.

(7.8) was more than five times greater than the rate in females (1.5). Major trauma in females only occurred during cycling (n = 11), swimming (n < 5), golf (n < 5), skiing (n < 5), and snowboarding (n < 5).

The severity of pediatric major traumas by type of sport or recreational activity is shown in Table 3. Most major traumas occurred during cycling (59/107, 55%), followed by hockey (9/107, 8%). The severity of trauma as measured by ISS was greatest in skateboarding (mean ISS 26.0, SD 14.1). The NS Pediatric Trauma Team was activated most often for traumas related to cycling (22/107, 21% of total; 22/59, 37% of cycling). Most of the injuries from cycling were blunt traumas

(58/59, 98%). Nearly half (28/59, 47%) of cycling-related traumas occurred while in traffic, of which 17 cases (17/59, 29%) involved collision with a vehicle. The remaining cycling-related traumas (31/59, 53%)

were non-traffic. Just over one-third (21/59, 36%) of cyclists were wearing a helmet at time of injury. Figure 2 shows the age of injured cyclists compared with patients injured during all other activities.

Patient outcomes by type of activity are shown in Table 4. Cycling-related trauma accounted for the greatest number of SCU admissions (24/107, 22% of total; 24/59, 41% of cycling) followed by hockey (6/107, 6% of total; 6/9, 67% of hockey). The longest in-hospital stays were from injuries related to diving (mean LOS 11.5 days, SD 14.8). The greatest number of severe TBIs were from cycling (32/107, 30% of total; 32/59, 54% of cycling traumas); helmets were not worn at time of injury in 72% (23/32) of cycling-related TBI cases. The five deaths that occurred during the study period resulted from cycling, skateboarding, and swimming.

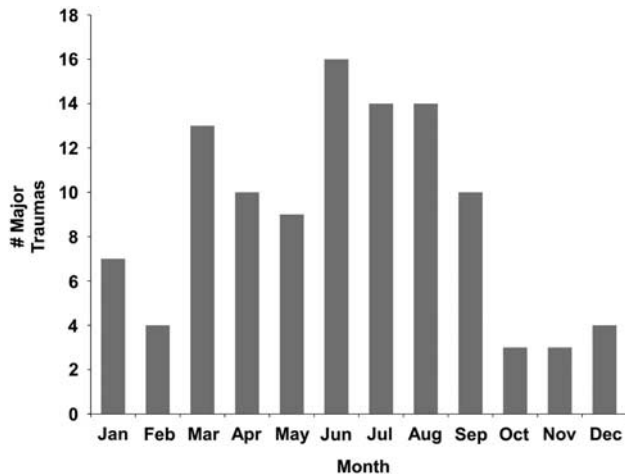


Figure 1. Distribution of pediatric sport and recreation-related major trauma by month of injury.

Age (Years)	Total	Male	Female
3–6	2.5	3.6	1.3
7–10	3.4	4.7	1.9
11–14	6.7	11.9	1.4
15–18	5.8	9.8	1.6
All Ages (3–18)	4.7	7.8	1.5

DISCUSSION

The results of our study demonstrate that cycling is the most common cause of pediatric sport- and recreation-related major trauma in NS, followed by hockey. Cycling was responsible for the most cases of severe TBI, while skateboarding was associated with the greatest injury severity as measured by ISS. These findings demonstrate that sport- and recreation-related major trauma, though less frequent than minor trauma in the pediatric population, results in significant morbidity and mortality that has not been thoroughly reported in the literature.

Sport (N = 107)	n (%)	Male (% of n)	Mean Age (SD)	Mean GCS (SD)	Mean ISS (SD)	Protective Device Worn % of n
Cycling	59 (55)	81	11.7 (3.6)	12.9 (3.5)	16.2 (10.1)	36
Hockey	9 (8)	100	14.4 (2.7)	10 (7.1)	18.3 (6.9)	100
Skateboarding	7 (7)	100	13 (4.2)	9.5 (5.5)	26.0 (14.1)	43
Skiing	7 (7)	86	14.9 (3.2)	12.3 (3.7)	15.6 (6.7)	57
Swimming	5 (5)	40	11.4 (5.9)	8.7 (6.7)	19.3 (4.9)	n/a
Football	<5	100	10.5 (4.9)	N/A	20.5 (6.4)	50
Golf	<5	75	9.2 (4.0)	N/A	16.75 (0.9)	n/a
Snowboarding	<5	75	14.7 (1.3)	12.3 (3.7)	15.6 (6.7)	50
Diving	<5	100	15 (4.2)	15 (0)	8.5 (10.6)	n/a
Ski-jumping	<5	100	17 (1.4)	13 (0)	16 (0)	50
Baseball	<5	100	12.2 (3.3)	11.5 (2.1)	16.2 (0.5)	0
Boxing	<5	100	15 (0)	N/A	16 (0)	100
Soccer	<5	100	17 (0)	N/A	13 (0)	n/a

SD = standard deviation; GCS = Glasgow Coma Scale score at the scene; ISS = Injury Severity Score; N/A = not available; n/a = not applicable.

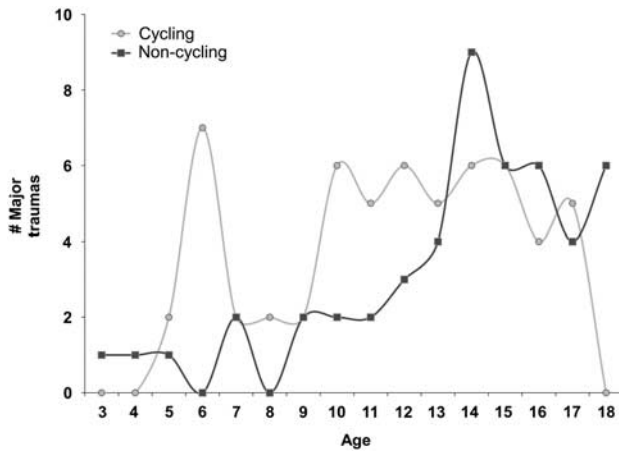


Figure 2. Age of pediatric major trauma patients injured while cycling or during all other activities.

Table 4. Outcomes of pediatric sport- and recreation-related major trauma

Sport (N = 107)	SCU Admissions % of n	Mean days in-hospital (SD)	Severe TBI % of n	Mortality
Cycling (n = 59)	41	4.3 (4.3)	54	<5
Hockey (n = 9)	67	4.0 (2.2)	33	0
Skateboarding (n = 7)	43	10.7 (13.6)	43	<5
Skiing (n = 7)	71	7.7 (8.1)	43	0
Swimming (n = 5)	80	4 (1.6)	40	<5
Football (n <5)	100	7 (0)	0	0
Golf (n <5)	25	2.7 (2.4)	100	0
Snowboarding (n <5)	75	4.7 (3.6)	50	0
Diving (n <5)	50	11.5 (14.8)	0	0
Ski-jumping (n <5)	100	3 (0)	50	0
Baseball (n <5)	25	4.2 (2.4)	100	0
Boxing (n <5)	0	1 (0)	100	0
Soccer (n <5)	0	1 (0)	100	0

SCU = Special care unit (Medical ICNU, Surgical ICNU, Trauma ICNU, Pediatric ICNU, Step-down medical unit, Step-down surgical unit); SD = standard deviation; Severe TBI = severe traumatic brain injury, defined as having an AIS-90 Head score ≥ 3 .

Comparing the results of the present study with previous sports injury research is problematic due to variability in study designs, populations, and methods by which injuries are defined and measured. While most previous reports of pediatric sport-related major trauma focus on a single sport,¹⁴⁻¹⁹ our study examined overall patterns of major trauma related to sport and recreational activities using a provincial trauma registry. Similar to previous reports, our study found sport- and recreation-related pediatric major trauma to be relatively infrequent in NS, with only 107 cases over a

13-year period (9% of all pediatric major traumas), and most traumas in males aged 11-14 years. A previous report from the United States found serious sport injuries in pediatrics accounted for 13% of trauma admissions over a 2-year period, with most injuries sustained playing baseball and football.²⁰ A prior Canadian analysis of severe pediatric trauma in Ontario determined that sports were responsible for 5% of trauma cases admitted to hospital over a four-year period.²¹ Unlike this prior study from Ontario, we examined injury severity and patient outcomes by type of activity, and we included cycling as a sport/recreational activity, since it has a corresponding CIHI Sport & Recreation Code in the NSTR. Our results agree with Canadian data from CIHI, showing that cycling injuries are the most common injury from summer sport and recreational activity, with males aged 10-14 years hospitalized most frequently.²² Despite evidence that use of bicycle helmets is highly effective at preventing head injury,²³ our results show that even when helmets are worn (9/32, 28%), the risk of sustaining a severe TBI remains.

The main strength of this study is that data were collected from a dedicated population-based registry that captures all major traumas in NS. However, in some cases information was unknown or incomplete. Furthermore, we are limited by the small size of the population under investigation. Another limitation of this study is that participation data for each activity were unavailable; hence we could not calculate rates of sport- and recreation-related major trauma. It is possible that participation in more popular sports, like hockey, may be one or two orders of magnitude greater than in sports such as golf or diving, and thus the absolute rates of major trauma presented here would suggest hockey is less dangerous than other activities with lower participation rates.

The results of this study are generalizable in the sense that the data were collected from a population-based trauma registry based on standardized ICD and CIHI coding, with major trauma and TTA defined a priori. However, variability exists by location with respect to the rules and regulations governing sport and recreational activities, rates of participation, environmental factors, health systems, and the timeliness with which major injuries are recognized and treated. While awareness is increasing among physicians and the public regarding the importance of protective devices, our study demonstrates that even with use (100% helmet use in hockey-related trauma, 36% in cycling-related trauma), it is still possible to sustain major traumatic

injury, including severe TBI. Further investigation and refinement of public policy is warranted to improve pediatric safety in sport and recreational activities.

CONCLUSION

Pediatric major trauma related to sport and recreational activity is relatively infrequent in Nova Scotia, with 107 cases recorded over a 13-year period, accounting for 9% of all pediatric major traumas during this time. Most major traumas resulted from cycling, followed by hockey. Severe TBI occurred in over half of all pediatric major trauma patients, including a third of hockey-related major traumas, despite 100% reported helmet use.

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