Canadian Institute for Health Information
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Analysis in Brief
Taking health information further

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Head Injuries in Canada: A Decade of Change (1994–1995 to 2003–2004)

1. Introduction

Traumatic injuries are a substantial health problem that can have serious implications, with the potential of resulting in long-term disability or death. In fiscal 2003–2004 (April 1, 2003 to March 31, 2004), there were 194,771 hospitalizations due to trauma in Canada. These hospitalizations accounted for 1,918,860 days in hospital in 2003–2004. In 2003–2004 there were 6,857 injury cases that died in hospital, representing 4% of all injury hospitalizations for that year.

Traumatic head injury is often a devastating diagnosis with considerable public health implications, as well as serious personal and caregiver implications. Canadian researchers have begun to make strides in describing the population with traumatic head injuries,[1, 2] but to date, there has been little in the way of a national picture to help to inform understanding of the mechanisms by which traumatic head injuries are sustained as well as the populations most at risk. There were 16,811 hospitalizations as a result of traumatic head injuries in 2003–2004.

This Analysis in Brief provides a description of the changing profile of head injury in Canada over the ten years between 1994–1995 and 2003–2004. It focuses on cycling as a cause of traumatic injury admission in Canada and provides a contextual framework for the other leading causes of head injury admission.

1.1 Head Injury Background

Traumatic head injury is an important cause of morbidity and mortality, especially in children/youth and the elderly.[3,4] Clinical evidence shows that the sequellae of a moderate to severe head injury can significantly impair multiple areas of physical, cognitive, emotional, and social functioning. Even mild traumatic head injuries present significant health problems that can result in disability for people because of the development of post injury syndromes or symptoms associated with a head injury diagnosis.[5, 6] All degrees of severity of traumatic brain injury have important public health implications.

2. Methods

The data sources for this study were the National Trauma Registry Minimal Data Set (NTR MDS) and National Trauma Registry Comprehensive Data Set (NTR CDS) and the National Ambulatory Care Reporting System (NACRS). NTR MDS captures information on all acute care injury hospitalizations in Canada. NTR CDS includes major trauma cases with injury severity score (ISS) >12.

The causes of head injury were identified using External Cause of Injury Codes, and head injuries were identified via appropriate diagnosis codes. A list of the External Cause of Injury Codes that are included and excluded in the definition of trauma is provided in the Appendix A. Definitions of causes and head injuries are listed in the Appendix B and C, respectively. Provincial differences within each year were compared using age standardization. Time trend age differences were analyzed using relative risk.

Population rates were calculated utilizing Statistics Canada Canadian Socio Economic Information Management System (CANSIM I).[7]

3. Profile of Head Injury Hospitalizations in 2003–2004

There were 16,811 hospital admissions for traumatic head injury in 2003–2004, representing 9% of all trauma admissions for this year. These admission numbers equate to 46 admissions every day in Canada for a traumatic head injury. Of these, 91% were diagnosed with a traumatic brain injury, usually the most severe form of the injury.

When examined by age group, the age category representing children and youth (0–19) was the most highly represented in the admissions (30%), followed by the elderly, defined here as those aged 60 and older (29%). It is important to note that the number of traumatic head injury admissions in the elderly is disproportionately high when one considers that this age group represents only 12% of the Canadian population overall, yet represent 29% of traumatic head injury admissions.

There were 1,368 head injury related deaths, which represents 8% of the traumatic head injury admissions, twice as high as the 4% death rate for all traumatic injury hospitalizations in Canada for 2003–2004. Deaths in hospital[i] following traumatic head injury represented 20% of all trauma deaths in this year. The number of deaths varied significantly between age groups, the majority of which occurred in the elderly (59%).

The following table gives an overview of the head injury admission population in Canada for 2003–2004.

i In-hospital deaths do not include deaths occurring before admission to hospital, such as those occurring at the scene or upon immediate arrival at the hospital

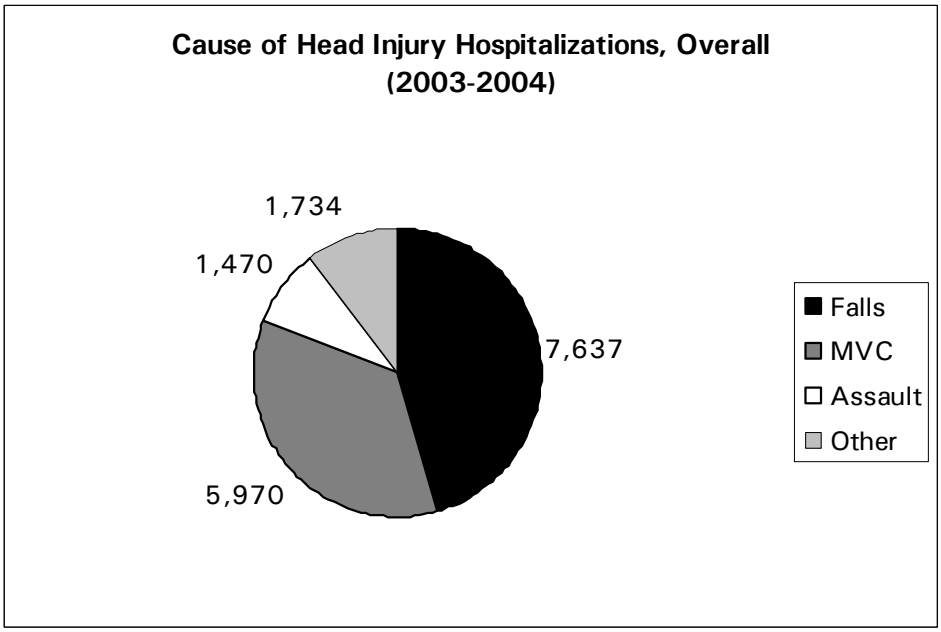
Table 1. Head Injury Admissions, by Age Group in Canada, 2003–2004

	0–19 years	20–39 years	40–59 years	60+ years	Overall
Number admitted	4,966	3,637	3,306	4,902	**16,811**
Male	3,318 (67%)	2,870 (79%)	2,403 (73%)	2,772 (57%)	**11,363 (68%)**
Average age (years)	10	29	49	76	**41**
Average LOS in hospital (days)	5	11	13	15	**11**
Deaths in hospital	120 (9%)*	217 (16%)	222 (16%)	809 (59%)	**1,368**

4. Causes of Head Injury

The overall leading causes of traumatic injury for all ages are falls, motor vehicle collisions, and intentional injury (assault). However, it is important to understand that the leading causes of traumatic injury requiring hospitalization differ by age group.

Figure 1. Cause of Head Injury Hospitalizations, NTR MDS, 2003–2004



* Percent of in hospital deaths (total = 1,368) due to traumatic head injury.

In 2003–2004 for children and youth the leading cause of traumatic head injury was related to injuries sustained in falls (n = 1,973, 40%), followed very closely by motor vehicle incidents (n = 1,955, 39%). Traumatic head injuries were sustained during sports and recreational activities in 28% of children and youth who were admitted to Canadian hospitals for traumatic injuries.

During the 2003–2004 year for the adult group aged 20 to 39 years the leading cause of head injury admission was found to be motor vehicle incidents (n = 1,867, 51%) followed by injury intentionally inflicted on another person (assault and homicide) (n = 722, 20%).

For Canadians aged 40 to 59 years in 2003-2004, the leading cause of traumatic head injury was as a result of motor vehicles (n = 1,308, 40%), followed closely by falls (n = 1,290, 39%).

For older Canadians (60+ years) the picture was quite different regarding cause of injury. Falls were the leading cause of injury (n = 3,732), which represented 49% of all fall related head injury admissions in this year. Of all head injury admissions in the elderly (n = 4,902), 76% were related to falls. The second leading cause of traumatic head injury in this age group was motor vehicle related, with 840 admissions (17%).

4.1 Falls

Falls are one of the leading causes of injury hospitalizations in Canada, and across the globe. In 2003–2004 they were the leading cause (overall), followed by injuries related to motor vehicles, of trauma hospitalizations for all ages (n = 7,637). Fall related causes accounted for 45% of the traumatic head injury admissions in Canada.

Falls are a prominent cause of head injury hospitalizations, representing the leading cause for all ages combined. For children and youth (n = 1,973) as well as those aged 60and older (n = 3,732), falls were the leading cause of head injury admission in 2003–2004. For those aged 20 to 39, falls represented the third leading cause of head injury admission (n = 642), and for those aged 40 to 59 years they were the second leading cause (n = 1,290).

The elderly are particularly vulnerable to falls in general and in 2003–2004 those 60 years of age and older experienced a fall related injury rate more than four times greater than those less than 60 years of age. For Canadian seniors in 2003–2004, 82% of all injury related hospitalizations are the result of falls. The anticipated growth among this age group in Canada[8] combined with the fact that medical improvements means that people are living longer with chronic conditions, may result in an increase in the fall related hospitalization rate for the elderly.

4.2 Motor Vehicles

Injuries sustained in motor vehicle related incidents are one of the leading causes of traumatic head injury overall and in 2003–2004 accounted for 5,970 admissions (36%). This represents 23% of all motor vehicle related traumatic injury admissions for this year (n = 25,952). The profile of motor vehicle incidents, as a cause of traumatic head injury in 2003–2004, varies considerably by age group.

Children and youth represent the highest proportion of head trauma related to motor vehicles, with 1,955 (33%) admissions. The 20 to 39 year old group followed closely with 1,867 (31%) cases of traumatic head injury admissions related to motor vehicle incidents, representing the leading cause of head injury in this age group. As a proportion of motor vehicle related head trauma, the two age groups at the upper end of the age continuum are represented to a smaller extent. For those 40 to 59 years of age, motor vehicles were the cause of 1,308 admissions for head injury (22%), representing the leading cause of head injury admission in this age group. Canadians aged 60 and older represent the smallest group in the head injury admissions related to motor vehicles with 840 admissions (14%).

4.3 Injury Inflicted by Another Person

Intentional injuries accounted for 1,470 traumatic head injuries that required hospitalization in Canada during 2003–2004. The largest percentage of these injuries (49%) occurred in the 20 to 39 year age group (n = 722), followed by the 40 to 59 year age group (n = 366, 25%), and there were 324 traumatic head injury admissions related to assault/homicide in the 0 to 19 year age group (22%). Canadians aged 60 years and older comprised a small proportion of these injury admissions with 58 admissions (4%).

For those aged 20 to 39 years of age, intentional injuries were the second leading cause of traumatic head injury admission.

4.4 Sports and Recreation

It is not surprising that, children and youth are highly represented in the sports and recreation category as a cause for head injury. Sports and recreational activities were the third leading cause of traumatic head injury admissions in Canada in 2003–2004. While 28% of head injuries in children and youth requiring admission to hospital are related to sporting and recreational activities, only 8% of head injuries sustained by adults (requiring admission to hospital) are incurred during recreational activities. Within this category, team based sports, causing concussion injuries, are an important cause of traumatic head injury especially in the youth (12 to 19 years) age group.[9,10]

Cycling is an important cause of head injury, often severe. The data analyzed over the 10-year span between 1994–1995 and 2003–2004 reveals several changes in the realm of head injury related to cycling, specifically with children and youth.

4.4.1 Cycling-Related Head Injuries

During the last decade (1994–1995 to 2003–2004) there were 44,577 hospitalizations due to cycling incidents in Canada. This represents 2% of all hospitalized injuries in Canada during this time period. Of these, 10,568 were hospitalizations due to head injuries (24%). Two thirds (n = 7,036, 67%) occurred among children and youth aged 5 to 24 years of age. Males were hospitalized more than three times more often than females (n = 8,065, 76% vs n = 2,503, 24%).

Head injuries are among the most severe injuries sustained by cyclists. Of the 4,605 cycling related hospitalizations across Canada in the year of study (2003–2004), 815 (18%) were due to head injuries. For those seen in Ontario Emergency Departments a much smaller proportion of cycling injuries (3%; n = 627) were due to head injuries in 2003–2004.[11] In 2003–2004 males comprised the majority of cycling hospitalizations (all injuries) (n = 3,524, 77%) with 1,081 (23%) of cycling related hospitalizations occurring in females.

There was a substantial difference between males and females in terms of the frequency with which they sustained a head injury requiring hospitalization with a higher proportion of male head injuries (79%, n = 646) as compared to female (21%, n = 169) (Table 2).

Table 2. Characteristics of Head Injuries Due to Cycling, by Sex, 2003–2004

	Male	Female	Total
Number of Head Injuries Due to Cycling (%)	646 (79)	169 (21)	**815**
Age (years)			
Mean (Std.Dev)	24.5 (18.8)	24.9 (20.2)	**24.6 (19.1)**
Median	16	14	**16**
LOS (days)			
Mean (Std.Dev)	6.7 (22.1)	7.4 (19.7)	**6.9 (21.6)**
Median	2	2	**2**
Discharge disposition (% of total discharged alive)*			
Discharged home	524(83)	137 (83)	**661 (83)**
Transferred to another facility providing inpatient hospital care	51 (8)	16 (10)	**67 (8)**
Discharged home with support services	24 (4)	8 (5)	**32 (4)**
Transferred to a long term care facility	***	***	**5 (1)**
All other	***	***	**31 (4)**
In-hospital deaths (%)	***	***	**19 (2.3)**

Notes:

* The denominator is the total number of hospitalizations within each gender discharged alive.

** Hospitalizations in the trauma database do not necessarily represent unique persons since a person can be admitted to hospital more than once within a fiscal year.

*** Cells with size of less than 5 are suppressed for privacy reasons

Between 1994–1995 and 2003–2004, 61% of cycling related traumatic head injuries occurred among those between the ages of 5 to19 years.

In the 10 years between 1994–1995 and 2003–2004, though the average age of those sustaining head injuries requiring hospitalization was 22 years, when examined by age group, nearly two thirds (61%, n = 6,481) of the injuries occurred among those aged 5 to 19 years (Fig. 2). Of the cases in this age group, 80% (n = 5,177) were between the ages of 5 and 14 years.

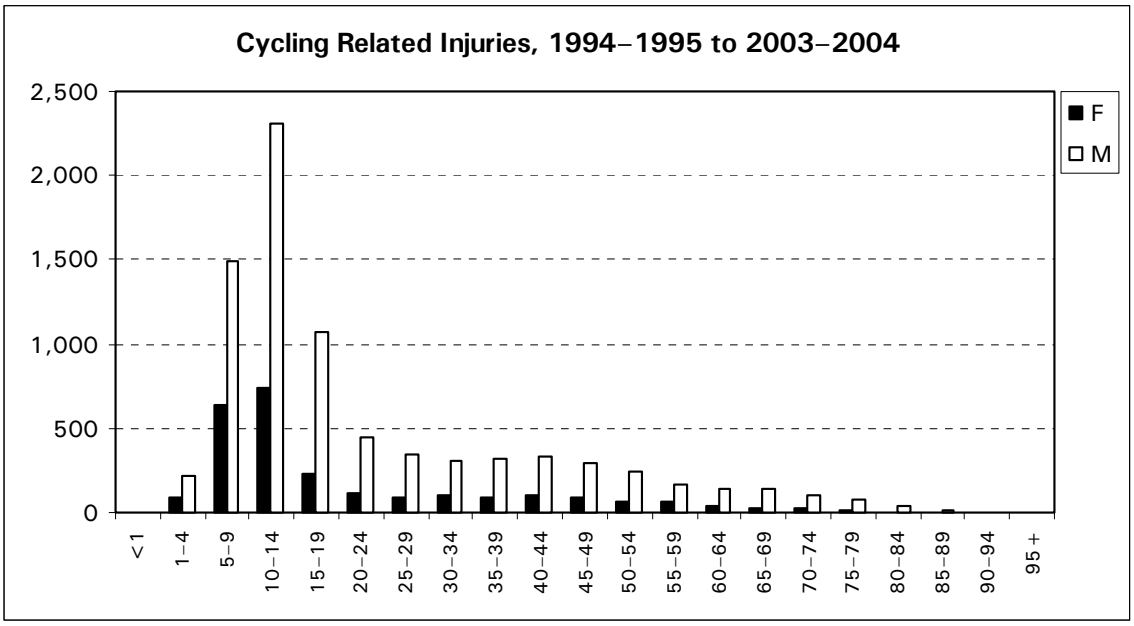


Figure 2. Cycling Related Head Injuries by 5 Year Age Groups, NTR MDS, 1994–1995 to 2003–2004

Figure 3 shows that when analyzed by age categories, and using those greater than 35 years as the reference, the highest risk ratio of injury hospitalizations appeared in those aged 10 to 14 years (RR = 9.8) ($p < 0.00$).

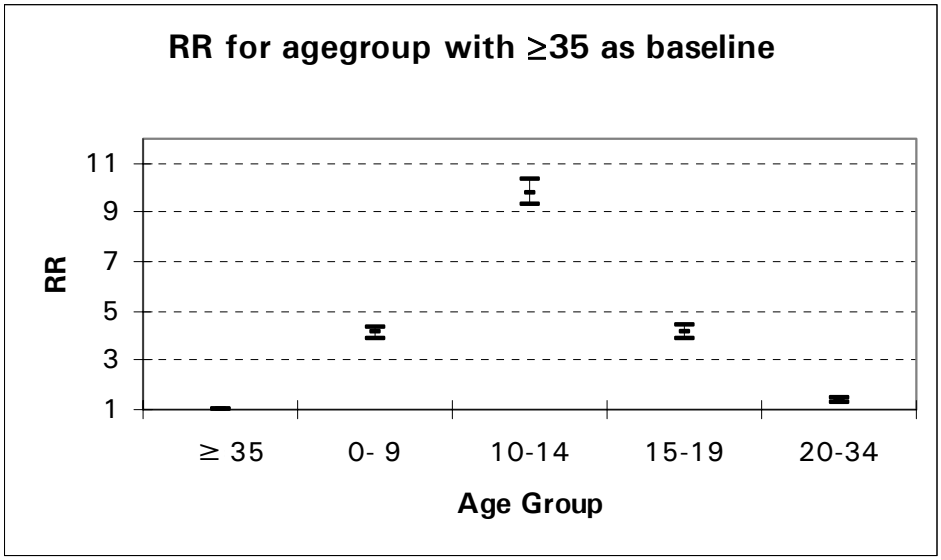


Figure 3. Relative Risks for Head Injuries Due to Cycling, by Age Group, Canada

Injury rates varied significantly between provinces with British Columbia having the highest cycling related head injury ratio (RR = 1.9, $p < 0.05$) and Nova Scotia the lowest (RR = 0.5, $p < 0.05$), when compared to Ontario. This variance could be related to various factors including a variation in cycling activity levels, cycling "environment", weather, attitudes toward helmet use[12] and helmet legislation.

5. Trend Analysis

The ability to examine the head injury admissions over the past decade has elucidated some noteworthy changes in the pattern of traumatic head injury in Canada. Overall, since 1994 there has been a 35% decrease in traumatic head injury admissions (n = 25,665 in 1994–1995 and 16,811 in 2003–2004). The magnitude and direction of the change differs between age groups, causes of injury, severity of injury and outcomes.

5.1 Trend Analysis Overview (1994–1995 to 2003–2004): Age

There has been an encouraging decrease in the rate of head injury admission in all age groups. When calculating rates of injury, the changes in population size are taken into consideration. Rates are calculated per 100,000 for this report (Table 3). The trend in hospitalization by age group shows important and positive differences since 1994–1995, with decreases in rate ranging from 15% in those 60 years and over (from 105.4 per 100,000 to 90.1 per 100,000), to the largest decrease of 53% (from 132.9 per 100,000 to 62.5 per 100,000) in those under 20 years.

Those in the 0 to 19 year age group have experienced the largest decrease (53%) in the number of traumatic head injury admissions, representing a significant reduction in 10 years (10,589 in 1994–1995 to 4,966 in 2003–2004). The Canadian population in this age group has remained stable over the period of study, decreasing by less than 1% over the decade under study. For people in this age group the number of head injury hospitalization deaths decreased 34% from 182 in 1994–1995 to 120 in 2003–2004.

For the adult groups (20 to 59 years), the changes are quite pronounced as well. For the 20 to 39 year group, for traumatic head injury admissions there is a decrease over time of 45%, which while not as marked a decrease as seen in the children and youth group, is important nonetheless. During the decade of study, the Canadian population in this age group decreased by 5%. During the ten years of study, 20 to 39 year olds saw a 14% decrease in deaths after admission to hospital for a traumatic head injury from 251 in 1994–1995 to 217 in 2003–2004.

For those in 40 to 59 age group there have been some fluctuations, both increasing and decreasing, throughout the decade, with a 9% decrease in traumatic head injury admissions overall. One of the factors to be considered in the evaluation of this more modest decrease, as compared to the younger age groups is that the Canadian population in this age group has increased by 32% over the ten years of study. For this group, between 1994–1995 and 2003–2004 the number of deaths related to traumatic head injury increased from 193 to 222, representing a change of 15%.

At the upper end of the age spectrum, those 60 years of age and over are the only age group to see an increase (4%) in the incidence of admissions due to traumatic head injury (n = 4,882 in 1994–1995 and 4,902 in 2003–2004). However, this segment of the Canadian population (60 years and older) increased by 17% over the decade of study. When the increase in population size is factored into the analysis, the rate of injury (per 100,000 population) in this age group is actually decreasing over the time period of study (Table 3). This age group accounts for the largest number of deaths due to traumatic head injuries in all the years of study, which has seen a significant increase of 35% from 601 in 1994–1995 to 809 in 2003–2004.

The differences over time as analyzed by age are presented in the following figure and table.

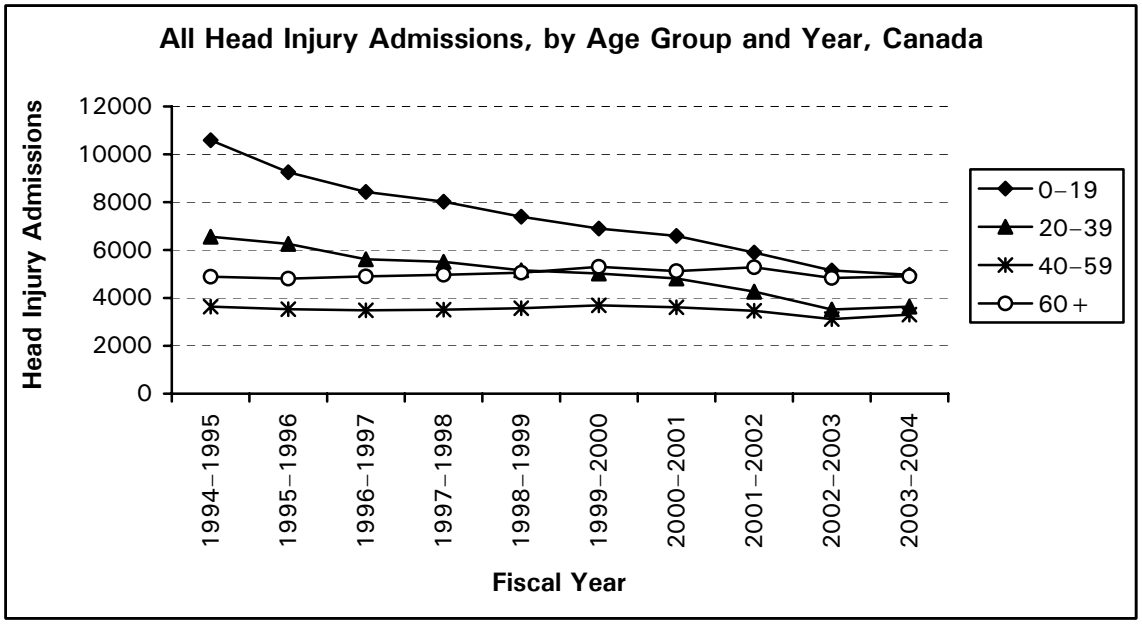


Figure 4. All Head Injury Admissions by Age Group and Year, NTR MDS, 1994–1995 to 2003–2004

Table 3. Head Injury Rates (Crude, per 100,000 population) by Age Group in Canada, 1994–1995 to 2003–2004

Year	Age			
	0–19	20–39	40–59	60+
1994–1995	132.9	68.9	51.7	105.4
1995–1996	115.6	66.0	48.5	102.2
1996–1997	104.8	59.5	46.3	102.6
1997–1998	99.6	58.6	45.1	102.4
1998–1999	91.9	55.3	44.4	102.6
1999–2000	85.8	54.7	44.6	106.0
2000–2001	82.1	52.7	42.3	100.6
2001–2002	73.5	46.7	39.4	101.7
2002–2003	64.4	38.7	34.4	91.0
2003–2004	62.5	40.1	35.6	90.1

* **Note:** Canadian population in 0–19 years age group has decreased by <1% over decade of study
Canadian population in 20–39 year age group has decreased by 5% over decade of study
Canadian population in 40–59 year age group has increased by 32% over decade of study
Canadian population 60 years of age and older has increased by 17% over decade of study

5.2 Trend Analysis Overview: Cause of Head Injury

There has been an encouraging decrease in the rate of head injury admissions for all causes overall. When calculating rates of injury, the changes in population size are taken into consideration. For this report, rates are calculated per 100,000 population. In general, the rates of hospitalization by cause of injury and by age group have decreased since 1994–1995. The decreases range from 17% for admissions related to assault and intentional injury to 43% for head injuries related to motor vehicle collisions. (Table 4)

Table 4: Head Injury Rates (per 100,000 population) by Age Group, and Cause of Injury in Canada, 1994–1995 to 2003–2004.

	Falls				Motor Vehicle Related				Assault/Intentional Injury			
	0–19	20–39	40–59	60 +	0–19	20–39	40–59	60 +	0–19	20–39	40–59	60 +
1994–1995	58.5	12.2	19.6	75.3	49.5	37.2	21.1	21.7	5.2	10.0	3.9	1.7
1995–1996	51.0	12.2	18.5	74.4	42.7	34.3	19.7	20.6	4.5	10.2	4.0	1.6
1996–1997	46.9	11.4	17.8	75.0	38.4	31.1	18.5	20.8	4.6	9.0	3.7	1.4
1997–1998	43.4	11.4	16.8	75.4	36.6	29.5	18.1	19.2	4.9	10.3	4.0	1.5
1998–1999	39.5	10.7	17.3	74.7	33.7	28.1	17.8	20.5	4.6	9.1	3.8	1.5
1999–2000	36.5	10.5	16.4	78.6	31.6	28.1	18.5	20.3	4.3	8.9	4.1	1.5
2000–2001	34.7	10.4	16.4	74.1	31.0	27.3	16.6	18.5	4.1	8.5	3.6	1.4
2001–2002	30.6	8.9	15.8	76.9	28.0	23.8	15.1	18.0	3.9	8.4	3.8	0.9
2002–2003	26.3	6.5	12.8	69.0	25.7	20.0	14.0	15.2	3.6	7.3	3.1	1.4
2003–2004	24.8	7.1	13.9	68.6	24.4	20.4	13.9	14.9	4.1	8.0	3.9	1.1

Falls as a cause of head injury admissions has decreased by 28% during the decade of study from 10,680 in 1994–1995 to 7,637 in 2003–2004. Children and youth (0 to 19 years) had the largest number of fall related head injury admissions for the years 1994–1995 to 1996–1997 (4,661 in 1994–1995 dropping to 3,769 in 1996–1997, while the 60 years and older age group had the highest number of fall related head injuries in latter years (3,652 in 1997–1998 and 3,732 in 2003–2004). Children and youth saw a 58% decrease in falls resulting in traumatic head injury admissions over the 10 years of study (4,661 in 1993–1994 to 1,973 in 2003–2004). Those in the 20 to 39 year age group represent the smallest number of cases of traumatic head injury admission caused by a fall in all years, and like the other age groups, the number of fall related head injury admissions also decreased during the decade in this group (44%). Head injury admissions due to falls remained relatively stable in the 40 to 59 year age group (4% decrease).

Canadians 60 years of age and older were the only age group to experience an increase in fall related injury hospitalizations over the ten year period, with an increase of 7% over the decade of study. This group experienced a population growth of 17% over the timeframe, which offsets the 9% decrease in the rate of admissions due to fall related traumatic head injury.

Incidents related to a motor vehicle as a cause of traumatic head injury has seen a steady decrease (41%) throughout the decade between 1994–1995 and 2003–2004. The numbers have decreased from a high of 10,089 in 1994–1995 to a low of 5,970 in 2003–2004. For children and youth the decrease was 51%. There was a 48% decrease for those aged 20 to 39 years, a more modest 12% decrease in the 40 to 59 year age group, and an 18% decrease in those aged 60 years and older.

For injury inflicted by another person the period of study is different from the other categories. The baseline year for this analysis is 2001–2002 due to the implementation of new coding practices, which impacted the categorization of this cause of injury. Data from the previous years may not therefore be completely comparable. During these three years, the numbers have fluctuated from 1,459 in 2001–2002, to 1,308 in 2002–2003 and a high of 1,470 in 2003–2004. The most highly represented age group for each of these years is the 20 to 39 age group representing 53%, 51%, and 49% respectively of the injuries with this cause in the years 2001–2002 to 2003–2004. In alignment with this high representation, injury inflicted by another person was the second leading cause of traumatic head injury admission in the 20 to 39 year age group.

Consistent with other types of head injuries, the rates (per 100,000 population) for all other causes of head injury admissions decreased by 45% over the decade of study. When analyzed by age group, the changes ranged from a decrease of 53% in those under the age of 20, to the lowest decrease of 13% in those 60 years of age and older.

There have been dramatic changes in the incidence of cycling related head injury admissions, particularly in children and youth. In this age group, the number of admissions due to cycling related head injuries has decreased by 55% (n = 1,085 to 494) since 1994–1995. In adults there was also a decrease, albeit not as dramatic at 24% over the decade of study. Six provinces currently have province wide helmet legislation for cyclists, while others have various municipal bylaws. Four provinces have legislation that covers all ages. In provinces with province wide legislation, there is a 17% decreased risk of hospitalization due to head injuries when compared to provinces without legislation.

The analysis of the data for the past decade shows some very positive changes, specifically related to the proportion of children and youth who sustain head injuries while cycling. Figure 5 shows that between 1994–1995 and 2003–2004, the crude age specific rates of injuries in the age groups 5 to 9 years, 10 to 14 years, and 15 to 19 years decreased. Those aged 5 to 9 years had the greatest decrease (64%), followed by those aged 10 to 14 years (56%), and those aged 15 to 19 years (38%).

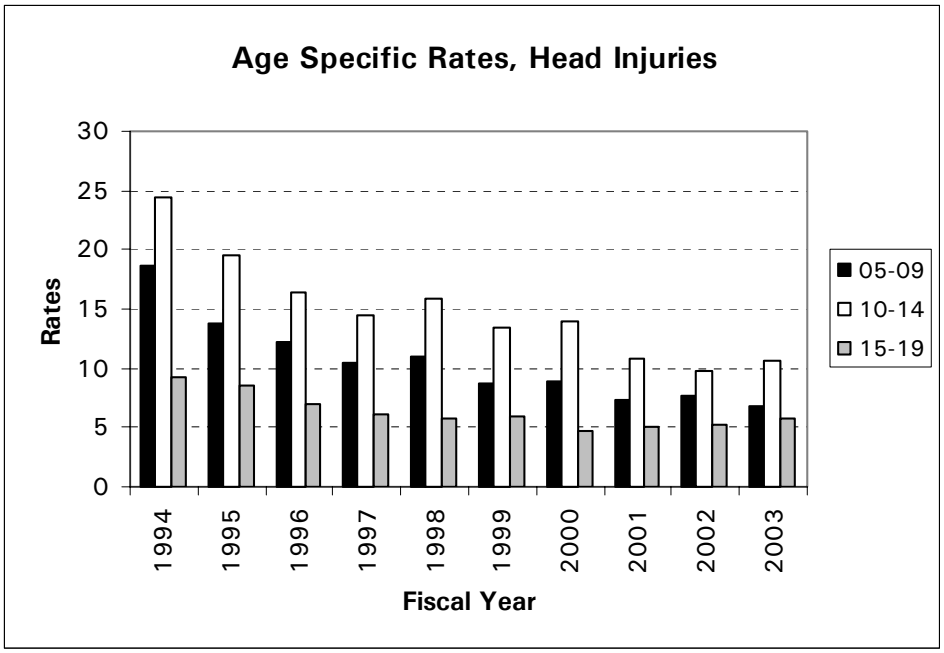


Figure 5. Age Specific Rates for Head Injuries (per 100,000 population) due to Cycling (5-19 years), Canada, 1994-1995 to 2003-2004

Although rates of head injuries due to cycling decreased in children, youth and young adults in this time period, the rates of head injuries due to cycling have remained virtually unchanged or have increased in adults over 50 years. (Figure 6)

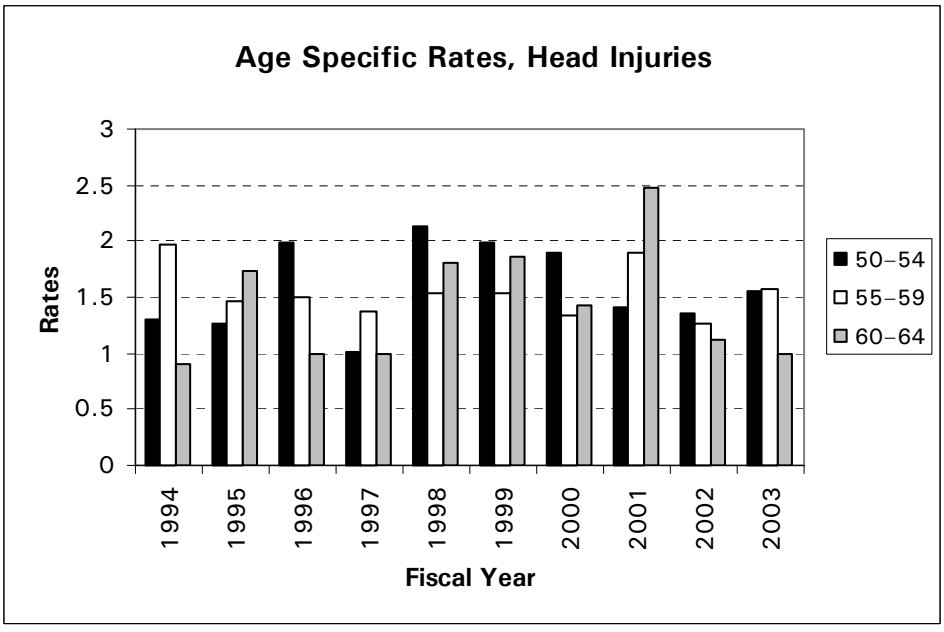


Figure 6: Age Specific Rates for Head Injuries (per 100,000 population) due to Cycling (50-64 years), Canada, 1994-1995 to 2003-2004

Figure 7 illustrates the relative risks for head injuries due to cycling for years using fiscal 1994–1995 as the baseline. The relative risks for sustaining a head injury while cycling have decreased over these 10 years. There were significant differences for the relative risks prior to 2000–2001 as compared to 2003–2004 ($p < 0.05$)

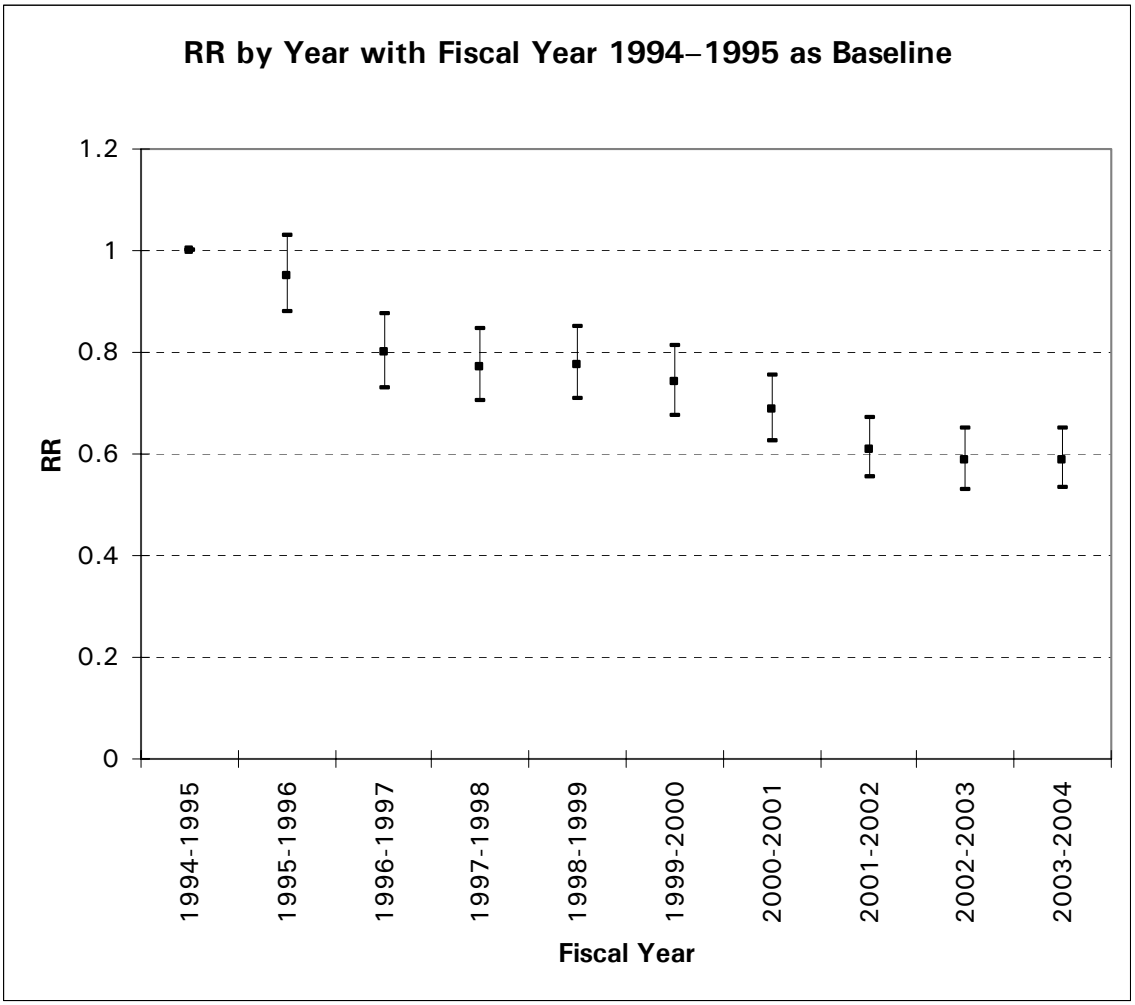


Figure 7. Relative Risks for Head Injuries Due to Cycling, by Fiscal Year, Canada, 1994–1995 to 2003–2004

Of note, while the length of stay for cycling injury admissions overall has decreased (from 4.6 to 4.2 days) over the decade of study, the length of stay in hospital for head injuries due to cycling has risen 4.3 to 6.9 days. This may be in keeping with the finding in the study that while the number of head injury admissions due to all causes has decreased in Canada for the decade of study, the number of serious (ISS >12) head injury admissions has increased significantly (46%) in the period since 2000–2001 when data became available.

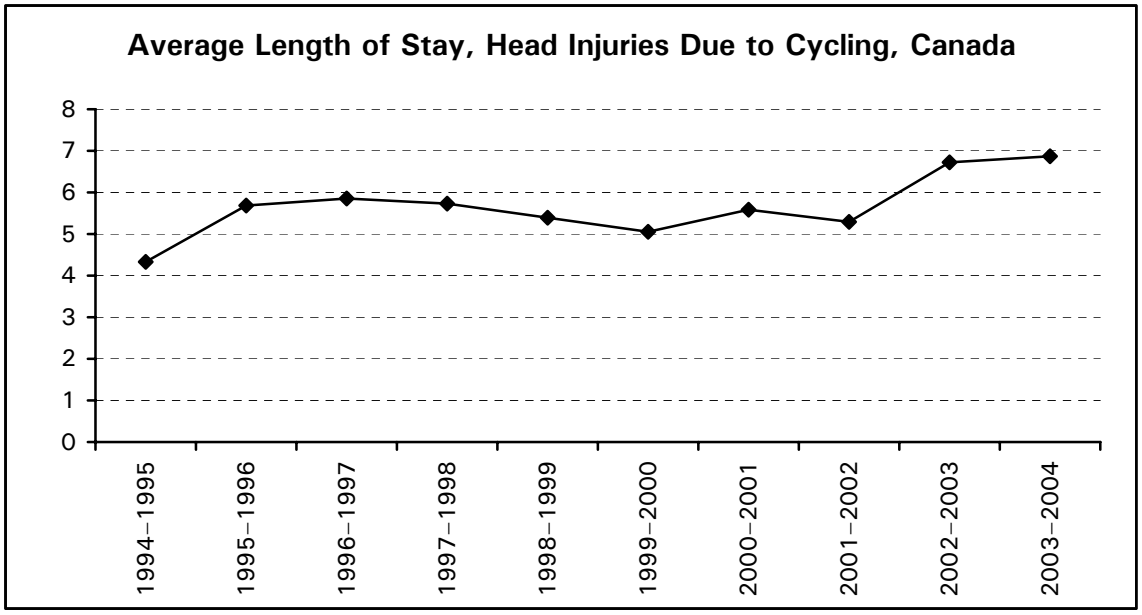


Figure 8. Average Length of Stay, Head Injuries Due to Cycling, NTR MDS, 1994–1995 to 2003–2004

An analysis of the number of cycling related trauma admissions excluding head injuries demonstrates that there has been an increase in other injuries due to cycling, as shown in Figure 9.

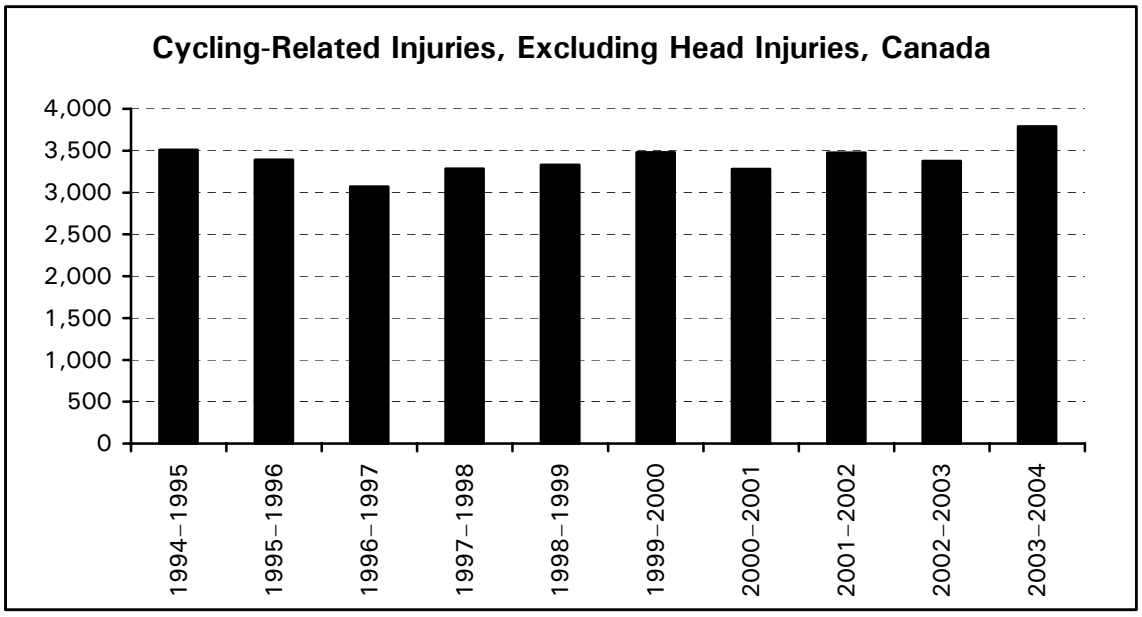


Figure 9. Cycling-Related Injuries, Excluding Head Injuries, NTR MDS 1994–1995 to 2003–2004

While cycling injury admissions (excluding head injury) have risen over the decade of study (from 3,512 to 3,790), admissions for head injuries have reduced significantly. Overall, head injuries due to cycling have significantly decreased between 1994–1995 and 2003–2004 from 1,507 to 815 (46%). The decrease in head injury admissions is seen most noticeably in children and youth (55%), specifically those between the ages of 5 and 19 years. However, there has been little or no decrease in cycling related head injury admissions in the adult population, and specifically no improvement seen for those aged 50 to 75 years.

5.3 Trend Analysis Overview: Severity of Injury

While the number of traumatic head injury admissions overall has seen an encouraging decline in occurrence over the last decade, the same cannot be said for the number of serious (ISS of >12) head injury admissions to lead trauma facilities.

Comprehensive data available for analysis goes back to 2000. In parallel with the overall decrease in traumatic head injury admissions, there has been a considerable increase in the number of admissions to specialized lead trauma facilities[ii] for serious head injury during this timeframe. In 2000–2001 there were 3,880 head injury cases captured in the CDS dataset, documented as having an ISS of >12 (defined as severe head trauma injuries) and admission to a lead trauma facility. The number of traumatic head injury admissions with an ISS >12 has increased by 46% to 5,660 in 2003–2004.

To provide context, analysis was performed on all injury admissions during this time period, with documented ISS >12. Head injury admissions demonstrate a different and disproportionate pattern of change when compared to other serious injury (NTR CDS) admissions. While the number of admissions to lead trauma facilities for severe trauma (all causes) grew from 8,784 in 2000–2001 to 10,249 in 2003–2004, representing a 17% increase, the number of admissions to specialized lead trauma facilities for severe head trauma increased by 46%.

ii Lead trauma facilities are hospitals that are designated by the provincial ministries of health to treat major traumatic injury

6. Conclusion

Traumatic head injury has significant impacts on the Canadian health care system, but more importantly on the lives of thousands of Canadian patients as well as their caregivers and families. Many of the changes seen throughout the decade under study are related to specific age groups, and as such each age group requires specific strategies to address continuing areas of concern.

Those Canadians aged 60 years and older remain a concern for head trauma admissions, particularly related to falls. While the rate of admission for fall related head injuries has dropped by 9% their outcomes are considerably worse than other age groups. In particular, those aged 60 and older require inpatient rehabilitation and continuing care with greater frequency than other age groups. As well, the proportion of older Canadians dying after admission to hospital, as a result of traumatic head injury has increased by 35%.

Children and youth are the largest group admitted to Canadian hospitals because of a traumatic head injury. It is encouraging that there has been a significant reduction in the number of head injury admissions in this group, particularly those due to cycling incidents.

Of note, while the number of head injuries overall has decreased substantially there has been an important increase in the number of admissions to specialized lead trauma facilities for severe head trauma. This increase could be related to a number of factors and requires further study. Areas for further study could include looking at the changes in the role of lead trauma facilities, treatment options (both at the scene of the incident and after admission) and/or administrative changes related to these cases. A better understanding of the factors contributing to the observed trend are required in order explain the trend and to determine what specific prevention strategies are required.

Children and youth have seen the largest improvements in the area of head injury related hospitalizations, and while the rates of seniors per 100,000 population requiring admission for head injury have decreased over time, the actual number of admissions has risen. As the Canadian population continues to age, it will important to develop and implement interventions for this age group.

In order to ensure sound prevention programs, decisions must be evidence-based, drawing on comprehensive data. This report provides evidence of an improving picture in Canada in relationship to traumatic head injuries. Overall, the number and rate of traumatic head injury admissions in Canada has shown an encouraging decrease in the last decade and it will be important in coming years to continue to identify and act on those factors that are related to the decrease in numbers.

Appendix A
Trauma Definition: External Cause of Injury Code Inclusions and Exclusions

Trauma Definition: External Cause Code Inclusions

The conceptual definition of trauma as *injury resulting from the transfer of energy* has been approved by the National Trauma Registry Advisory Committee.

The following table lists the External Cause of Injury Code categories used for reporting purposes based on the trauma definition. Incident and unintentional have been substituted for the terms accident and accidental used in the ICD definitions.

A. NTR MDS ICD-10-CA Inclusions

External Cause Code Category	Definition
V01–V99	Transport incidents
V01–V06, V09–V90	Land transport incidents
V91–V94	Water transport incidents
V95–V97	Air and space transport incidents
V98–V99	Other and unspecified transport incidents
W00–W19	Unintentional falls
W20–W45, W49	Exposure to inanimate mechanical forces
W50–W60, W64	Exposure to animate mechanical forces
W65–W70, W73, W74	Unintentional drowning and submersion
W75, W76, W77, W81, W83, W84	Other unintentional threats to breathing except due to inhalation of gastric contents, food, or other objects
W85–W94, W99	Exposure to electric current, radiation and extreme ambient air temperature and pressure
X00–X06, X08, X09	Exposure to smoke, fire and flames
X10–X19	Contact with heat and hot substances
X30–X39	Exposure to forces of nature
X50	Overexertion and strenuous or repetitive movements
X52	Prolonged stay in weightless environment
X58–X59	Unintentional exposure to other and unspecified factors
X70–X84	Intentional self-harm, excluding poisoning

External Cause Code Category	Definition
X86, X91–X99, Y00–Y05, Y07–Y09	Assault, excluding poisoning
Y20–Y34	Event of undetermined intent, excluding poisonings
Y35–Y36	Legal intervention and operations of war

B. NTR MDS ICD-9 Inclusions

E Code Category	Definition
E800–E807	Railway incidents
E810–E819	Motor vehicle traffic incidents
E820–E825	Motor vehicle non-traffic incidents
E826	Pedal cycles
E827–E829	Other road vehicle incidents
E830–E838	Water transport incidents
E840–E845	Air and space transport incidents
E846–E848	Vehicle incidents not elsewhere classifiable
E880–E888	Unintentional falls
E890–E899	Incidents caused by fire and flame
E900–E902, E906–E909	Incidents due to natural and environmental factors
E910, E913	Incidents caused by drowning and suffocation
E914–E915	Foreign bodies (excluding choking)
E916–E928	Other incidents
E953–E958	Suicide and self-inflicted injury (excluding poisoning)
E960–E961, E963–E968	Homicide and injury purposely inflicted by other persons (excluding poisoning)
E970–E976, E978	Legal intervention
E983–E988	Injury undetermined whether unintentionally or purposely inflicted
E990–E998	Injury resulting from operations of war

The following lists the ICD-9 and ICD-10-CA External Cause Code categories that are *excluded* from the National Trauma Registry definition of trauma.

ICD-10-CA Code Exclusions	Definition	ICD-9 E Code Exclusions	Definition
W78–W80	W78: Inhalation of gastric contents; W79: Inhalation and ingestion of food causing obstruction of respiratory tract; W80: Inhalation and ingestion of other objects causing obstruction of respiratory tract	E911–E912	Inhalation and ingestion of food and other objects causing obstruction
X20–X29	Contact with venomous animals and plants	E905	Venomous animals and plants
X40–X49	Unintentional poisoning and exposure to noxious substances	E850–E858, E860–E869	Poisonings by drugs or gases
X51	Travel and motion	E903	Travel and motion
X53, X54, X57, Y06	X53: Lack of food; X54: Lack of water; X57: Unspecified privation; Y06: Neglect and abandonment	E904	Hunger, thirst, exposure, neglect
X60–X69	Intentional self-harm by poisoning	E950–E952	Suicide and self inflicted injury (poisonings)
X85, X87–X90	Assault by poisoning	E962	Assault by poisoning
Y10–Y19	Poisonings of undetermined intent	E980–E982	Poisoning undetermined whether unintentionally or purposely inflicted
Y40–Y59	Drugs, medicaments and biological substances causing adverse effects in therapeutic use	E930–E949	Drugs, medicinal and biological substances causing adverse effects
Y60–Y69	Misadventures to patients during surgical and medical care	E870–E876	Misadventures
Y70–Y82	Medical devices associated with adverse incidents in diagnostic and therapeutic use	New category—no ICD-9 equivalent	
Y83–Y84	Surgical and other medical procedures as the cause of abnormal reaction of the patient, or of later complication, without mention of misadventure at the time of the procedures	E878–E879	Complications

ICD-10-CA Code Exclusions	Definition	ICD-9 E Code Exclusions	Definition
Y85–Y89	Sequelae of external causes of morbidity and mortality	E929, E959, E969, E977, E989, E999	Late effects
Y90–Y98	Supplementary factors related to causes of morbidity and mortality classified elsewhere	New category—no ICD-9 equivalent	

Appendix B
External Cause of Injury Reporting Categories

External Cause Code Groups	ICD-10-CA Codes	ICD-9 Codes
MOTOR VEHICLE TRAFFIC—Driver	V30.5, V31.5, V32.5, V33.5, V34.5, V35.5, V36.5, V37.5, V38.5, V39.4, V40.5, V41.5, V42.5, V43.5, V44.5, V45.5, V46.5, V47.5, V48.5, V49.4, V50.5, V51.5, V52.5, V53.5, V54.5, V55.5, V56.5, V57.5, V58.5, V59.4, V60.5, V61.5, V62.5, V63.5, V64.5, V65.5, V66.5, V67.5, V68.5, V69.4, V70.5, V71.5, V72.5, V73.5, V74.5, V75.5, V76.5, V77.5, V78.5, V79.4, V83.0, V84.0, V85.0, V86.00, V86.08	E810–E816, E818–E819 (.0)
MOTOR VEHICLE TRAFFIC—Passenger	V30.6, V31.6, V32.6, V33.6, V34.6, V35.6, V36.6, V37.6, V38.6, V39.5, V40.6, V41.6, V42.6, V43.6, V44.6, V45.6, V46.6, V47.6, V48.6, V49.5, V50.6, V51.6, V52.6, V53.6, V54.6, V55.6, V56.6, V57.6, V58.6, V59.5, V60.6, V61.6, V62.6, V63.6, V64.6, V65.6, V66.6, V67.6, V68.6, V69.5, V70.6, V71.6, V72.6, V73.6, V74.6, V75.6, V76.6, V77.6, V78.6, V79.5, V83.1, V84.1, V85.1, V86.10, V86.18	E810–E816, E818–E819 (.1)
MOTOR VEHICLE TRAFFIC—Motorcycle Driver	V20.4, V21.4, V22.4, V23.4, V24.4, V25.4, V26.4, V27.4, V28.4, V29.4	E810–E816, E818–E819 (.2)
MOTOR VEHICLE TRAFFIC—Motorcycle Passenger	V20.5, V21.5, V22.5, V23.5, V24.5, V25.5, V26.5, V27.5, V28.5, V29.5	E810–E816, E818–E819 (.3)
MOTOR VEHICLE TRAFFIC—Pedestrian	V02.1, V02.9, V03.1, V03.9, V04.1, V04.9, V09.2	E810–E816, E818–E819 (.7)
MOTOR VEHICLE TRAFFIC—Pedal Cyclist	V12 (.4, .5, .9) V13 (.4, .5, .9) V14 (.4, .5, .9) V19 (.4, .5, .6)	E810–E816, E818–E819 (.6)

External Cause Code Groups	ICD-10-CA Codes	ICD-9 Codes
MOTOR VEHICLE TRAFFIC—Other/ Unspecified	V20.9, V21.9, V22.9, V23.9, V24.9, V25.9, V26.9, V27.9, V28.9, V29.6, V29.8, V29.9, V30.7, V30.9, V31.7, V31.9, V32.7, V32.9, V33.7, V33.9, V34.7, V34.9, V35.7, V35.9, V36.7, V36.9, V37.7, V37.9, V38.7, V38.9, V39.6, V39.8, V39.9, V40.7, V40.9, V41.7, V41.9, V42.7, V42.9, V43.7, V43.9, V44.7, V44.9, V45.7, V45.9, V46.7, V46.9, V47.7, V47.9, V48.7, V48.9, V49.6, V49.8, V49.9, V50.7, V50.9, V51.7, V51.9, V52.7, V52.9, V53.7, V53.9, V54.7, V54.9, V55.7, V55.9, V56.7, V56.9, V57.7, V57.9, V58.7, V58.9, V59.6, V59.8, V59.9, V60.7, V60.9, V61.7, V61.9, V62.7, V62.9, V63.7, V63.9, V64.7, V64.9, V65.7, V65.9, V66.7, V66.9, V67.7, V67.9, V68.7, V68.9, V69.6, V69.8, V69.9, V70.7, V70.9, V71.7, V71.9, V72.7, V72.9, V73.7, V73.9, V74.7, V74.9, V75.7, V75.9, V76.7, V76.9, V77.7, V77.9, V78.7, V78.9, V79.6, V79.8, V79.9, V82.1, V83.2, V83.3, V84.2, V84.3, V85.2, V85.3, V86 (.2, .30, .38) V87 (.0, .1, .2, .3, .4, .5, .6, .7, .8) V89.2	E810–E816, E818–E819 (.4, .5, .8, .9)
MOTOR VEHICLE NON TRAFFIC—Driver	V30.0, V31.0, V32.0, V33.0, V34.0, V35.0, V36.0, V37.0, V38.0, V39.0, V40.0, V41.0, V42.0, V43.0, V44.0, V45.0, V46.0, V47.0, V48.0, V49.0, V50.0, V51.0, V52.0, V53.0, V54.0, V55.0, V56.0, V57.0, V58.0, V59.0, V60.0, V61.0, V62.0, V63.0, V64.0, V65.0, V66.0, V67.0, V68.0, V69.0, V70.0, V71.0, V72.0, V73.0, V74.0, V75.0, V76.0, V77.0, V78.0, V79.0, V83.5, V84.5, V85.5, V86.50, V86.51, V86.58	E820–E823, E825 (.0)
MOTOR VEHICLE NON TRAFFIC—Passenger	V30.1, V31.1, V32.1, V33.1, V34.1, V35.1, V36.1, V37.1, V38.1, V39.1, V40.1, V41.1, V42.1, V43.1, V44.1, V45.1, V46.1, V47.1, V48.1, V49.1, V50.1, V51.1, V52.1, V53.1, V54.1, V55.1, V56.1, V57.1, V58.1, V59.1, V60.1, V61.1, V62.1, V63.1, V64.1, V65.1, V66.1, V67.1, V68.1, V69.1, V70.1, V71.1, V72.1, V73.1, V74.1, V75.1, V76.1, V77.1, V78.1, V79.1, V83.6, V84.6, V85.6, V86.60, V86.61, V86.68	E820–E823, E825 (.1)
MOTOR VEHICLE NON TRAFFIC—Motorcycle Driver	V20.0, V21.0, V22.0, V23.0, V24.0, V25.0, V26.0, V27.0, V28.0, V29.0	E820–E823, E825 (.2)

External Cause Code Groups	ICD-10-CA Codes	ICD-9 Codes
MOTOR VEHICLE NON TRAFFIC—Motorcycle Passenger	V20.1, V21.1, V22.1, V23.1, V24.1, V25.1, V26.1, V27.1, V28.1, V29.1	E820–E823, E825 (.3)
MOTOR VEHICLE NON TRAFFIC—Pedestrian	V02.0, V03.0, V04.0, V09.0	E820–E823, E825 (.7)
MOTOR VEHICLE NON TRAFFIC—Pedal Cyclist	V12 (.0, .1, .2) V13 (.0, .1, .2) V14 (.0, .1, .2) V19 (.0, .1, .2)	E820–E823, E825 (.6)
MOTOR VEHICLE NON TRAFFIC—Other/Unspecified	V20.2, V21.2, V22.2, V23.2, V24.2, V25.2, V26.2, V27.2, V28.2, V29.2, V29.3, V30.2, V30.3, V31.2, V31.3, V32.2, V32.3, V33.2, V33.3, V34.2, V34.3, V35.2, V35.3, V36.2, V36.3, V37.2, V37.3, V38.2, V38.3, V39.2, V39.3, V40.2, V40.3, V41.2, V41.3, V42.2, V42.3, V43.2, V43.3, V44.2, V44.3, V45.2, V45.3, V46.2, V46.3, V47.2, V47.3, V48.2, V48.3, V49.2, V49.3, V50.2, V50.3, V51.2, V51.3, V52.2, V52.3, V53.2, V53.3, V54.2, V54.3, V55.2, V55.3, V56.2, V56.3, V57.2, V57.3, V58.2, V58.3, V59.2, V59.3, V60.2, V60.3, V61.2, V61.3, V62.2, V62.3, V63.2, V63.3, V64.2, V64.3, V65.2, V65.3, V66.2, V66.3, V67.2, V67.3, V68.2, V68.3, V69.2, V69.3, V70.2, V70.3, V71.2, V71.3, V72.2, V72.3, V73.2, V73.3, V74.2, V74.3, V75.2, V75.3, V76.2, V76.3, V77.2, V77.3, V78.2, V78.3. V79.2, V79.3, V80 (.3 .4 .5) V82.0, V83.7, V83.9, V84.7, V84.9, V85.7, V85.9, V86.7, V86.90, V86.91, V86.98, V88 (.0, .1, .2, .3, .4, .5, .6, .7, .8) V89.0	E820–E823, E825 (.4, .5, .8, .9)
MOTOR VEHICLE—Boarding or Alighting	V20.3, V21.3, V22.3, V23.3, V24.3, V25.3, V26.3, V27.3, V28.3, V30.4, V31.4, V32.4, V33.4, V34.4, V35.4, V36.4, V37.4, V38.4, V40.4, V41.4, V42.4, V43.4, V44.4, V45.4, V46.4, V47.4, V48.4, V50.4, V51.4, V52.4, V53.4, V54.4, V55.4, V56.4, V57.4, V58.4, V60.4, V61.4, V62.4, V63.4, V64.4, V65.4, V66.4, V67.4, V68.4, V70.4, V71.4, V72.4, V73.4, V74.4, V75.4, V76.4, V77.4, V78.4, V83.4, V84.4, V85.4, V86.4	E817 (all 4th digits), E824 (all 4th digits)
RAILWAY—Occupant	V81 (.0, .1, .2, .3, .4, .5, .6, .7, .8, .9)	E800–E807 (.0.1)
RAILWAY—Pedestrian	V05 (.0, .1, .9)	E800–E807 (.2)

External Cause Code Groups	ICD-10-CA Codes	ICD-9 Codes
RAILWAY—Pedal Cyclist	V15 (.0, .1, .2, .3, .4, .5, .9)	E800–E807 (.3)
RAILWAY—Other	V80.6	E800–E807 (.8, .9)
OTHER ROAD VEHICLE—Pedestrian	V01 (.0, .1, .9), V06 (.0, .1, .9), V09.1, V09.3, V09.9	E826–E829 (.0)
OTHER ROAD VEHICLE—Pedal Cyclist	V10 (.0, .1, .2, .3, .4, .5, .9), V11 (.0, .1, .2, .3, .4, .5, .9), V12.3, V13.3, V14.3, V16 (.0, .1, .2, .3, .4, .5, .9), V17 (.0, .1, .2, .3, .4, .5, .9), V18 (.0, .1, .2, .3, .4, .5, .9), V19 (.3, .8, .9)	E826–E829 (.1)
OTHER ROAD VEHICLE—Animal-Rider/Occupant of Animal-Drawn Vehicle	V80 .0, V80.1, V80.2, V80.7, V80.8, V80.9	E826–E829 (.2, .3)
OTHER ROAD VEHICLE—Occupant of Streetcar	V82 (.2, .3, .4, .5, .6, .7, .8, .9)	E826–E829 (.4)
OTHER ROAD VEHICLE—Other	V87.9, V88.9, V89 (.1, .3)	E826–E829 (.8, .9)
WATER TRANSPORT—Involving Drowning/ Submersion	V90 (.0, .1, .2, .3, .4, .5, .6, .7, .8, .9), V92 (.0, .1, .2, .3, .4, .5, .6, .7, .8, .9)	E830, E832 (.0, .1, .2, .3, .4, .5, .6, .8, .9)
WATER TRANSPORT—Incident to/on Watercraft Not Causing Drowning and Submersion	V91 (.0, .1, .2, .3, .4, .5, .6, .7, .8, .9), V93 (.0, .1, .2, .3, .4, .5, .6, .7, .8, .9)	E831, E833, E834, E835, E836, E837 (.0, .1, .2, .3, .4, .5, .6, .7, .8, .9)
WATER TRANSPORT—Other/Unspecified	V94 (.0, .1, .2, .3, .4, .5, .6, .7, .8, .9)	E838 (.0, .1, .2, .3, .4, .5, .6, .8, .9)
Air and Space Transport	V95 (.0, .1, .2, .3, .4, .8, .9), V96 (.0, .1, .2, .8, .9), V97 (.0, .1, .2, .3, .8)	E840–E845 (.0, .1, .2, .3, .4, .5, .6, .7, .8, .9)
Vehicle Incidents Not Elsewhere Classified	V89.9, V98, V99	E846–E848
UNINTENTIONAL FALLS—Slipping, Tripping and Stumbling	W01	E885

External Cause Code Groups	ICD-10-CA Codes	ICD-9 Codes
UNINTENTIONAL FALLS—Collision With/Pushed by, Another Person	W03	E886
UNINTENTIONAL FALLS—Fall on/From Stairs and Steps	W10	E880
UNINTENTIONAL FALLS—Fall on/From Ladder or Scaffolding	W11, W12	E881
UNINTENTIONAL FALLS—Fall From, out of or Through Building or Structure	W13	E882
UNINTENTIONAL FALLS—Other Fall From One Level to Another	W06, W07, W08, W09, W14, W15, W16, W17	E883, E884
UNINTENTIONAL FALLS—Other/ Unspecified Fall	W00, W02, W04, W05, W18, W19	E888
Fire and Flames	X00–X06, X08, X09	E890–E899
Drowning	W65–W70, W73, W74	E910
Operations of War	Y36	E990–E998
Legal Intervention	Y35	E970–E976, E978
Attempted Suicide and Self Inflicted Injury (Excluding Poisoning)	X70–X84	E953–E958
Undetermined Whether Unintentionally or Purposely Inflicted (Excluding Poisonings)	Y20–Y34	E983–E988
Assault and Injury Purposely Inflicted (Excluding Poisonings)	X86, X91–X99, Y00–Y05, Y07–Y09	E960, E961, E963–E968
Suffocation	W75, W76, W77, W81, W83, W84	E913
Foreign Bodies (Excluding Choking)	W44, W45	E914, E915

External Cause Code Groups	ICD-10-CA Codes	ICD-9 Codes
Cutting and Piercing	W25, W26, W27, W28, W29, W60	E920
Unintentional Firearm Injuries	W32, W33, W34	E922
Machinery-Related Injuries	W24, W30, W31	E919
Overexertion and Strenuous/Repetitive Movements	X50	E927
Struck by or Against Objects and Persons	W20, W21, W22, W50, W51, W52	E916, E917
Explosive Material	W39, W40	E923
Hot Substances	X10–X19	E924
Electric Current	W85–W87	E925
Caught, Crushed, Jammed or Pinched in or Between Objects	W23	E918
Explosion of Pressure Vessel	W35, W36, W37, W38	E921
Exposure to Radiation	W88-W91, X32	E926
Other/Unspecified	W41, W42, W43, W49, X58–X59	E887, E928
Natural and Environmental Factors	W53, W54, W55, W56, W57, W58, W59, W64, W92, W93, W94, W99, X30–X31, X33–X39, X52	E900, E901, E902, E906, E907, E908, E909

Appendix C
Head Injury Definition

The following provides information on the specific diagnosis codes used to identify head injuries.

Description	ICD-10 Code Range	ICD-9 Code Range
Head Injury	S02000, S02001, S02100, S02101, S02700, S02701, S02890, S02891, S02900, S02901, S06000, S06010, S06020, S06030, S06040, S06090, S06101, S06111, S06121, S06131, S06141, S06191, S06100, S06110, S06120, S06130, S06140, S06190, S06101, S06111, S06121, S06131, S06141, S06191, S06200, S06210, S06220, S06230, S06240, S06290, S06201, S06211, S06221, S06231, S06241, S06291, S06300, S06310, S06320, S06330, S06340, S06390, S06301, S06311, S06321, S06331, S06341, S06391, S06400, S06410, S06420, S06430, S06440, S06490, S06401, S06411, S06421, S06431, S06441, S06491, S06500, S06510, S06520, S06530, S06540, S06590, S06501, S06511, S06521, S06531, S06541, S06591, S06600, S06610, S06620, S06630, S06640, S06690, S06601, S06611, S06621, S06631, S06641, S06691, S06800, S06810, S06820, S06830, S06840, S06890, S06801, S06811, S06821, S06831, S06841, S06891, S06900, S06910, S06920, S06930, S06940, S06990, S06901, S06911, S06921, S06931, S06941, S06991, S071, S078, S079, T020	800, 801, 803, 804, 850–854

Appendix D
Logistic Regression Model

```
proc genmod data = head_pop;
class year prov agecat;
model count = legislat prov year agecat/dist = poisson
                link = log
                offset = lnpop;
```

legislat = 0 as non-legislated province and 1 as legislated province

prov = province

year = fiscal_year

agecat = age category

lnpop = log(pop)

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