CHILD HEALTH BC
LEAD BENEFACTOR
save on foods

BC INJURY research and prevention unit

Credit: © Zurijeta|Shutterstock.com|

THE BURDEN OF CONCUSSION IN BRITISH COLUMBIA

This report was commissioned and funded by Child Health BC. Child Health BC is a network of British Columbia health authorities, BC government ministries, health professionals, and provincial partners dedicated to improve the health status and health outcomes of BC's children and youth by working collaboratively to build an integrated and accessible system of health services. One of the focus areas of Child Health BC is Injury Prevention.

The British Columbia Injury Research and Prevention Unit (BCIRPU) was established by the Ministry of Health and the Minister's Injury Prevention Advisory Committee in August 1997. BCIRPU is housed within Developmental Neurosciences and Child Health (N2N) cluster and supported by the Provincial Health Services Authority (PHSA), the Child and Family Research Institute (CFRI) and the University of British Columbia (UBC). BCIRPU's vision is "to be a leader in the production and transfer of injury prevention knowledge and the integration of evidence-based injury prevention practices into the daily lives of those at risk, those who care for them, and those with a mandate for public health and safety in British Columbia".

Authors: Fahra Rajabali, Aybaniz Ibrahimova, Kate Turcotte, Shelina Babul.

Acknowledgements: Jat Sandhu and Tim Chu at the Vancouver Coastal Health Authority Public Health Surveillance Unit, Gurjeet Sivia and Carol Astley at the Fraser Health Authority Health and Business Analytics, and Mhairi Nolan at BC Children Hospital Injury Reporting and Prevention Program.

BC Injury Research and Prevention Unit
F508-4480 Oak Street
Vancouver, BC V6H 3V4
Email: bcinjury1@cw.bc.ca
Phone: (604) 875-3776 Fax: (604) 875-3569
Webpage: www.injuryresearch.bc.ca

Child Health BC
#305-4088 Cambie Street
Vancouver, BC V5Z 2X8
Email: info@childhealthbc.ca
Phone: 604-877-6410
Webpage: www.childhealthbc.ca

October 2012

TABLE OF CONTENTS

INTRODUCTION

Concussion and mild traumatic brain injury (mTBI) – used synonymously in the literature – have received enormous attention in recent years, both in the media as well as the scientific literature. The Centers for Disease Control has estimated that 1.6 to 3.8 million cases of sport-related concussions occur annually in the United States [1]. Sport and recreational activities contribute to about 21 percent of all traumatic brain injuries among children in the US [2]. This means that nearly 80 percent of head injuries are not sports-related.

A concussion can occur to anyone from a variety of causes, such as hitting your head while falling down a flight of stairs, falling off a slide in a playground, or running into a door frame. Concussions are caused by a direct blow to the head or other body part resulting in a rotational movement of the brain within the skull. Concussion can occur with or without loss of consciousness and symptoms can be subtle, including headache, confusion, nausea or dizziness, and may not appear for hours or days. Recommended treatment includes both physical and mental rest [3].

If an individual returns to activity too soon and a second concussion is sustained before recovering from the first, a condition known as second-impact syndrome (SIS) may occur: a swelling of the brain that can result in brain damage causing severe disability or even death [3]. Furthermore, an individual is 3-times more likely to sustain a second concussion while in recovery from a concussion [4].

The short- and long-term effects of concussion can vary from person to person and can greatly affect quality of life. A significant percentage of professional hockey and football players, as well as high school athletes, with previously reported concussions or other head-related injury were found to have reported an impact on their social and professional lives including difficulties at work, attending school, playing sports and other simple activities such as riding stationary bicycles or lifting weights [5]. This implies that the long-term effects of concussion are often not recognized early enough to prevent post-concussion syndrome and permanent brain damage.

Although concussion has not been recognized as a potentially life threatening condition in the past, SIS is the most catastrophic and lethal brain injury resulting from sport-related trauma [6].

Concussion is among the most devastating of catastrophic injuries, with twice the death rate of injuries overall [7]. Evidence exists that children and adolescents take longer than adults to recover following a concussion [8], and can permanently change the way a child or youth talks, walks, learns, works and interacts with others. Therefore, concussion management and appropriate return to activity is crucial, particularly in the pediatric and adolescent populations.

Active and timely rehabilitation is essential for concussion patients who remain symptomatic longer than a six week period. This may include physiotherapy, occupational therapy, educational support, neuropsychology and in some case neuropsychiatry. Coordination by integrated team of professionals is required to tailor a unique rehabilitation plan for each patient.

Concussions impact the lives of children and youth at all levels and therefore having a provincial program in place with immediate access is crucial to their quality of life and future.

Purpose

The purpose of this report is to describe the burden of concussion in BC, for the general population, with a focus on children and youth ages 0 to 19 years. This will be accomplished by describing mortality and hospitalization data at the provincial level, as well as emergency department visits at participating sites within Vancouver Coastal Health (VHC), Fraser Health (FH), and the BC Children's Hospital (BCCH) located in Vancouver within the Provincial Health Services Authority.

This report will be used to facilitate discussion around the need for a concussion program for children and youth in BC.

THE BURDEN OF CONCUSSION IN BRITISH COLUMBIA – AN OVERVIEW

Mortality

- Head injuries accounted for 2,781 deaths in BC during the 2001-2010 period.
- 66.4% of all head injury deaths were males.
- 9.5% of head injury deaths were children and youth ages 0-19 years.
- There were no head injury deaths documented to be the result of a concussion.
- Age-specific head injury mortality rates were lowest among children 5-9 years of age (0.7/100,000), and highest among older adults aged 90 years and over (70.1/100,000).
- Head injury mortality rates among children and youth ages 0-19 years were seen to decline significantly (p=0.014) from 2001 to 2010.
- Head injury mortality rates were consistently higher among males within the 0-19 year olds.
- Head injury standardized mortality rates were highest in Northern and Interior Health and lowest in Vancouver Coastal Health.
- Head injury mortality rates for ages 0-19 years were highest in Northern and lowest in Vancouver Coastal Health.

Hospitalization

- Head injuries accounted for 42,766 hospitalizations in BC during the 2001-2010 period.
- 22.2% of head injury hospitalizations were children and youth ages 0-19 years.
- Concussion accounted for 9.7% of all head injury hospitalizations.
- Concussion hospitalizations rates were lowest among 30-34 year olds (5.3/100,000), and highest among older adults 85-89 years and over (27.4/100,000).
- Among children and youth, concussion hospitalization rates were highest among 10-14 year olds (19.8/100,000); second highest among teens 15-19 years (17.1/100,000); and lowest among infants less than 1 year (6.9/100,000).
- 69.2% of all concussion hospitalizations among children and youth 0-19 years were males.
- Concussion standardized hospitalization rates were highest in Northern and lowest in Vancouver Coastal Health.
- Concussion hospitalization rates for ages 0-19 years showed the same geographic pattern as for the total population.

Lower Mainland Emergency Departments (VCH/FH/BCCH)

- There were 16,888 concussions seen in emergency departments throughout the BC Lower Mainland in 2011: 6,651 from VCH (2011); 8,959 from FH (2011/12); and 1,278 presenting to BCCH (2009).
- 59.4% of all concussion emergency department visits were males.
- 39.5% of concussion emergency department cases were children and youth ages 0-19 years.
- Concussion emergency department rates were highest among infants less than one year of age (1,930.6/100,000), followed by young children ages 1 to 4 years (1,715.0/100,000).
- The leading cause of concussion was falls (32.5%), followed by sports and recreational activities (18.0%) and struck by or against an object (9.4%).

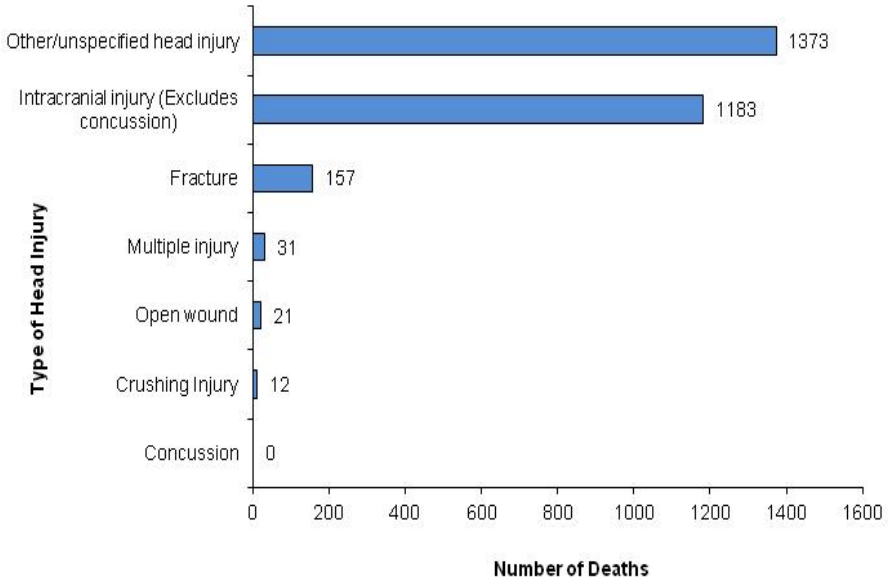
BC Children's Hospital

- 9,027 children and youth ages 0-19 years presented to BCCH with a concussion/minor head injury during the 2001-2009 period.
- 53.2% of concussions/minor head injury seen at BCCH were young children ages 0-4 years.
- 61.7% of concussions/minor head injury seen at BCCH were males.
- Concussion emergency department visits to BCCH were seen to increase significantly (p=0.001) from 2001 to 2009.
- The proportion of concussions and minor head injury occurring at home decreased with age; while the proportion occurring in educational institutions and places of sport and recreation increased with age.
- Among infants less than one year of age, 36.4% of all concussions/minor head injuries occurred while sitting, standing-passive, 11.2% playing, dancing and climbing, and 10.2% walking, running and crawling.
- The highest proportions of concussions/minor head injuries for organized sports were among 15-19 year olds (33.2%) and 10-14 year olds (27.7%).
- Helmet use was highest for horseback riding (80.0%), all hockey (78.8%) and lacrosse (76.2%).

MORTALITY FROM HEAD INJURIES IN BC, 2001-2010

There were 2,781 deaths resulting from head injuries in BC over the 10-year time period from 2001 to 2010. Males accounted for 66.4 percent (1,846) of these deaths. Children and youth ages 0 to 19 years accounted for 9.5 percent (265) of all deaths due to head injury. Males within the child and youth age limits accounted for 68.3 percent (181) of all cases. There were less than five head injury deaths among infants less than one year of age (suppressed in Figure 2).

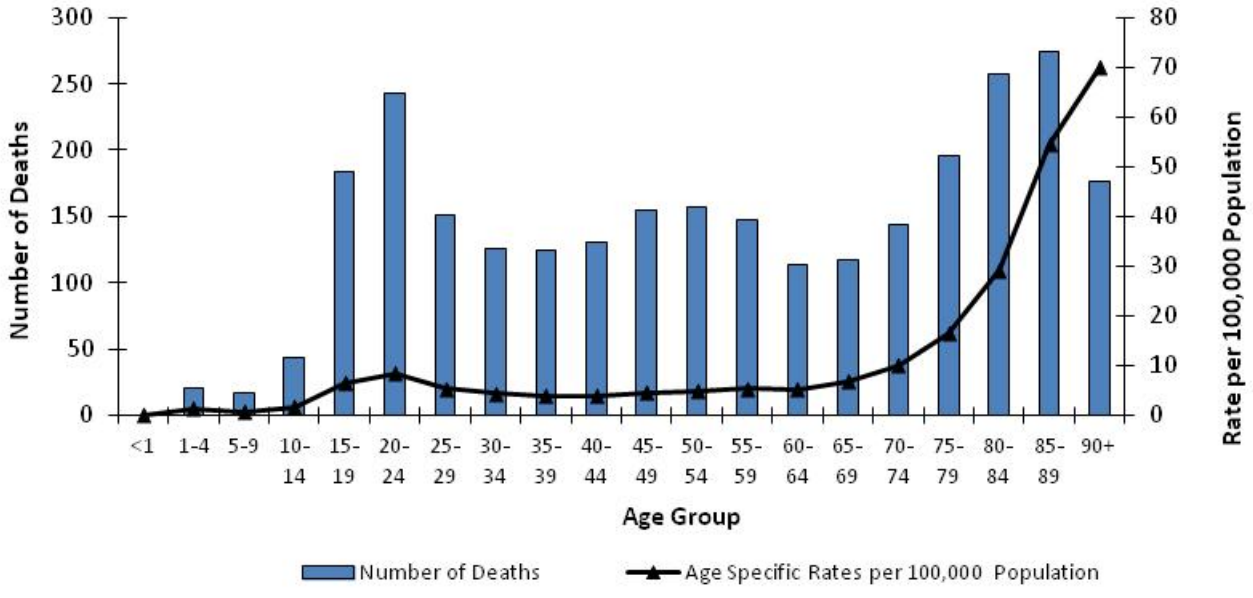
Figure 1: Number of head injury deaths by type, BC, 2001-2010



Although none of these deaths were documented to be the result of concussion, 49.4 percent were "other/unspecified head injury", followed by 42.5 percent "intracranial injury excluding concussion" (Figure 1). Almost half of these deaths were transport-related.

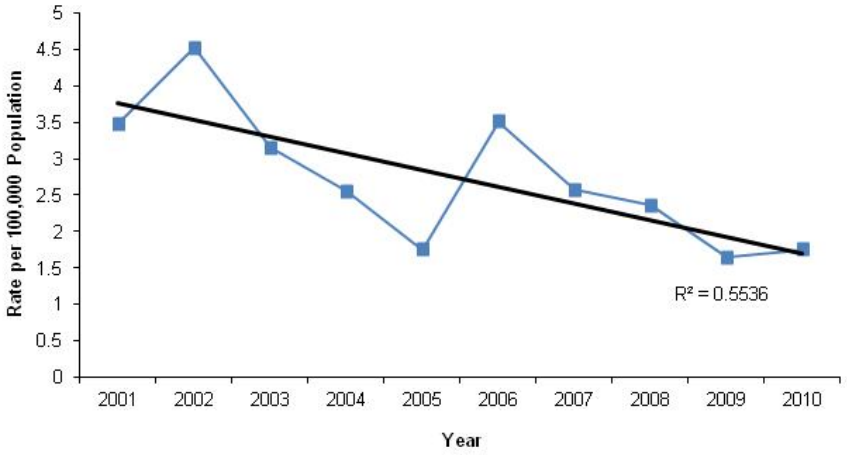
Head injury mortality rates were lowest among 5 to 9 year olds (0.7/100,000), and highest among older adults aged 90 years and over (70.1/100,000) (Figure 2). Among children and youth, rates increased to 6.5 per 100,000 among 15 to 19 year olds. In terms of numbers, the least burden of head injury mortality is seen among children less than 14 years old, with the greatest burden among the elderly and among young adults ages 20 to 24 years.

Figure 2: Head injury mortality rate and cases by age group, BC, 2001-2010



Head injury mortality rates among children and youth ages 0 to 19 years were seen to decline significantly (p=0.014) from 2001 to 2010 (Figure 3). Rates within this age group peaked in 2002 at 4.5 per 100,000 and were lowest in 2009 at 1.6 per 100,000.

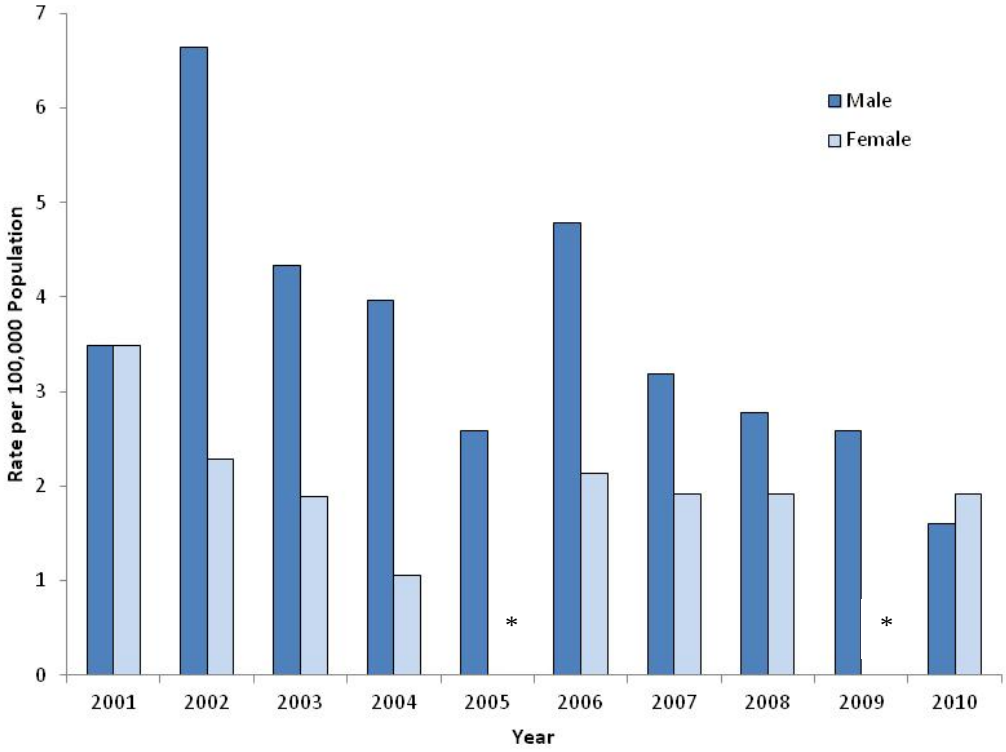
Figure 3: Head injury mortality rate, 0-19 years old, by year, BC, 2001-2010



Rates were consistently higher among males within this age group from 2002 to 2009, with those in 2001 being the same between males and females. Rates peaked for males in 2002 at 6.6 per 100,000, and were lowest in 2010 at 1.6 per 100,000. Rates peaked for females 0 to 19 years of age in 2001 at 3.5 per 100,000 and were lowest in 2005 and 2009 when there were fewer than 5 cases of head injury mortality among females 0 to 19 years of age (Figure 4).

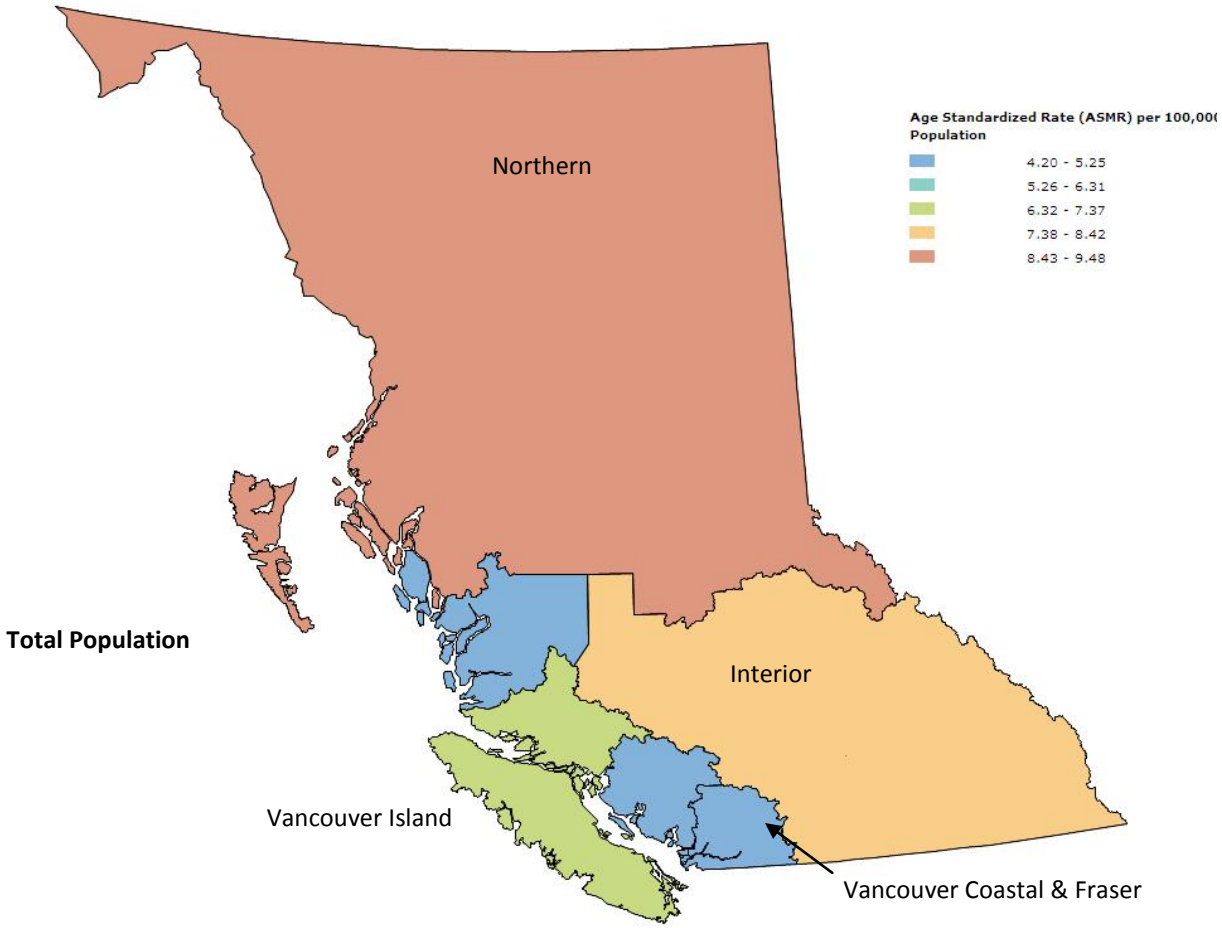
Head injury standardized mortality rates for the total BC population indicate that rates are highest in Northern and Interior Health and lowest in Vancouver Coastal Health (Figure 5). Head injury mortality rates for ages 0-19 years were highest in Northern and lowest in Vancouver Coastal Health.

Figure 4: Head injury mortality rate, 0-19 years old, by sex and year, BC, 2001-2010

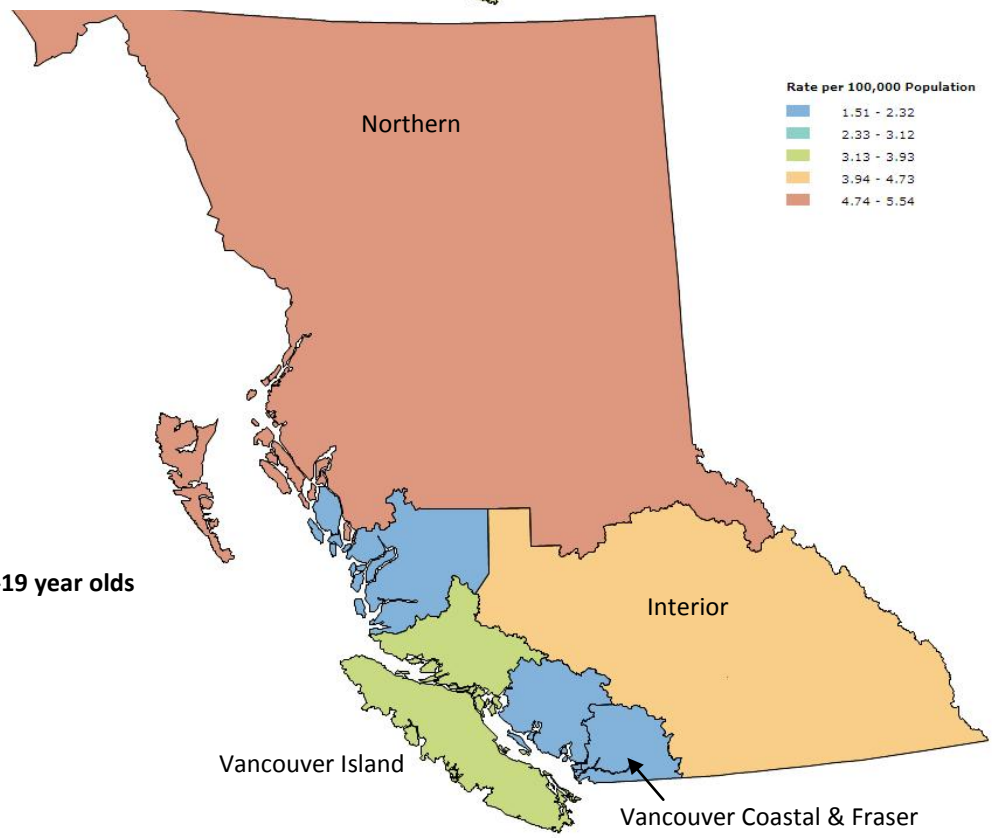


*Note: * indicates less than 5 cases*

Figure 5: Map of head injury standardized mortality rates for total population and age-specific rates for 0-19 year olds, BC, 2001-2010



Total Population



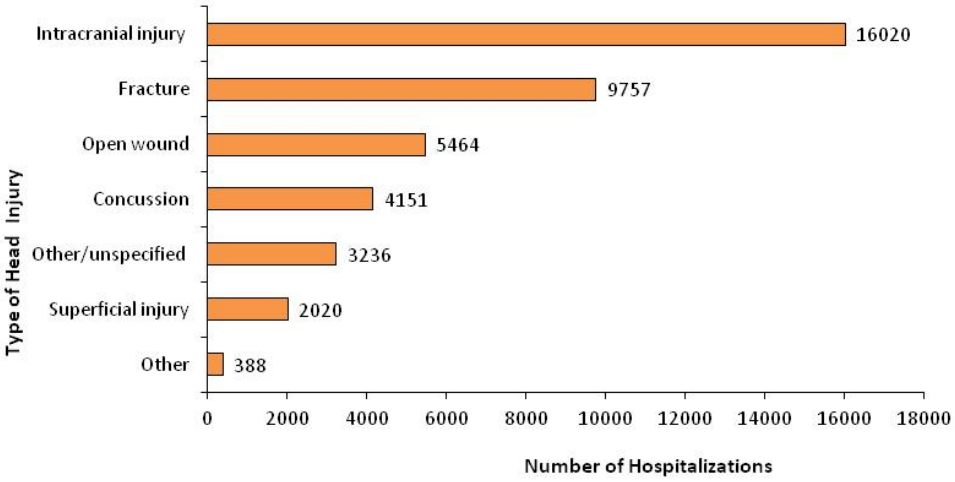
0-19 year olds

HOSPITALIZATION FOR CONCUSSIONS IN BC, 2001/02 – 2010/11

There were 42,766 hospitalizations resulting from head injuries in BC over the 10-year time period from 2001 to 2010. Males accounted for 64.1 percent (27,399) of these cases. Children and youth ages 0 to 19 years accounted for 22.2 percent (9,514) of all hospitalizations due to head injury.

Concussion accounted for 9.7 percent of all head injury hospitalizations (Figure 6). The leading cause was intracranial injury, which excludes concussion, at 37.5 percent. The leading causes for these concussions were Falls (46.8%) and Transport-related (40.9%) (data not shown).

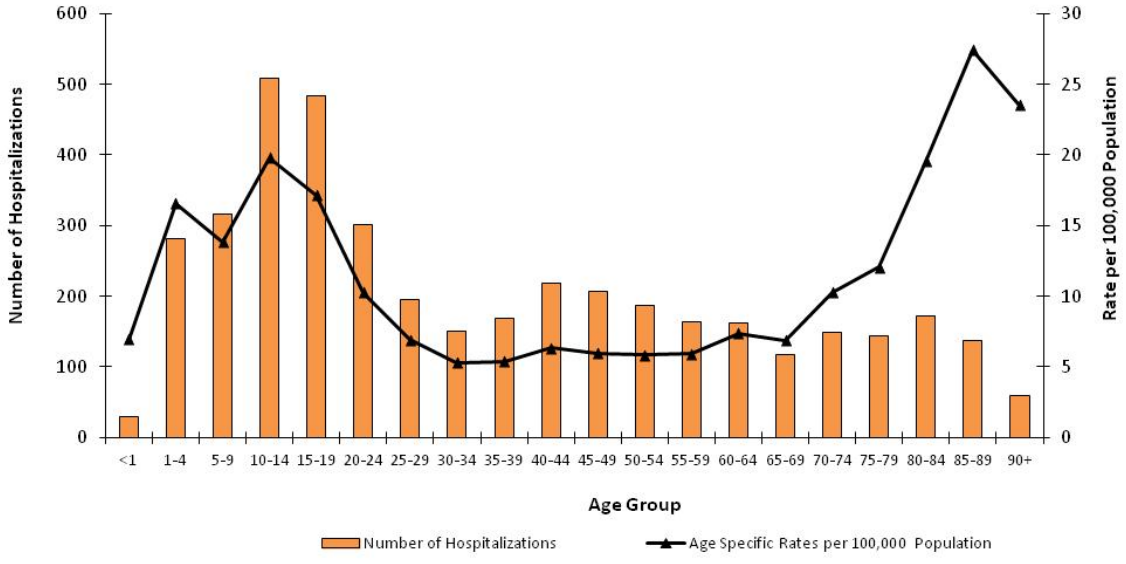
Figure 6: Number of head injury hospitalizations by type, BC, 2001/02 – 2010/2011



Concussion hospitalizations rates were lowest among 30 to 34 year olds (5.3/100,000), and highest among older adults aged 85 to 89 years and over (27.4/100,000) (Figure 7). Among children and youth, rates were highest among 10 to 14 year olds at 19.8 per 100,000, and second highest among teens 15 to 19 years of age at 17.1 per 100,000. Child and youth concussion hospitalization rates were lowest among infants less than one year of age at 6.9 per 100,000.

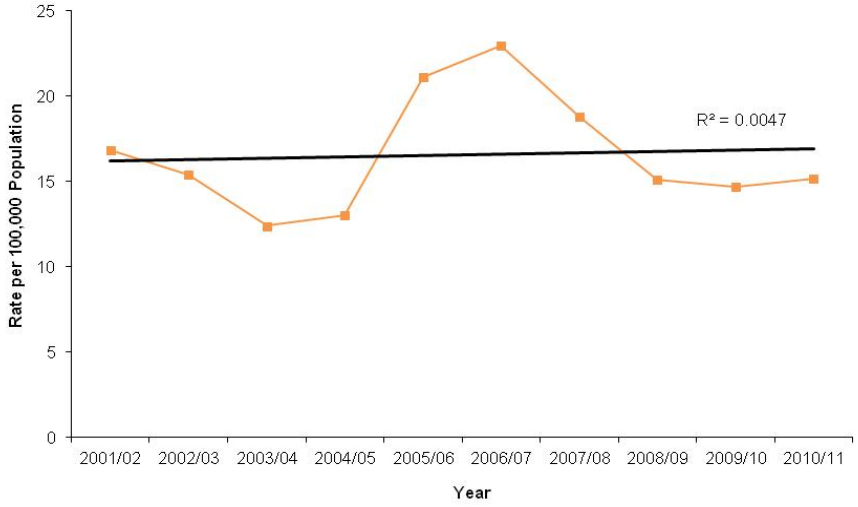
In terms of numbers, the least burden of concussion hospitalization is seen among infants less than one year of age and among the elderly ages 90 years and over. The greatest burden is seen to be among children and teens ages 10 to 19 years.

Figure 7: Concussion hospitalization rates and cases by age group, BC, 2001/02 – 2010/11



Concussion hospitalization rates among children and youth ages 0 to 19 years were seen to be variable from 2001/02 to 2010/11 (Figure 8). Rates peaked in 2006/07 at 23.0 per 100,000 and were lowest in 2003/04 at 12.4 per 100,000.

Figure 8: Concussion hospitalization rate, 0-19 years old, by year, BC, 2001/02 - 2010/11



As with mortality head injury rates for children and youth ages 0 to 19 years, hospitalization concussion rates were consistently higher among males within this age group from 2001/02 to 2010/11.

Males within the child and youth age limits accounted for 69.2 percent (1,121) of all concussions hospitalizations. Rates peaked for males in 2005/06 at 30.3 per 100,000, and were lowest in 2003/04 at 15.6 per 100,000. Rates peaked for females 0 to 19 years of age in 2006/07 at 15.8 per 100,000 and were lowest in 2010/11 at 7.9 per 100,000 (Figure 9).

Concussion standardized hospitalization rates for the total BC population indicate that rates are highest in Northern Health and lowest in Vancouver Coastal Health (Figure 5). Rates among children and youth 0 to 19 years mirrored the same rankings as the total population.

Figure 9: Concussion hospitalization rate, 0-19 years old, by sex and year, BC, 2001/02 – 2010/11

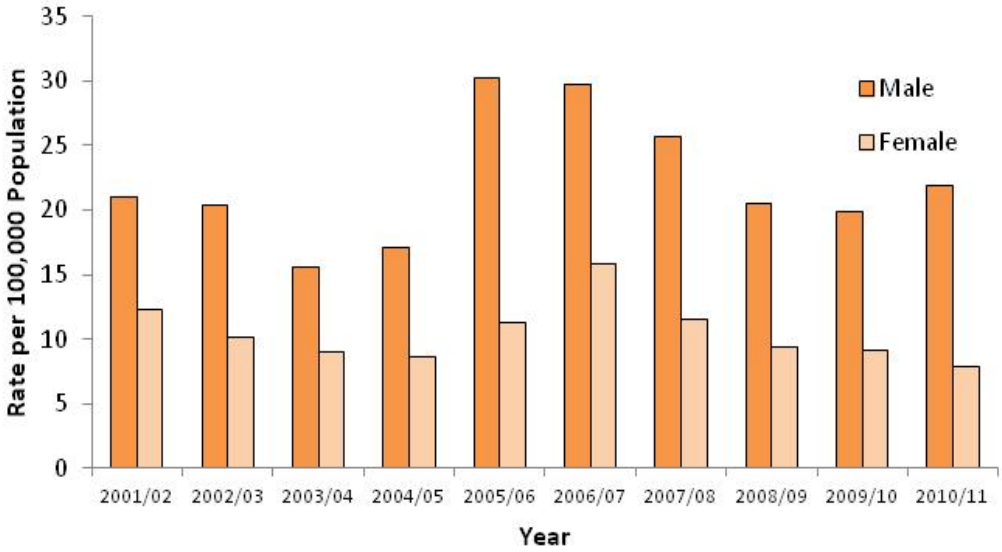
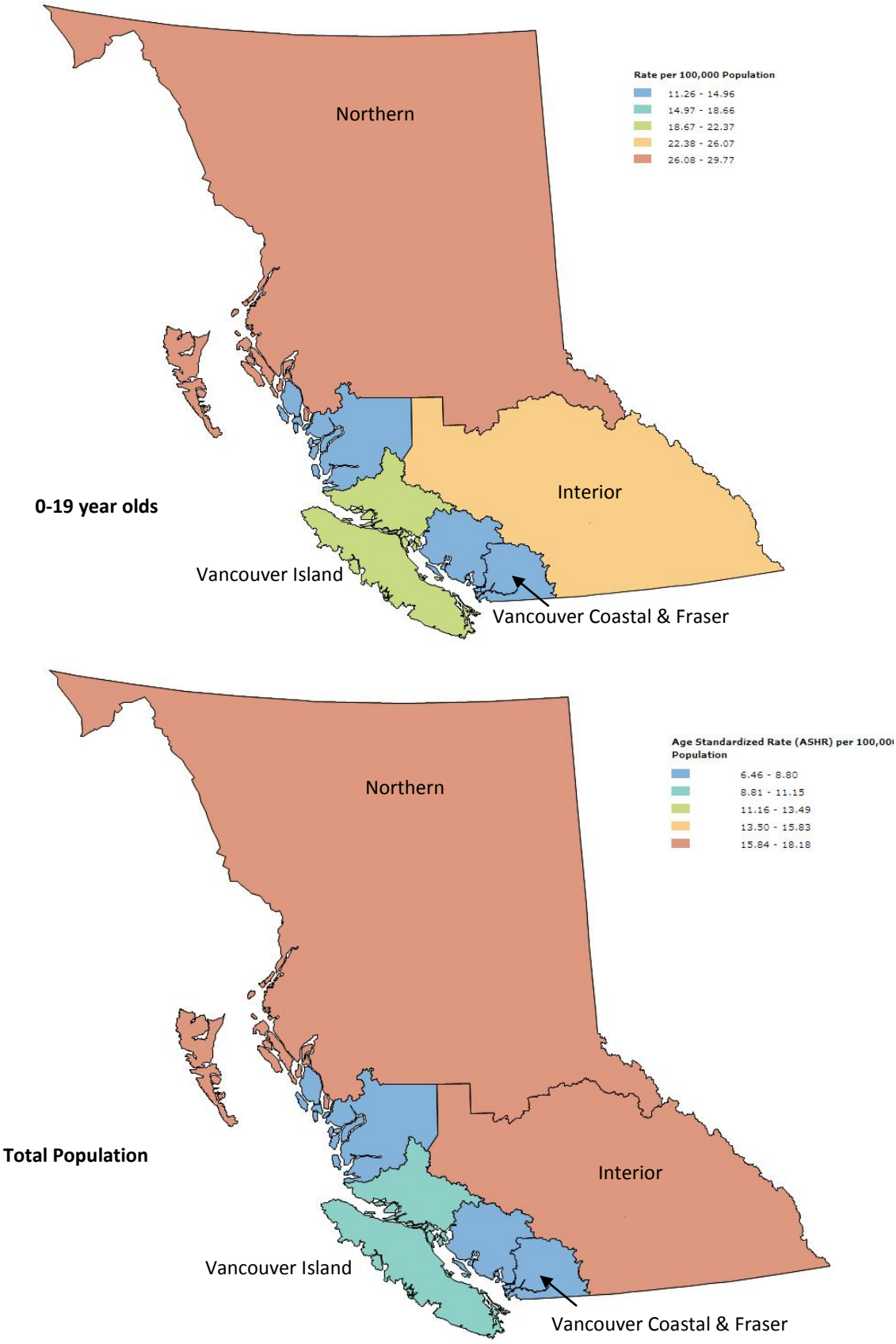


Figure 10: Map of concussion standardized hospitalization rates for total population and age-specific rates for 0-19 year olds, BC, 2001/02 - 2010/11



EMERGENCY DEPARTMENT VISITS FOR CONCUSSIONS, 2011

There were 16,888 concussions seen in emergency departments throughout the BC Lower Mainland in 2011: 6,651 from VCH (2011); 8,959 from FH (2011/12); and a further 1,278 children and youth ages 0 to 19 years presenting to BCCH (2009). (See next section for a detailed look at the cases presenting to BCCH.)
Males accounted for 59.4 percent (10,035) of these total cases. Children and youth ages 0 to 19 years accounted for 39.5 percent (6,675) cases; and among children and youth alone, males account for 63.7 percent of cases (4,250).

Of the nine participating VCH hospitals, St. Paul's had the highest number of emergency department visits at 1,749, followed by Vancouver General (1,251) and Lion's Gate (1,090) (Figure 11). Of the 12 participating FH hospitals, Surrey Memorial had the highest number of emergency department visits at 1,540, followed by Burnaby (1,122) and Royal Columbian (1,037).

Concussion emergency department rates were highest among infants less than one year of age (1,930.6/100,000), followed by young children ages 1 to 4 years (1,715.0/100,000) (Figure 12). The smallest burden of concussion emergency department visits is among infants less than one year of age (537) and among older adults 70 to 79 years (673). The greatest burden is among young adults 20 to 29 years (2,934).

Figure 11: Number of concussion emergency department visits by attending hospital, VCH 2011 and FH 2011/12

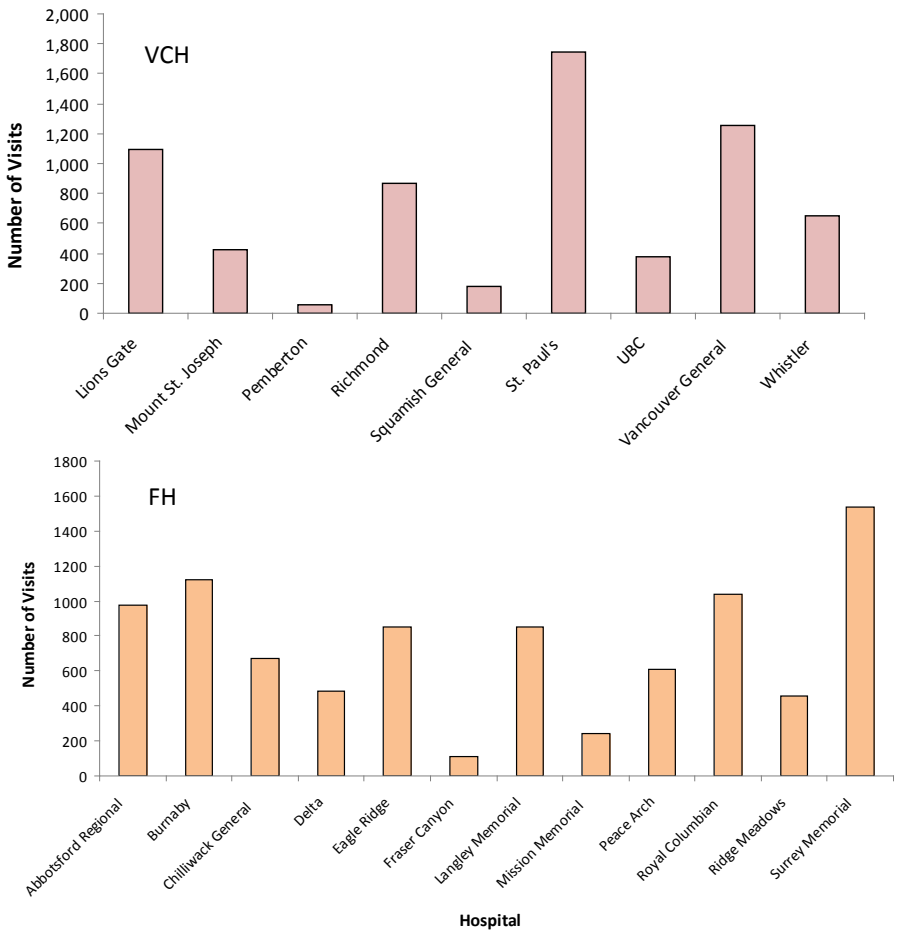
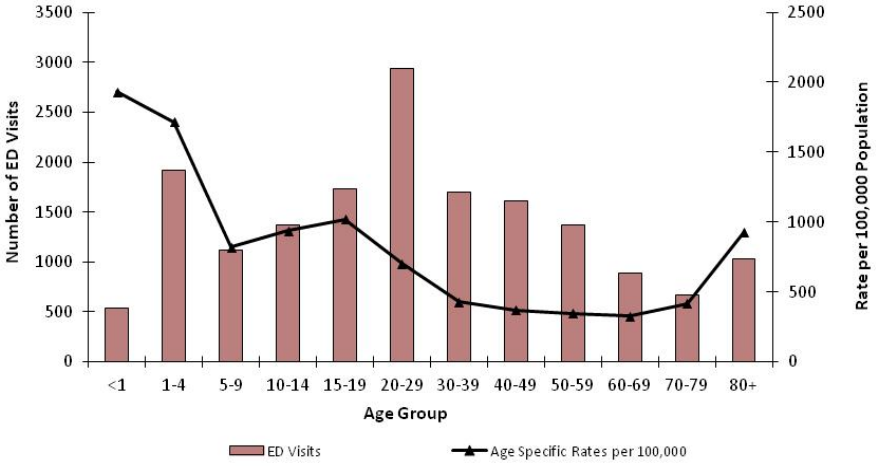


Figure 12: Concussion emergency department rates and cases by age group, BC Lower Mainland, 2011 (*VCH 2011; FH 2011/12; BCCH 2009)*



Note: Age Group was missing for 6 cases

No significant trends were found in the emergency departments of VCH during the period 2008 to 2011 (Figure 13).

Among children and youth, concussion emergency department rates were highest among female infants less than one year of age (1,960.7/100,000) and young males ages 1 to 4 years (1,943.0/100,000) (Figure 14). Rates were lowest among females 10 to 14 years at 541.6 per 100,000.

The cause of concussion injury was available for 68.9 percent (10,761) of the total of emergency department cases for VCH and FH. (Please see next section for a detailed look at the cases presenting to BCCH.) The leading cause of concussion was falls, representing 32.5 percent of cases (5,072) in 2011, followed by sports and recreational activities at 18.0 percent (2,814) and struck by or against an object at 9.4 percent (1,474) (Figure 15).

Figure 13: Number of concussion emergency department cases, VCH 2008-2011

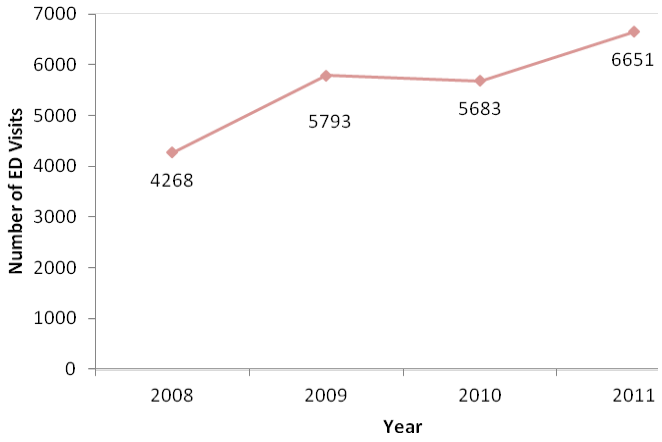


Figure 14: Concussion emergency department rates by sex, 0-19 years old, BC Lower Mainland, 2011 (*VCH 2011; FH 2011/12; BCCH 2009)*

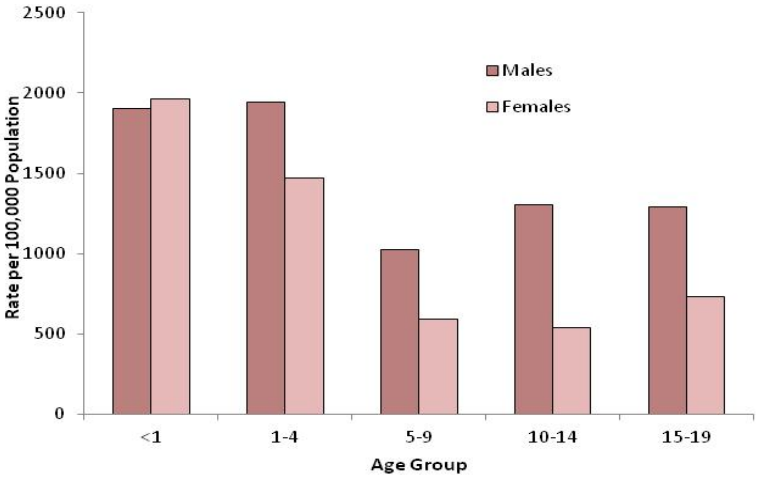
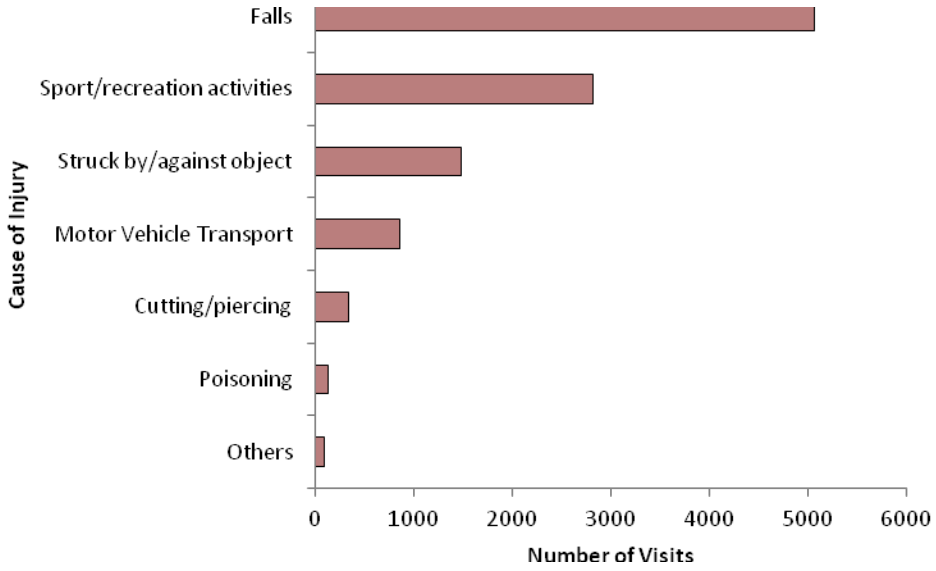


Figure 15: Number of concussion emergency department visits, by cause of Injury, Lower Mainland, 2011 (*VCH 2011 and FH 2011/12)*

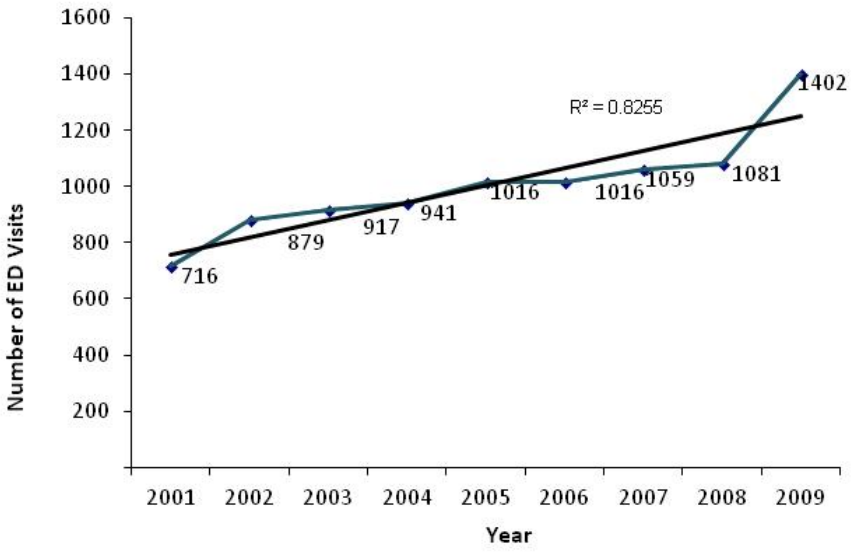


Note: Cause of Injury was missing for 4,849 cases

BC CHILDREN'S HOSPITAL EMERGENCY DEPARTMENT VISITS FOR CONCUSSION, 2001-2009

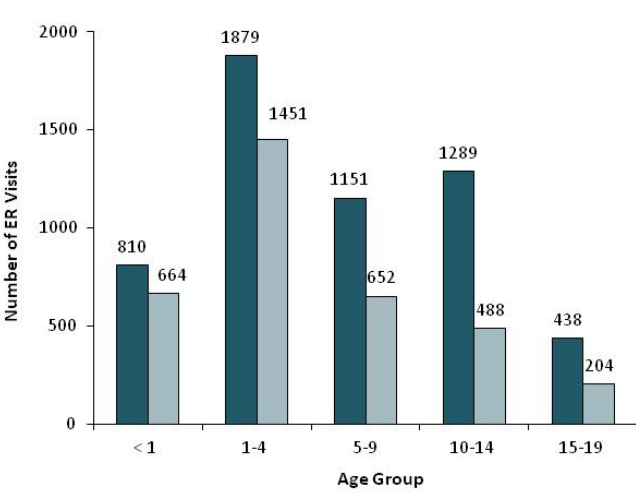
There were 9,027 children and youth ages 0 to 19 years presenting to BCCH with a concussion or minor head injury over the 9-year period from 2001 to 2009, as captured by the Canadian Hospital Injury Reporting and Prevention Program (CHIRPP). The annual number of presentations increased significantly (p= 0.001) from 716 in 2001 to 1,402 in 2009 (Figure 16).

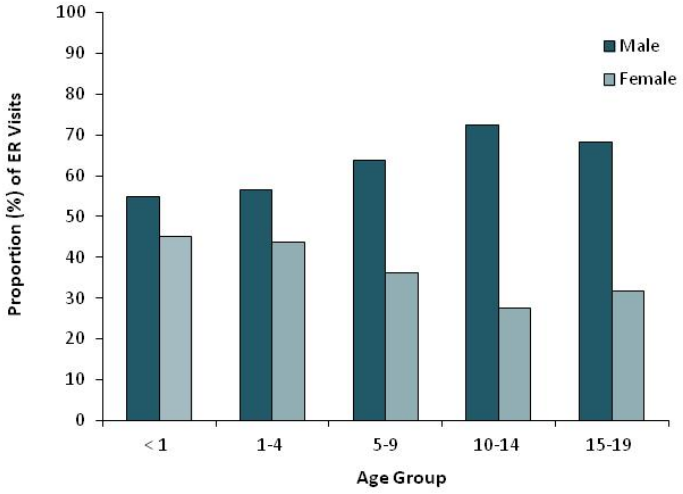
Figure 16: Number of concussion and minor head injury by year, 0-19 years old, BC CHIRPP, 2001-2009



Young children ages 0 to 4 years accounted for 53.2 percent (4,804); 5 to 9 year olds accounted for 20.0 percent (1,803); and 10 to 14 year olds 19.7 percent (1,778) of all concussion and minor head injury cases presenting to BCCH (Figure 17). Males accounted for 61.7 percent (5,567) of all cases. The proportion of males was greatest at 72.5 percent among 10 to 15 year olds and lowest at 55.0 percent among infants less than one year of age.

Figure 17: Number and proportions of concussion and mild head injury by age group and sex, 0-19 years old, BC CHIRPP, 2001-2009



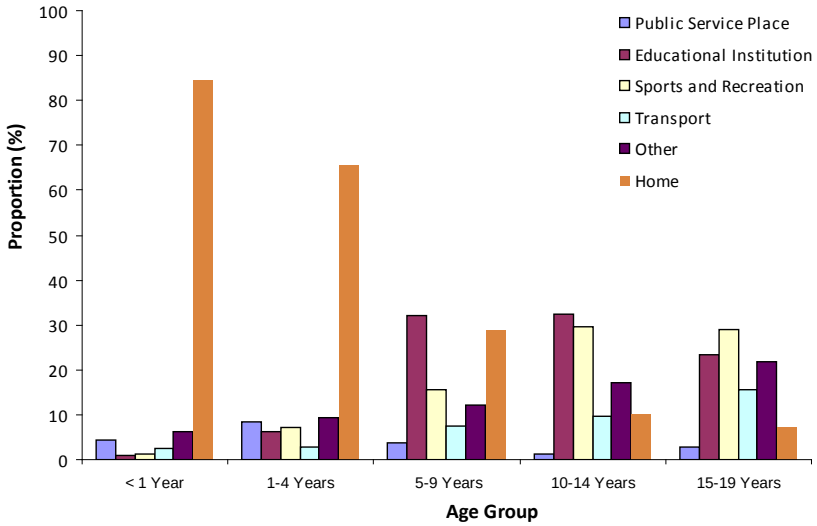


Note: Sex was missing for 1 case

Among infants less than one year of age, 84.3 percent of all concussions and minor head injuries occurred in the home setting (Figure 18). The proportion of concussions and minor head injury occurring at home decreased with age, being 65.3 percent among young children 1 to 4 years of age; 28.8 percent among 5 to 9 year olds; 10.1 percent among 10 to 14 year olds; and 7.5 percent among teens 15 to 19 years old.

These data show that concussion and minor head injury occurrences in educational institutions and places of sport and recreation increase with age.

Figure 18: Proportion of concussion and minor head injury by age group and location, 0-19 years old, BC CHIRPP, 2001-2009



Note: Location was missing for 66 cases

The highest proportion of cases occurring at educational institutions (32.0%) and sport and recreation facilities (29.2%) were both among children 10 to 14 years old. The highest proportion of cases occurring in areas of transport (15.4%) was among teens 15 to 19 years of age.

Context in the CHIRPP data is defined as what the injured person was doing when the injury happened, for example participating in a sport, traveling in a vehicle or playing. Among infants less than one year of age, 36.4 percent of all concussions and minor head injuries occurred while sitting, standing-passive, 21.4 percent while sleeping and resting, 11.2 percent while playing, dancing and climbing, and 10.2 percent while walking, running and crawling (Figure 19). Of those head injuries from sitting/standing, the majority were as a result of a fall (84.3%). The proportions of head injuries occurring while the child was playing were highest for 1 to 4 year olds (36.3%) and 5 to 9 year olds (38.5%). The highest proportions for organized sports were among 15 to 19 year olds (33.2%) and 10 to 14 year olds (27.7%). Other sport and recreation activities were more common among 10 to 14 year olds (22.2%) and 15 to 19 year olds (18.8%).

Figure 19: Proportion of child and youth concussion and minor head injury by age group and context, BC CHIRPP, 2001-2009

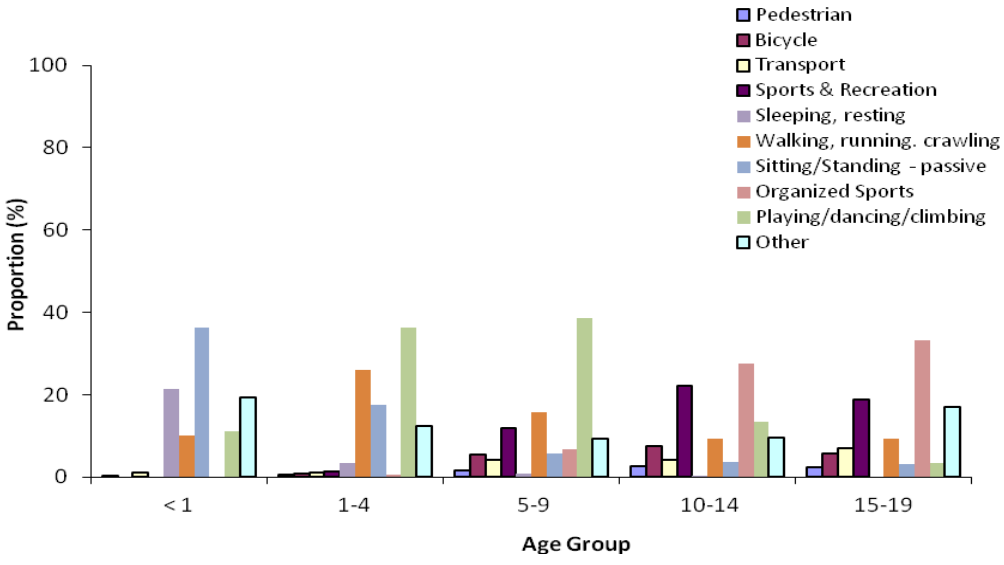


Table 1 provides context and location for children and youth ages 0 to 19 years sustaining concussion and mild head injury. Highest numbers of injuries were sustained in the home while playing, dancing and climbing (1,276), walking, running and crawling (921) and sitting, standing-passive (797). Playing, dancing, climbing accounted for 506 concussions and mild head injuries occurring in educational institutions and 277 occurring at sports and recreation locations. Organized sports accounted for 430 concussions and mild head injuries occurring in sport and recreation locations and 248 occurring in educational institutions. Sport and recreation activities accounted for 304 injuries occurring in sport and recreation locations and 246 occurring in educational institutions.

Table 1: Number of child and youth concussion and minor head injury by context and location, 0-19 years old, BC CHIRPP, 2001-2009

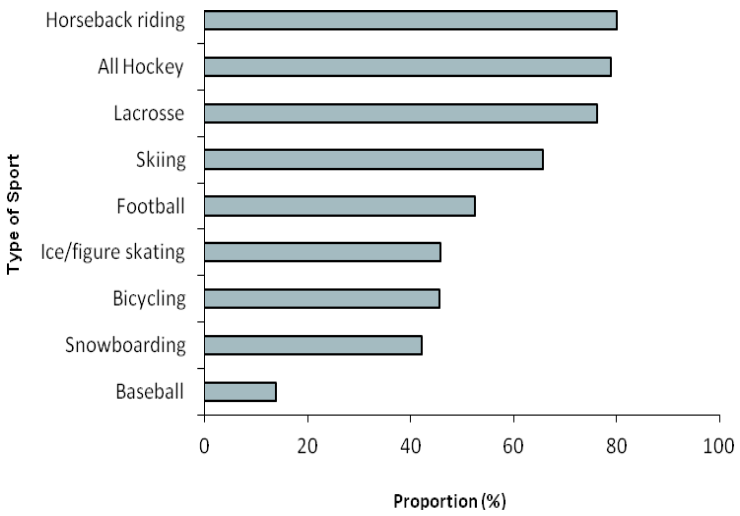
	CONTEXT										
LOCATION	Pedestrian	Bicycle	Transport	Sports & Recreation	Sleeping, resting	Walking, running, crawling	Sitting, standing -passive	Organized Sports	Playing, dancing, climbing	Other	**Total**
Public Service Place	0	*	5	5	9	84	206	0	63	78	**451**
Educational Institution	*	21	*	246	*	241	95	248	506	148	**1511**
Sports and Recreation	0	61	10	304	0	75	44	430	277	39	**1240**
Transport	91	107	158	37	*	56	32	0	17	38	**537**
Other	20	68	68	167	11	144	130	164	189	163	**1124**
Home	*	44	6	81	428	921	797	*	1276	608	**4164**
Total	**114**	**302**	**249**	**840**	**452**	**1521**	**1304**	**843**	**2328**	**1075**	**9027**

*Note: * indicates less than 5 cases.*

Concussions and mild head injuries sustained while engaging in sports activities, either organized sports or other sports and recreation, demonstrate a variation in helmet use. Injuries sustained while horseback riding (80.0%) had highest proportion of helmet use, followed by playing all types of hockey (78.8%) and lacrosse (76.2%) (Figure 20). The sport with the lowest proportion of helmet use was baseball (13.8%).

Note: Safety device information was not available for 367 cases

Figure 20: Proportion of concussion and mild head injury by Type of Sport and Helmet Use, 0-19 years old, BC CHIRPP, 2001-2009



METHODOLOGY

DATA SOURCES

The five datasets used for this report were:

- BC Vital Statistics
- Discharge Abstract Database
- Vancouver Coastal Health (VCH), Public Health Surveillance Unit, Emergency Department Data
- Fraser Health (FH) Emergency Department Data
- BC Children's Hospital Emergency Department data from the Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP)

Mortality: Mortality data were provided by the BC Vital Statistics Agency. This report is based on 2,781 head injury deaths from 2001 to 2010 among known residents of BC. The mortality dataset includes external causes of death classified as injury deaths according to the International Classification of Diseases (ICD-10) [9]. Head injury cases were extracted using ICD-10 codes S00-S09.

Hospital Separations: Source data were obtained from the Discharge Abstract Database, BC Ministry of Health Services. This report is based on 42,766 head injury hospitalizations during the fiscal years 2001/02 to 2010/11 among known residents of BC. Data for this study include external causes of injury classified according to ICD-10. Causes of injury categories were derived according to the same coding scheme as used for mortality data. In addition to head injury hospitalizations, concussion-related hospitalizations were also extracted separately using ICD-10 code S06.

Vancouver Coastal Health: Emergency department visit data for the years 2008 to 2011 were obtained from nine of thirteen acute care hospitals: CareCast System (Richmond Hospital, UBC Hospital, Vancouver General Hospital), Eclipsys System (Mount Saint Joseph Hospital, St. Paul's Hospital) and McKesson System (Lions Gate Hospital, Pemberton Health Centre, Squamish General Hospital, Whistler Health Care Centre). Concussion data were extracted through ICD9 code 800-804, 850-854, 907.0 and 959.01 and keywords "concussion" or "head injury" where indicated in presenting complaints or discharge diagnoses..

Fraser Health: Data for the fiscal year 2011/12 were obtained for head injuries from decision support services in Fraser Health. The twelve participating hospitals included: Abbotsford Regional, Burnaby, Chilliwack General, Delta, Eagle Ridge, Fraser Canyon, Langley Memorial, Mission Memorial, Peace Arch, Royal Columbian, Ridge Meadows, and Surrey Memorial. The raw data included information by facility. Head injury information was captured using the patient chief and stated complaints, as well as description. The patient chief and stated complaint fields did not capture concussions and therefore the data required some cleaning and coding so that concussion information could be captured using both the complaint fields as well as the description field.

BC CHIRPP: Data were extracted from the emergency department of BC Children's Hospital (BCCH) for the period 2001-2009. This report is based on 9,028 injuries captured by BC CHIRPP. This surveillance system collects in-depth information regarding the patient's age and sex; the activity when injured, cause of injury, and factors contributing to the injury; the nature of injury, body area affected by the injury and the outcome of the emergency department visit.

Analysis

Mortality and hospitalization rates were calculated per 100,000 population for age, sex, year, leading cause of injury and Health Authority. Age-specific and crude rates are used throughout the report in order to describe actual burden rather than comparative rates across time and regions (where age-standardized rates would normally be used).

The age-specific rates were calculated by dividing the number of cases in each age group by the population of that specific age group.

As CHIRPP data are not population based, rates can not be calculated based on this database alone. In order to calculate rates, the CHIRPP data for 2009 was extracted by postal code and matched to its corresponding health authority. Cases for the Lower Mainland were then identified. Emergency department visit rates for Lower Mainland were calculated using the total number of cases from CHIRPP 2009 Lower Mainland data for ages 0-19,

2011 VCH data and 2011/12 FHA data. The 2009 CHIRPP data was used as an estimate for the most recent year. Lower Mainland population data for ages 0-19 years was calculated using the average FHA and VCHA population for 2009 and 2011. The remaining age-specific rates were calculated using 2011 population. Population data were obtained from BC Vital Statistics Agency.

Trend analyses were conducted using a linear regression model to test the statistical significance of the association between injuries over time. This test appraises the linear component of the relationship between injury rates and scores allocated to the categories of time (calendar years).

The in-depth analysis of BC CHIRPP data allowed for the examination of several variables describing the pre-injury, injury and post-injury phases [10]. Specifically, patterns of injury among males and females were described by time (year, month, day of the week, and time of day), location of injury (where the injury occurred), activity and nature of injury. This provides additional information that is not captured in the mortality, hospitalization or other emergency department datasets.

Data Limitations

Concussion as a health event is recognized to be under reported and inconsistently coded. Concussion may also be labels a mild traumatic brain injury (mTBI), or sometimes as a head injury (which may include other injuries not involving the brain).

Complete accuracy and consistency of mortality data cannot be assumed because physicians and other health professionals responsible for diagnosing and coding the cause of death differ in their skills and practices. Some variation in death certification and coding practices may exist. None of the mortality head injury cases were coded as concussion; however 49.4 percent were “other/ unspecified head injury”.

Hospitalization data can vary over time and between areas for factors not related to health, such as accessibility of treatment, and medical and administrative decisions that may affect the number of hospitalizations and lengths of hospital stay [11, 12].

The CHIRPP emergency department data are not representative of all regions of BC. BC Children’s Hospital (BCCH) is the only BC hospital participating in CHIRPP, capturing children from across the Lower Mainland as well as higher severity cases from across BC. As such, this is not considered to be stand-alone population-based data; data are presented as frequencies and proportions only. It is also important to note that CHIRPP forms may not be completed for all injuries seen in the emergency department as it may not be the parent’s nor physician’s priority at the time of admittance. As a result, there may be missing data for certain variables and cases.

When combining emergency department data from VCH, FH and BCCH, the data are reported as 2011 in order to obtain rates for the lower mainland. For VCH, this represents the 2011 calendar year. For FH this represents the fiscal 2011/12 year. However, for BCCH, the most recent data available are for 2009. These data (i.e. BCCH) have been used as a proxy for the 2011 numbers when added to the VCH and FH emergency department data.

Although external causes of injury are uniformly classified and analyzed according to the ICD-10 for both mortality and hospitalization data, CHIRPP data are not coded using this system. Further, VCH data were coded using ICD-9, while FH data were pulled based on text. Therefore the emergency department data presented are the best representation of concussion available at this time.

REFERENCES

[1] Trzepacz P. Book Review. Sports Neuropsychology: Assessment and Management of Traumatic Brain Injury (ed. RJ Echemendia). Neuropsychiatry Clin Neurosci 2008; 20 (4): 504

[2] American Association of Neurological Surgeons (AANS) July 2010 http://www.aans.org/Patient%20Information/Conditions%20and%20Treatments/Sports-Related%20Head%20Injury.aspx accessed Sept 27, 2011

[3] CBC News. Kelly Crow. Q&A Concussion: Q&A with Dr. Charles Tator. Posted Feb 22, 2011

[4] Guskiewicz KM, Weaver NL, Padua DA, Garrett WE Jr. Epidemiology of concussion in collegiate and high school football players. Am J Sports Med 2000;28(5):643-50

[5] Ackery A, Provvidenza C, Tator C. Concussion in hockey: compliance with return to play advice and follow-up status. Can J Neurol Sci 2009; 36:207-12.

[6] Echlin P. Concussion education, identification, and treatment within a prospective study of physician-observed junior ice hockey concussions: social context of this scientific intervention. Neurosurg Focus 2010; 29 (5):E7. 1-13

[7] Zygun DA, Laupland KB, Hader WJ Kortbeek JB, Findlay C, Doig CJ, Hameed SM. Severe traumatic brain injury in a large Canadian health region. Can J Neurol Sci, 2005;32:87-92.

[8] Guskiewicz KM & Valovich McLeod TC. Pediatric sports-related concussion. Am Acad Phys Med Rehab 2011;3:353-364.

[9] World Health Organization. Manual of the International Statistical Classification of Diseases. Tenth Revision), Vol 1. Geneva: World Health Organization, 2005.

[10] Haddon W Jr. Advances in the epidemiology of injuries as a basis for public health policy. Public Health Reports 1980;95:411-21.

[11] Walsh SS & Jarvis SN. Measuring the frequency of “severe” accidental injury in childhood. J Epi Com Health 1992;46:26-32.

[12] Chevalier S, Choiniere, R, Ferland, M, Pageau, M, & Sauvageau, Y. Community Health Indicators: Definitions and Interpretations. Ottawa: Canadian Institute for Health Information, 1995.