

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 in the Evidence to Innovation theme within the Child and Family Research Institute (CFRI) and supported by the Provincial Health Services Authority (PHSA) 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".

Acknowledgements: The BC Injury Research and Prevention Unit (BCIRPU) would like to acknowledge the contributions of Child Health BC in the development of this report. In particular, BCIRPU would like to acknowledge Jennifer Scarr, Provincial Lead, Health Promotion, Prevention and Primary Care, Child Health BC, who assisted in obtaining the National Ambulatory Care Reporting System data and provided the maps. Child Health BC is a network of BC 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.

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Suggested Citation:

Ramsden R, Wada M, Rajabali F, Turcotte K, Babul S. Concussion in Children and Youth: Interior Health Authority. Vancouver, BC: BC Injury Research and Prevention Unit; 2015.

KEY HIGHLIGHTS

The purpose of this report is to provide details on the burden of concussion hospitalizations among children and youth in Interior Health Authority. This report is targeted to health care providers and community stakeholders in the health authority to be used to facilitate discussion of the need for standardized concussion prevention, diagnosis and management specific to children and youth.

Evidence suggests that children and youth are at greater risk of concussion and more serious head injury than the general population, take longer than adults to recover following a concussion, and that concussions can permanently change the way a child or youth talks, walks, learns, works and interacts with others.

Concussion management and appropriate return to activity is crucial, particularly in the paediatric 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 cases neuropsychiatry.

It is important to note that an individual is 3-times more likely to sustain a second concussion while recovering from the primary concussion. Furthermore, while a rare occurrence, a condition known as second-impact syndrome (SIS) may occur if a second injury to the brain is sustained within a day or two after the first concussive event. This leads to swelling of the brain that can result in brain damage, causing severe disability and in a few cases even death.

Concussions are the most common form of head injury, yet this significant health issue is under-reported due to a lack of education and awareness among the general public and inconsistent and limited availability of data around the burden of this injury. The data presented in this report represent only a fraction of the children and youth that may have sustained a concussion as this report does not capture concussions treated at physicians' offices, walk-in clinics, or those not recognized and treated at all.

Highlights include:

- From 2001/02 – 2013/14 there were 630 concussion hospitalizations among children and youth aged 0 to 19 years who reside within Interior Health.
- Male children and youth in Interior Health had more than twice the rates of concussion hospitalizations as females (43.2/100,000 vs 19.2/100,000).
- The leading causes of child and youth concussion hospitalizations in Interior Health were due to falls (42%) and transport-related events (40%).
- Among children and youth aged 0 to 19 years in Interior Health, those under the age of five years had the highest rates of fall-related concussion hospitalizations (20.4/100,000) and older youth aged 10 to 19 years had the highest rates for transport-related concussions (18.5/100,000).
- Leading causes of child and youth fall-related concussion hospitalizations in Interior Health were 'fall involving skates, skis and skateboards' (18.1%) and 'fall involving bed, chair and other furniture' (16.2%).
- Older youth in Interior Health experienced a larger proportion of sports-related concussion hospitalizations as compared to younger children, with a greater rate of occurrence among males than females.
- Cycling (36.5%), ski and snowboard (10.1%) and playground (8.7%) activities were the greatest contributors for sport and recreation-related concussion hospitalizations in Interior Health among both males and females of all ages 0 to 19 years.
- Child and youth residents within East Kootenay had the highest rates of concussion hospitalizations (51.0/100,000), with 93.9 percent admitted to Interior Health hospitals. Rates within East Kootenay and Kootenay Boundary were high among all age groups, except for infants less than one year of age.

Concussions remain a significant health issue for children and youth in Interior Health, and require further attention given the potential long-lasting effects. This may include concussion prevention, education and awareness, standardizing care, ensuring correct treatment protocols are adhered to and appropriate concussion management is employed.

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INTRODUCTION

Children and youth are at greater risk of concussions and more serious head injury than the general population. Concussions are the most common form of head injury, yet it is believed that they are under-reported owing to both a lack of consensus in the definition of a concussion and the presence of misconceptions among the general public on the symptoms of concussions [1]. The rate of concussion hospitalization in the adult at-risk population has been measured at 1 to 3 per 1,000 in the United States, but it is estimated that the true concussion rate could be as high as 6 per 1,000 [2]. Nonetheless, concussions reportedly account for 3 to 8 percent of all sports-related injuries among youth presenting to urban emergency departments in Canada, which is expected to increase as public awareness rises [1, 3]. Furthermore, studies using national injury reporting databases in the United States indicate that sports-related injuries are responsible for 46 to 58 percent of all concussions suffered by youth between the ages of 8 and 19 years [1, 4]. Comparable Canadian data are not available.

Concussion, also known as mild traumatic brain injury (mTBI), occurs as a result of an impact to or forceful motion of the head or other part of the body, resulting in a jarring of the brain. This may lead to a brief alteration of mental status, which may include: confusion, loss of memory directly preceding the event, sensitivity to light, slurred speech, dizziness, emotional changes, and may or may not be accompanied by loss of consciousness or seizures [1, 5, 6].

Evidence exists that children and youth take longer than adults to recover following a concussion [1], and that concussion 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 protocol are crucial, particularly in the paediatric 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 cases neuropsychiatry. It is important to note that an individual is 3-times more likely to sustain a second concussion while in recovery from a concussion [7]. Also, while rare, a condition known as second-impact syndrome (SIS) may occur if a second injury to the brain is sustained within a day or two of the first concussion event, where swelling of the brain that can result in brain damage causing severe disability or even death [8].

Purpose

The purpose of this report is to provide details on the burden of concussion hospitalizations among children and youth living within the Interior Health Authority. In addition, this report provides details on emergency department visits among children and youth attending Royal Inland Hospital in Interior Health.

This report will be used to facilitate discussion of the need for standardized concussion prevention, diagnosis and management specific to children and youth.

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

METHODOLOGY

Data Sources

Hospitalization Data: Discharge Abstract Database (DAD) obtained from the BC Ministry of Health was used to provide information on concussion hospitalizations for the fiscal years 2001/02 to 2013/14. The data includes external causes of injury classified according to *International Classification of Disease (ICD)-10 CA*. In 2001, injury hospitalization data coding switched from ICD-9 to ICD-10 CA. By 2002, all hospitals in BC reported using ICD-10 CA for their Discharge Abstract Data. Differences in numbers between 2001 and 2002 may be attributed to some hospitals still converting to the new coding structure. Concussion hospitalizations were also extracted separately using ICD-10 CA code S06. The hospitalization data include all acute, rehab and day surgery cases. The data are based on hospital separations rather than on patient, therefore multiple admissions of the same patient for the same injury are counted as separate cases.

Emergency Department Visit Data: The emergency department data are part of the National Ambulatory Care Reporting System (NACRS). Data were available and obtained from Decision Support Services, Provincial Services Health Authority (PHSA) for Royal Inland Hospital only from April 1, 2013 to December 31, 2013.

Data were obtained from Decision Support Services, Provincial Health Services Authority (PHSA). The emergency department data are part of the National Ambulatory Care Reporting System (NACRS). Data were available by age, sex and type of injury. Unintentional concussion emergency department visits were extracted separately using ICD-10 CA code S06. External codes for injury were not available and data by cause of injury are therefore not presented for emergency department visits.

Analysis

Hospitalization rates were calculated per 100,000 population for age, sex, year and leading cause of injury. Age-specific and crude rates are used in the report 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 within Interior Health. Rates presented by region are based on the patients' residence and not the location of injury occurrence.

Emergency department rates for Royal Inland Hospital were calculated per 100,000 emergency department visits for all diagnoses.

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). In addition, Z tests for proportions were conducted to test significance between age groups and region.

Definitions for leading causes of concussion:

- Transport-related events include: crashes involving cars, trucks, motorcycles, bicycles, pedestrians, etc.
- Falls include: fall on the same level, fall from a height, falls on stairs or steps, fall from a building or other structure, etc.
- Struck by/against an object includes: forceful contact with a falling object, striking against or struck accidentally by objects or persons, and caught between objects, depending on the coding system, struck by/against an object involving sport may be captured by *sports and recreation*

activities. This category does not include assault.

- Sports and recreational activities include: falls on same level from collision, pushing, or shoving, by or with other person in sports, striking against or struck accidentally by objects or persons in sports, and object in sports with subsequent fall.

Data Limitations

Concussion as a health event is recognized to be under-reported and inconsistently coded.

Concussion is often not clearly defined and may also be labelled as a minor traumatic brain injury (mTBI), or sometimes as a 'head injury' which may include other injuries not involving the brain.

The data presented in this report represent only a fraction of the children and youth that may have sustained a concussion. This report does not capture concussions treated at physician offices, medical clinics, or not treated at all.

Hospitalization data can vary over time and between areas for factors not related to health, such as accessibility of treatment, and medical or administrative decisions that may affect the number of hospitalizations and lengths of hospital stay [9, 10].

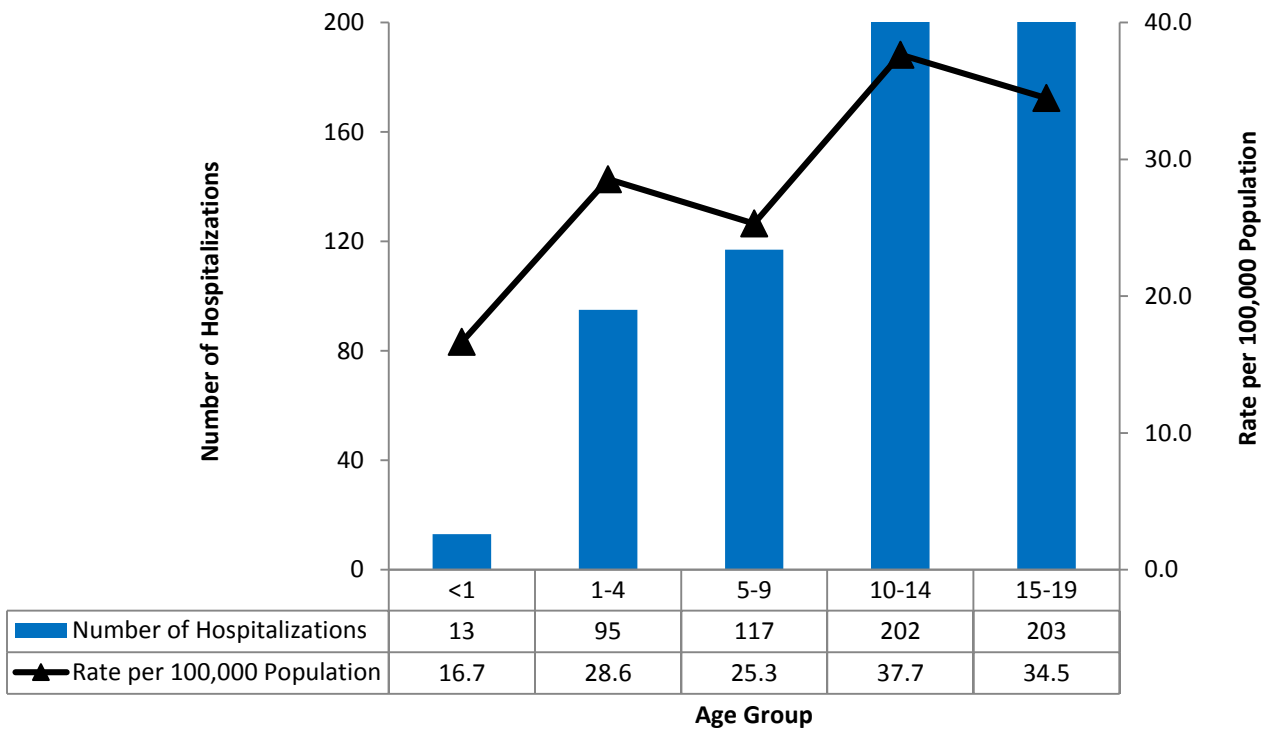
Emergency department data from NACRS was not available for Kelowna General Hospital. As a result, emergency department visit data for concussion in Interior Health has been underestimated. In addition, there is further underestimation of the emergency department visits relating to concussion as emergency department discharge diagnosis information for Royal Inland Hospital was incomplete due to technical difficulties at this hospital.

CONCUSSION HOSPITALIZATION

There were 630 hospitalizations among children and youth aged 0 to 19 years resulting from concussion within Interior Health over the 13-year period from 2001/02 to 2013/14. Concussion hospitalization rates were lowest among infants less than one year of age (16.7/100,000), and

highest among 10 to 14 year olds (37.7/100,000), followed by youth 15 to 19 years of age (34.5/100,000) (Figure 1).

Figure 1: Concussion hospitalization rates and counts by age group, ages 0-19 years, Interior Health, 2001/02 - 2013/14.



Concussion hospitalization rates among children and youth were seen to vary from 2001/02 to 2013/14 (Figure 2). Rates peaked in 2001/02 at 46.1 per 100,000 and were lowest in 2013/14 at 22.3 per 100,000. Concussion hospitalization rates were consistently higher among males than females from 2001/02 to 2013/14.

Concussion hospitalization rates peaked for males aged 0 to 19 years in 2002/03 at 59.8 per 100,000, and were lowest in 2013/14 at 25.9 per 100,000 (Figure 2). Rates peaked for

females in 2001/02 at 31.9 per 100,000 and were lowest in 2004/05 at 13.2 per 100,000.

Males accounted for 70.3 percent (n=443) of all concussion hospitalizations among children and youth. Rates for males were higher than for females in all age groups. Males accounted for the highest rate of concussion hospitalizations among children aged 10 to 14 years (58.2/100,000), in comparison to females within this age group (16.1/100,000) (Figure 3).

Figure 2: Concussion hospitalization rates by year and sex, ages 0-19 years, Interior Health, 2001/02 - 2013/14.

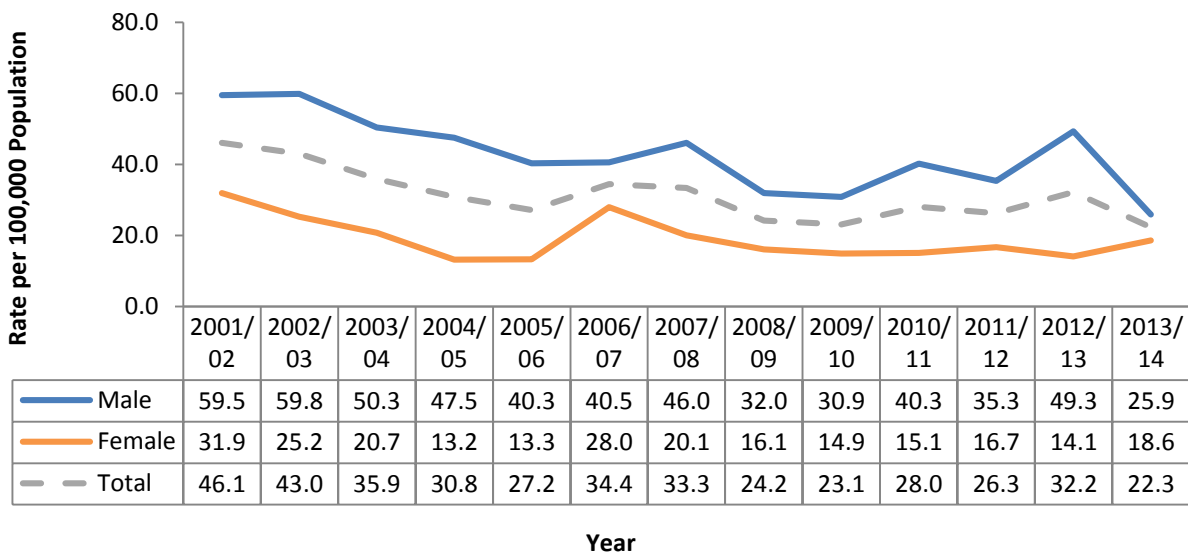
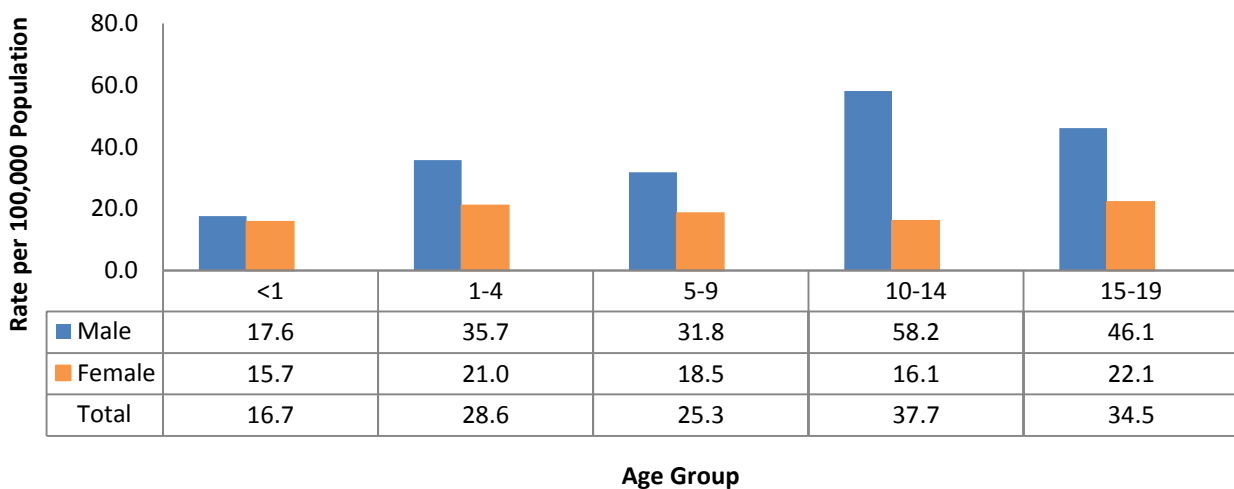


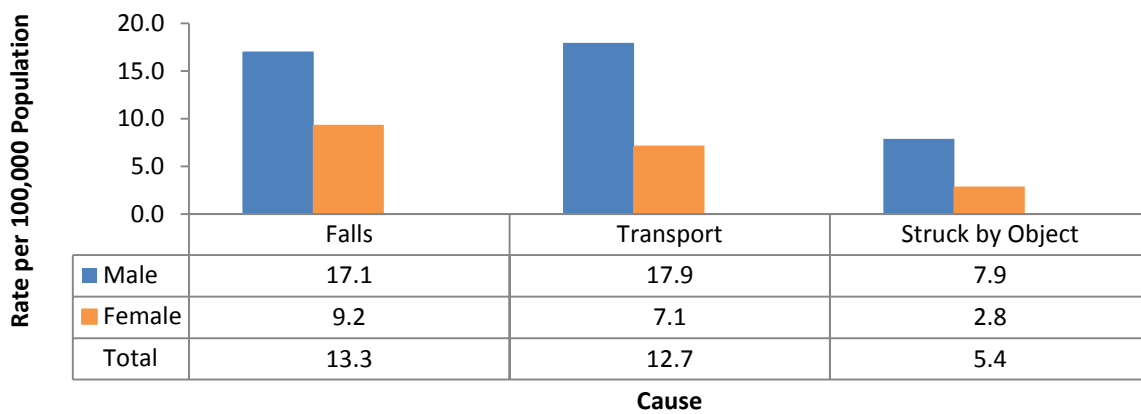
Figure 3: Concussion hospitalization rates by age group and sex, ages 0-19 years, Interior Health, 2001/02 - 2013/14.



Leading causes of concussion hospitalization among children and youth included falls, transport-related events and struck by/against an object (Figure 4). Transport-related concussion hospitalizations were the leading cause for males at 17.9 per 100,000 and falls were leading for females at 9.2 per 100,000. Of those concussions caused by struck by/against an object, 73.1 percent occurred during sport and recreation activities.

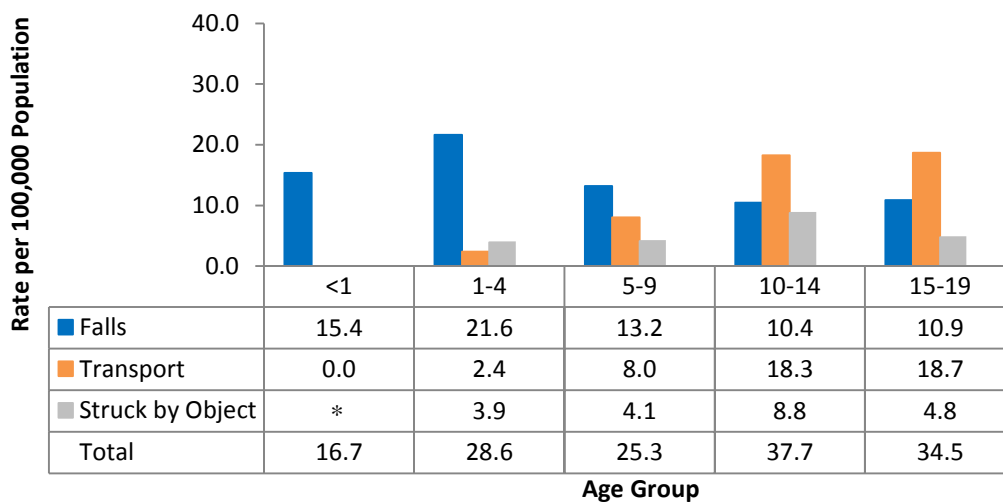
Leading causes varied by age group, with falls being the leading cause for 0 to 9 year olds, while transport-related events were the leading cause of concussion hospitalizations for 10 to 19 year olds (Figure 5). Concussion hospitalization rates for falls were highest among 1 to 4 year olds (21.6/ 100,000), while transport-related concussion rates were highest among both 10 to 14 and 15 to 19 year olds (18.3/ 100,000 and 18.7/100,000, respectively).

Figure 4: Concussion hospitalization rates by cause and sex, ages 0-19 years, Interior Health, 2001/02 - 2013/14.



Note: * Represents fewer than 5 cases. Total also includes other causes of concussion hospitalizations which are not shown as there are no or fewer than 5 cases.

Figure 5: Concussion hospitalization rates by cause and age group, ages 0-19 years, Interior Health, 2001/02 - 2013/14.



Note: * Represents fewer than 5 cases; Total also includes other causes of concussion hospitalizations which are not shown as there are no or fewer than 5 cases.

Fall-related Concussion Hospitalization

Concussion hospitalizations among children and youth resulting from a fall were primarily the result of falls involving skates, skis, skateboards (18.1%, n=48), falls from furniture (16.2%, n=43) and falls on the same level (14.0%, n=37) (Figure 6). One-fifth of cases were classified as “other and unspecified” falls (20.4%, n=54). Falls from furniture were most common among infants less than one year of age (9.0/100,000). Among young

children aged 1 to 4 years, the leading causes of concussion hospitalization rates were attributable to falls from furniture (7.2/100,000) and falls from stairs/steps/ladder/scaffolding (3.3/100,000) (Figure 7). Falls involving skates, skis and skateboards were more common among older youth aged 10 to 14 years (3.0/100,000) and 15 to 19 years (4.4/100,000).

Figure 6: Proportion of fall-related concussion hospitalizations by type of fall, ages 0-19 years, Interior Health, 2001/02 - 2013/14.

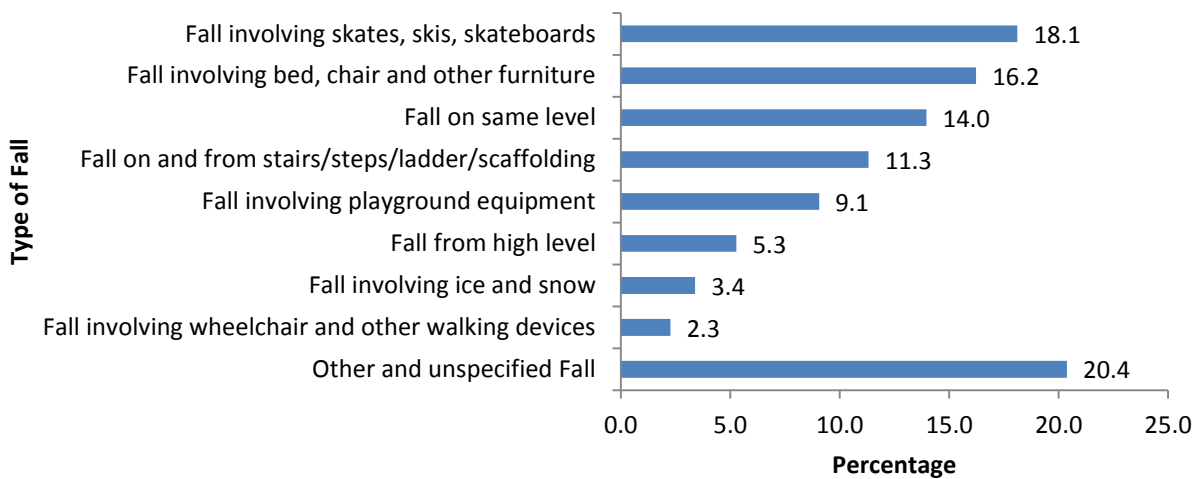
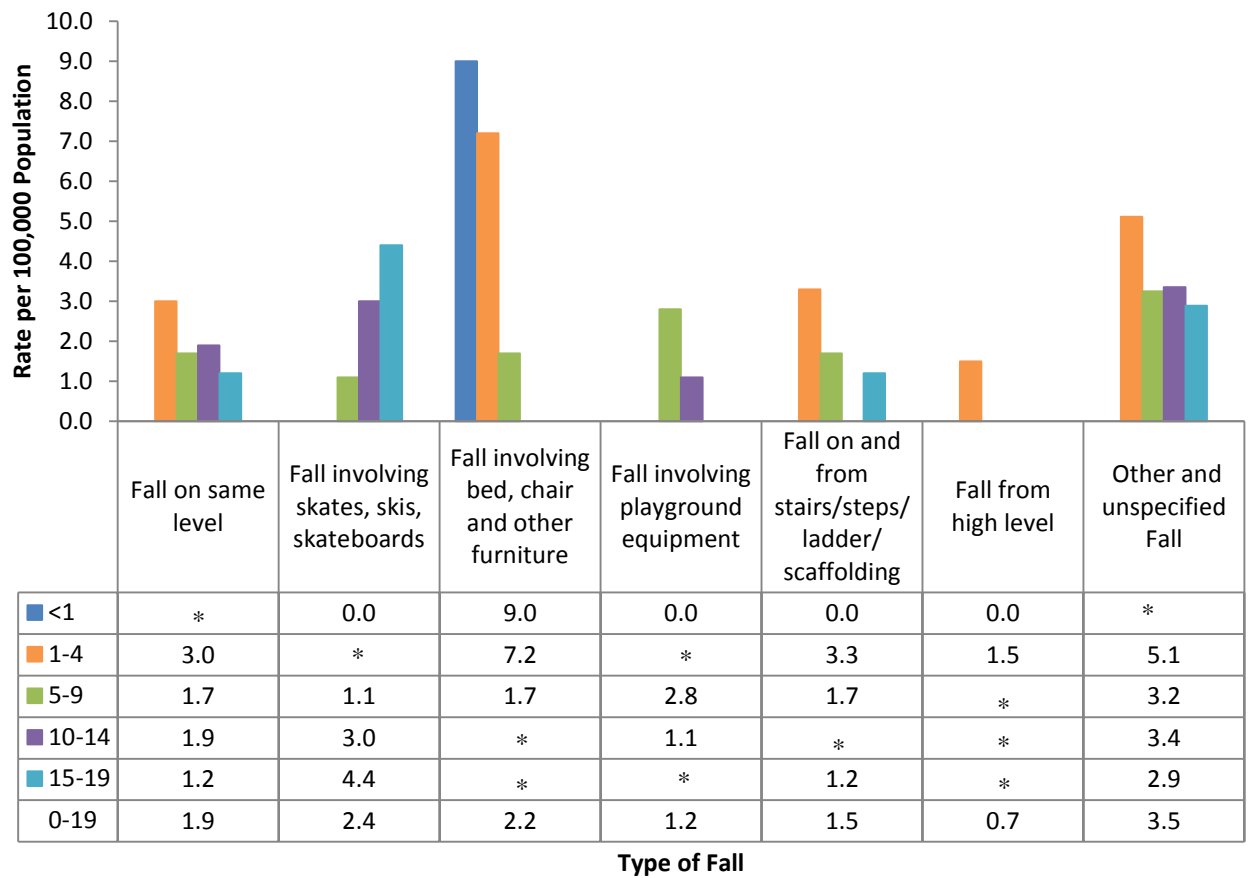


Figure 7: Fall-related concussion hospitalization rates by type of fall and age group, ages 0-19 years, Interior Health, 2001/02 - 2013/14.



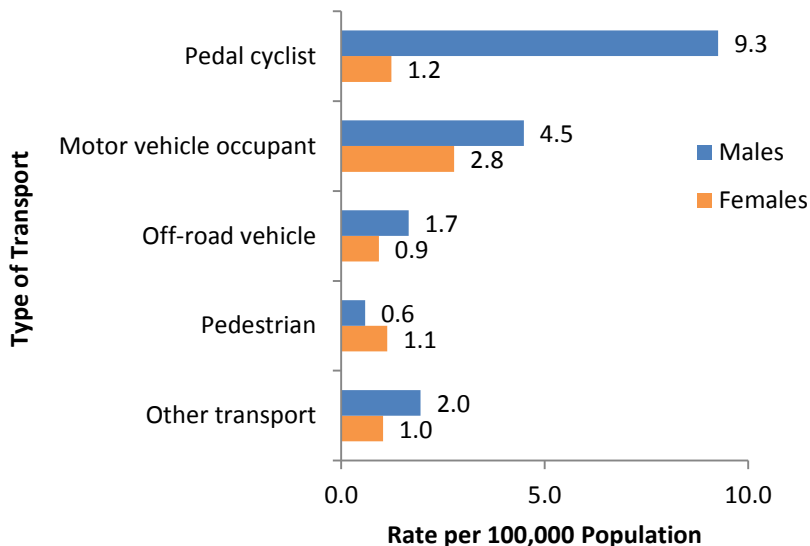
Note: * Represents fewer than 5 cases; 'Other and unspecified falls' includes fall involving ice and snow and fall involving wheelchair.

Transport-related Concussion Hospitalization

Concussion hospitalization rates from transport-related injuries among children and youth were generally higher among males than females, except among pedestrians (Figure 8).

Rates among males were highest for pedal cyclists (9.3/100,000) and motor vehicle occupants (4.5/100,000), while highest rates among females were for motor vehicle occupants (2.8/100,000) followed by pedal cyclist (1.2/100,000).

Figure 8: Transport-related concussion hospitalization rates by type of transport and sex, ages 0-19 years, Interior Health, 2001/02 - 2013/14.

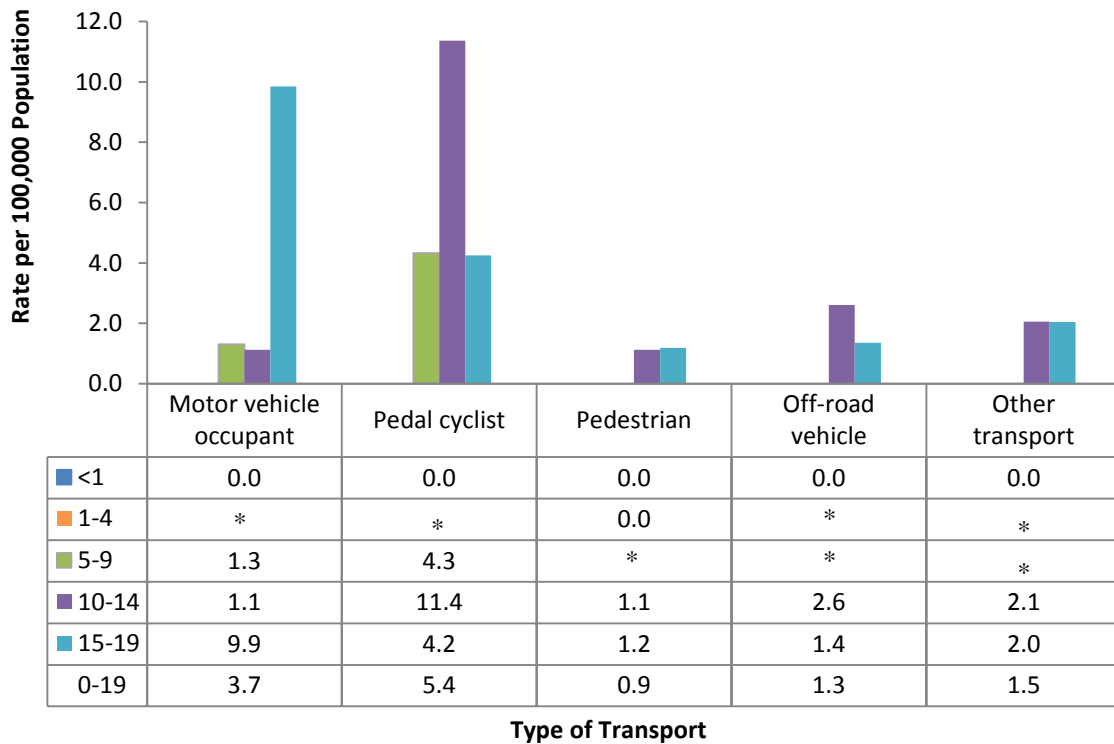


Note: 'Other transport' includes concussion hospitalizations due to motorcyclist, other land transport, and water transport.

Rates of motor vehicle occupant-related concussion hospitalization were highest among youth aged 15 to 19 years (9.9/100,000) while pedal cyclist rates were highest among 10 to 14 year olds (11.4/100,000) (Figure 9).

Across all age groups from 0 to 14 years, pedal cyclist-related concussion hospitalizations had the highest rates compared to any other transport type.

Figure 9: Transport-related concussion hospitalization rates by type of transport and age group, ages 0-19 years, Interior Health, 2001/02 - 2013/14.



Note: * Represents fewer than 5 cases; 'Other transport' includes concussion hospitalizations due to motorcyclist, other land transport and water transport.

Sport and Recreation-related Concussion Hospitalization

Sport and recreation-related concussion hospitalization rates for children and youth were generally higher among males than females, with the highest rates being among males aged 10 to 14 years (40.0/100,000) and 15 to 19 years (21.7/100,000) (Figure 10). Rates for females were highest for children aged 10 to 14 years at 8.0 per 100,000.

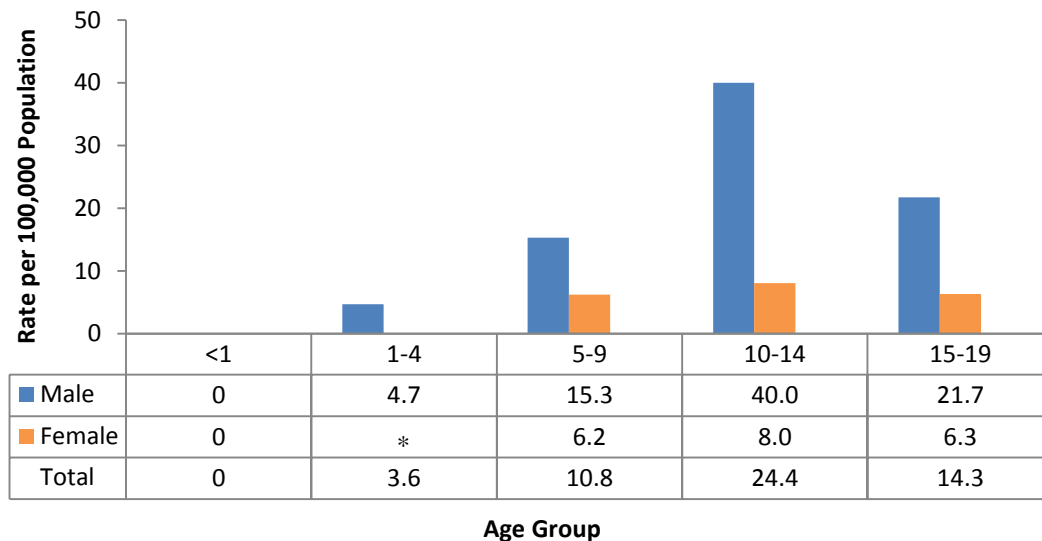
Cycling was the sport and recreation activity with the highest proportion of concussion hospitalizations among children and youth, at 36.5 percent (n=101) (Figure 11). Other leading types included skis/snowboard, playground, all-terrain vehicles and hockey.

The rate of cycling-related concussion hospitalizations for males was 8.7 per 100,000, followed by

ski and snowboard (1.9/100,000) and hockey (1.9/100,000) (Figure 12). For females, highest rates were seen for cycling (1.2/100,000), playground (0.9/100,000) and ski and snowboard (0.9/100,000).

Rates of cycling-related concussion hospitalizations were highest among youth aged 10 to 14 years (10.4/100,000) and 15 to 19 years (4.2/100,000) (Figure 13). Playground concussion rates were higher among younger children, while generally sport concussion rates were highest among the older youth.

Figure 10: Sport and recreation-related concussion hospitalization rates by age group and sex, ages 0-19 years, Interior Health, 2001/02 - 2013/14.



Note: * Represents fewer than 5 cases

Figure 11: Proportions of sport and recreation-related concussion hospitalizations by type of sport/recreation, ages 0-19 years, Interior Health, 2001/02 - 2013/14.

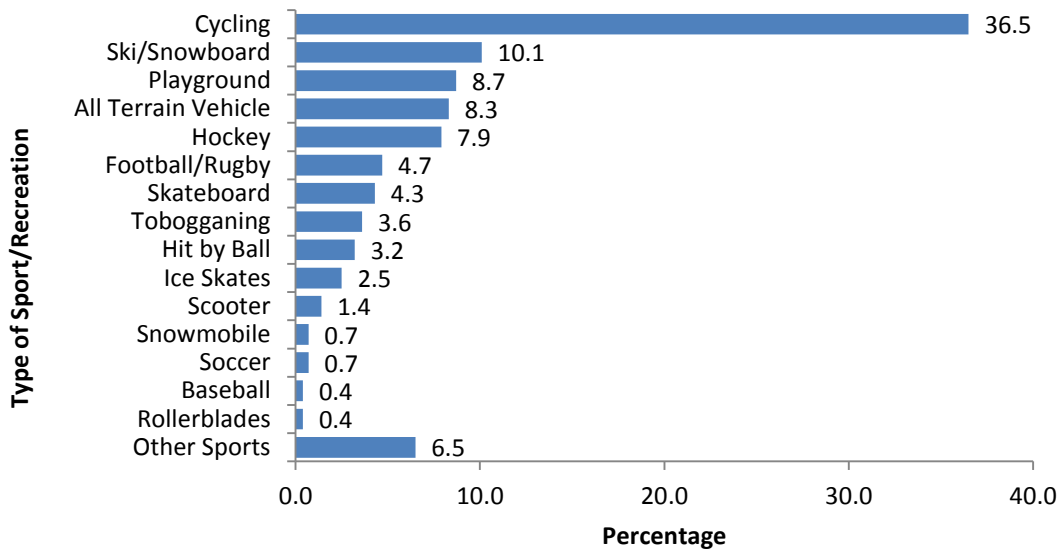
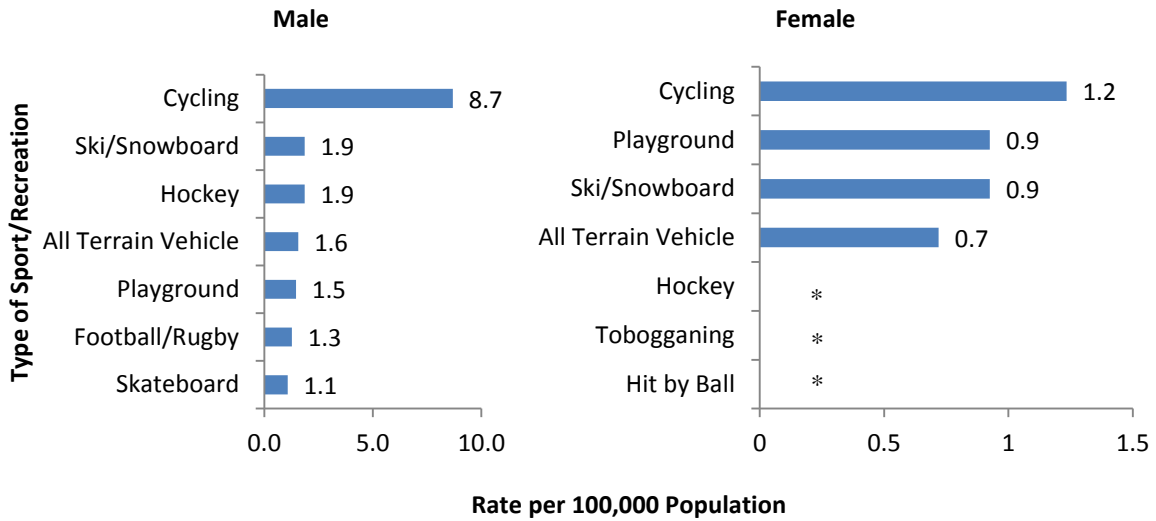
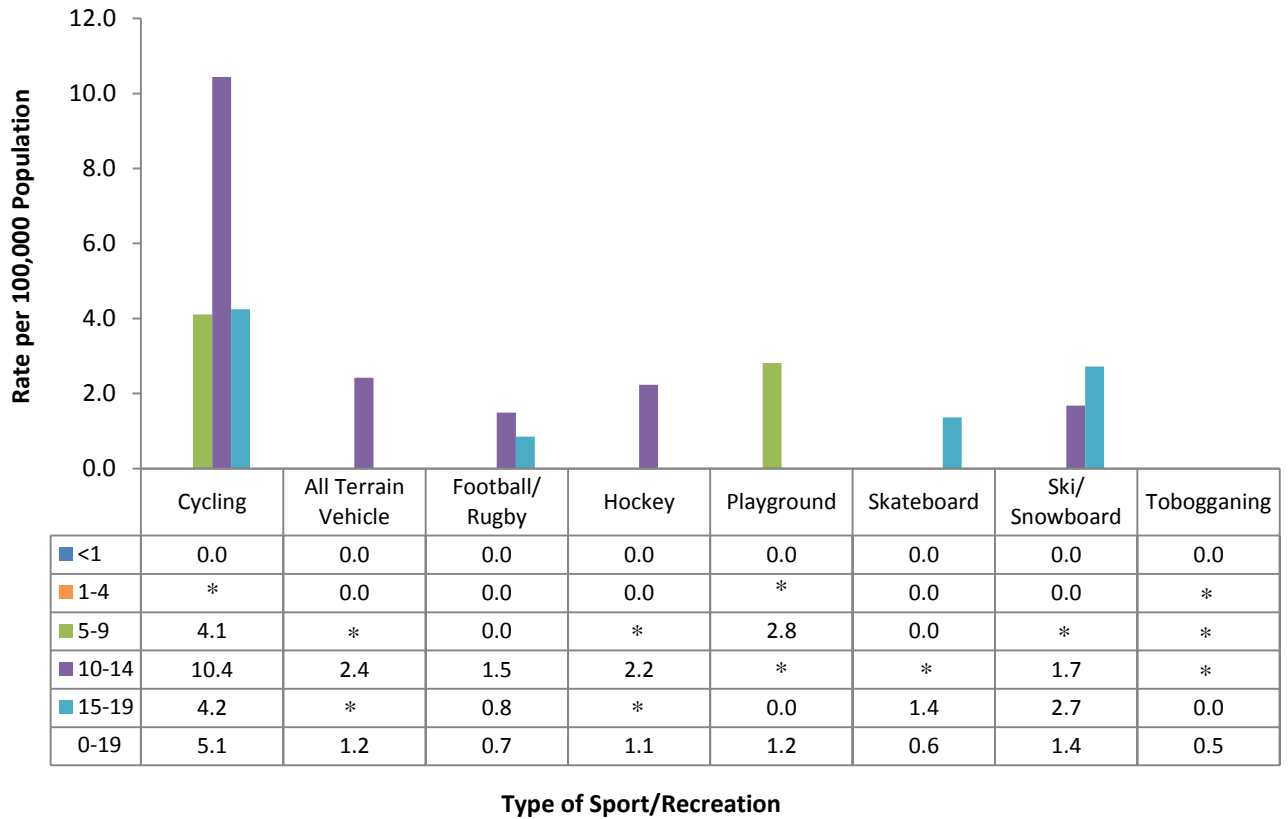


Figure 12: Sport and recreation-related concussion hospitalization rates by leading type of sport/recreation and sex, ages 0-19 years, Interior Health, 2001/02 - 2013/14.



Note: * Represents fewer than 5 cases

Figure 13: Sport and recreation-related concussion hospitalization rates by leading type of sport/recreation and age group, ages 0-19 years, Interior Health, 2001/02 - 2013/14.



Note: * Represents fewer than 5 cases

Concussion Hospitalization between Health Service Delivery Areas

Interior Health consists of four Health Service Delivery Areas (HSDAs): East Kootenay, Kootenay Boundary, Okanagan and Thompson Cariboo Shuswap. The majority of Interior Health residents who were hospitalized for concussion sought treatment within the Interior Health Authority (Table 1). Ninety percent of concussion cases admitted to hospital among Thompson Cariboo residents were admitted to hospitals within Interior Health; proportions of cases admitted to hospitals in Interior Health were higher for residents of East Kootenay (93.9%), Okanagan (95.2%) and Kootenay Boundary (97.3%). Across all HSDAs, most residents who did not seek hospital treatment within Interior Health were treated out of province (n=15).

Concussion hospitalization rates were highest among residents of East Kootenay (51.0/100,000) and lowest among residents of Thompson/Cariboo (24.4/100,000) (Figure 14). The highest number of concussion hospitalizations was within Okanagan (249 cases).

Concussion hospitalization rates within East Kootenay and Kootenay Boundary were high among all age groups, except for infants less than one year of age (Figure 15). Okanagan had the highest rate of concussion hospitalizations for infants less than one year of age (19.8/100,000). Noticeably high rates were seen within the area of Kootenay Boundary among 1 to 4 year olds (69.2/100,000).

Table 1: Concussion hospitalization counts by health service delivery area of patient's residence and health authority in which treatment sought, ages 0-19 years, Interior Health, 2001/02-2013/14.

Health Authority in which treatment sought	Health Service Delivery Area of patient's residence				Total
	East Kootenay	Kootenay Boundary	Okanagan	Thompson Cariboo Shuswap	
Interior Health	108 (93.9%)	107 (97.3%)	237 (95.2%)	141 (90.4%)	593
Fraser Health	0	0	*	*	6
Vancouver Coastal Health	0	*	*	*	*
Island Health	0	0	*	0	*
Northern Health	0	0	*	*	*
Provincial Health Services ⁺	0	*	*	6	8
Out-of-Province	6	*	*	*	15
Grand Total	115	110	249	156	630

Note: * Represents fewer than 5 cases; ⁺Provincial Health Services Authority refers to BC Children's Hospital.

Figure 14: Concussion hospitalization rates and counts by health service delivery area, ages 0-19 years, Interior Health, 2001/02-2013/14.

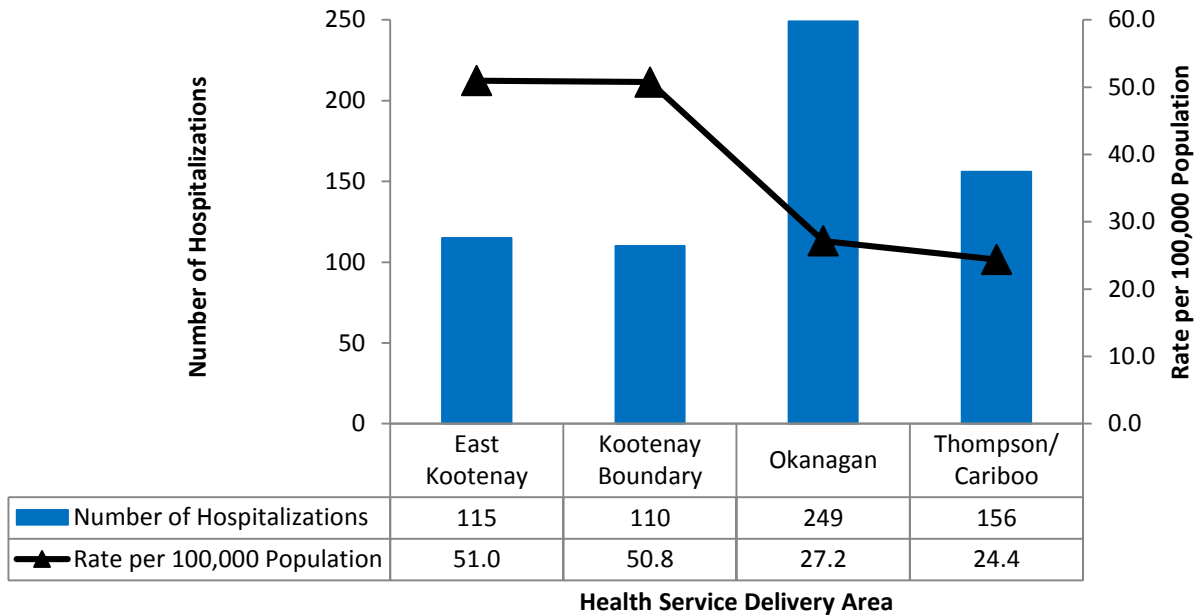
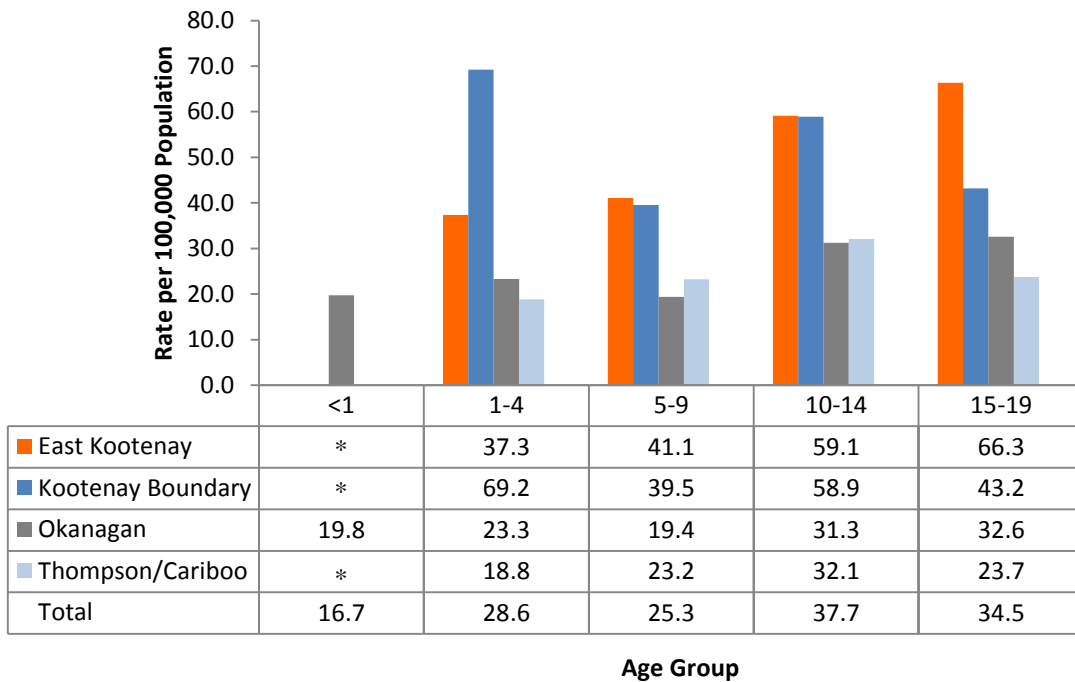


Figure 15: Concussion hospitalization rates by health service delivery area and age group, ages 0-19 years, Interior Health, 2001/02-2013/14.

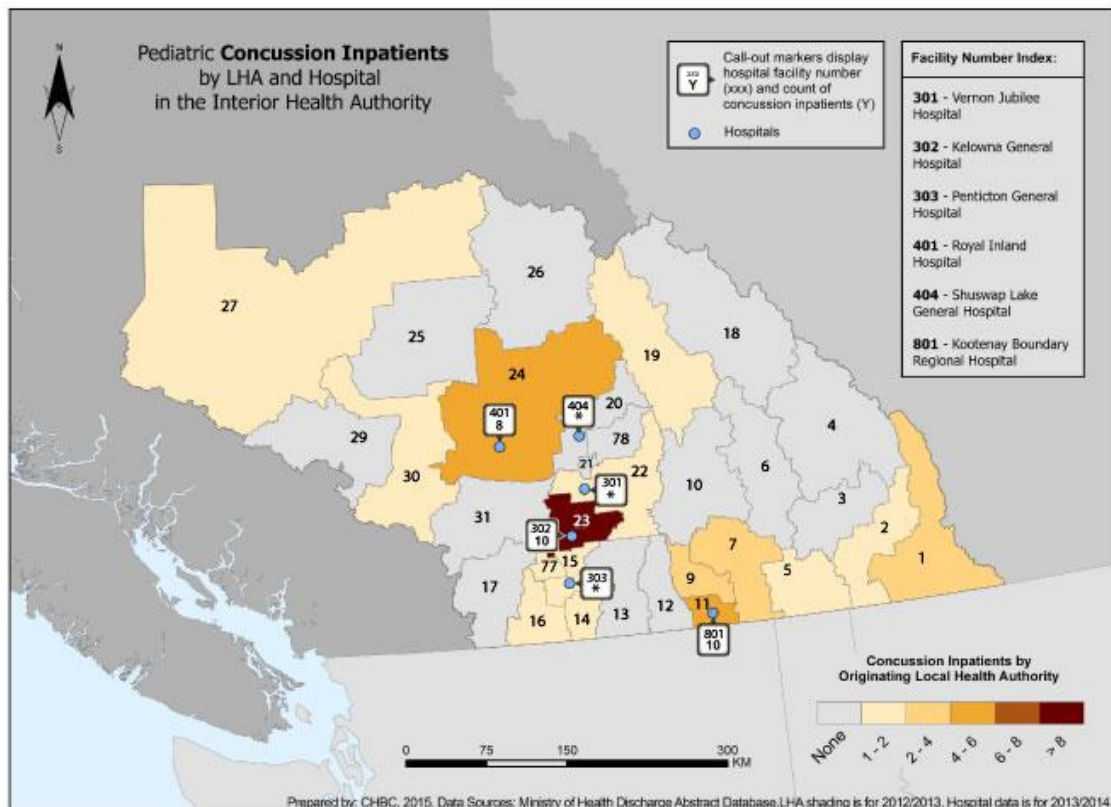


Note: * Represents fewer than 5 cases

The number of concussion inpatients was highest at Kelowna General Hospital (10 cases) and Kootenay Boundary Regional Hospital (10 cases) in the 2013/14 year (Figure 16).

The municipality of Kelowna reported the highest number of concussion inpatients from their region (over 8 patients), along with Trail (about 6 patients) and Kamloops (about 6 patients).

Figure 16: Pediatric Concussion Inpatients by local health area and hospital in the Interior Health Authority, 2013/2014



Note: * Represents fewer than 5 cases

Note: 1: Fernie, 2: Cranbrook, 3: Kimberley, 4: Windmere, 5: Creston, 6: Kootenay Lake, 7: Nelson, 9: Castlegar, 10: Arrow Lakes, 11: Trail, 12: Grand Forks, 13: Kettle Valley, 14: Southern Okanagan, 15: Penticton, 16: Keremeos, 17: Princeton, 18: Golden, 19: Revelstoke, 20: Salmom Arm, 21: Armstrong-Spallumcheen, 22: Vernon, 23: Central Okanagan, 24: Kamloops, 25: 100 Mile House, 26: North Thompson, 27: Cariboo-Chilcotin, 29: Lillooet, 30: South Cariboo, 31: Merritt, 77: Summerland, 78: Enderby

Concussion Hospitalization by Health Service Delivery Area: East Kootenay

A total of 115 concussion hospitalizations were reported for East Kootenay between 2001/02 and 2013/14. Among all age groups, 15 to 19 year olds had the highest rate of concussion, most of which comprised of fall and transport-related cases.

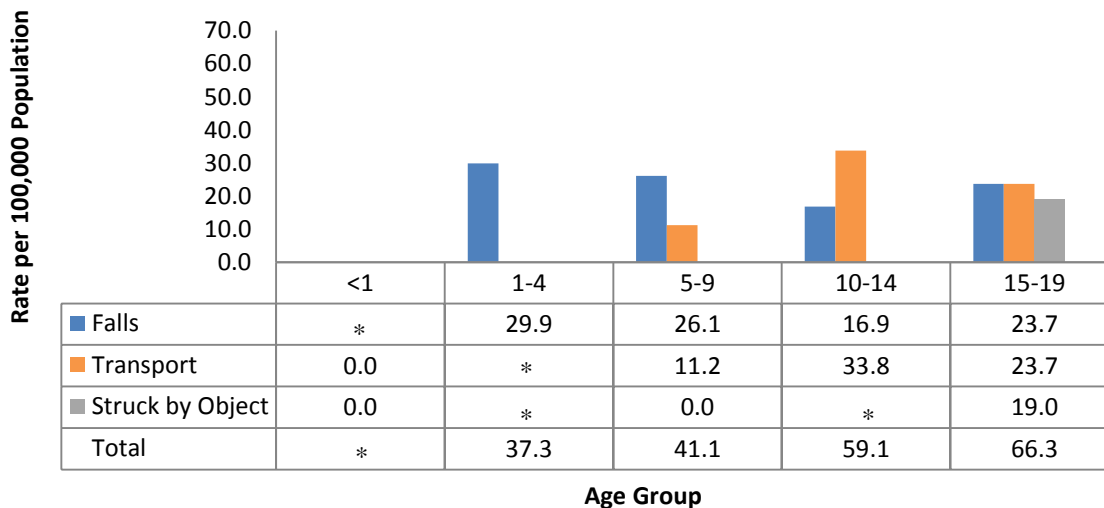
Within East Kootenay, rates of fall-related concussion hospitalizations were highest among children aged 1 to 4 years (29.9/100,000); however, rates remained relatively high even among 15 to 19 year olds (23.7/100,000) (Figure 17). Transport-related concussion hospitalizations were highest among children and youth aged 10 to 14 years old (33.8/100,000).

East Kootenay is split into six Local Health Areas (LHAs): Golden, Creston, Fernie, Windermere, Kimberley and Cranbrook. Rates of concussion hospitalizations was highest in Golden (98.0/100,000) and lowest in Cranbrook (25.7/100,000) (Figure 18).

Concussion hospitalization rates were higher among males than females within all LHAs except for Creston, which had the highest concussion hospitalization rates among females within East Kootenay (93.9/100,000). The highest rate for males was in Golden (136.6/100,000). The lowest concussion hospitalization rate for both males and females was in Kimberley (Figure 19).

Creston had the highest rates of concussion hospitalization among children under the age of 9 years, while Golden had the highest rates within the ages of 10 to 19 years. Golden, Creston and Fernie exhibited high rates among 15 to 19 year olds (169.3/100,000, 107.8/100,000 and 56.7/100,000, respectively) (Figure 20).

Figure 17: Concussion hospitalization rates by cause and age group, ages 0-19 years, Interior Health: East Kootenay, 2001/02-2013/14.



Note: * Represents fewer than 5 cases

Figure 18: Concussion hospitalization rates and counts by local health area, ages 0-19 years, Interior Health: East Kootenay, 2001/02-2013/14.

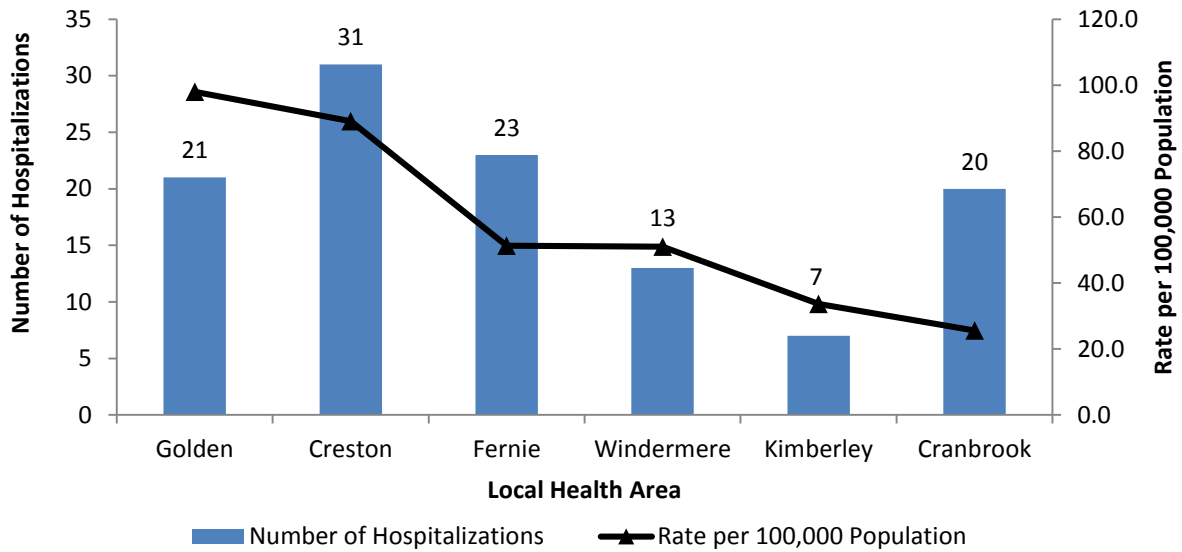
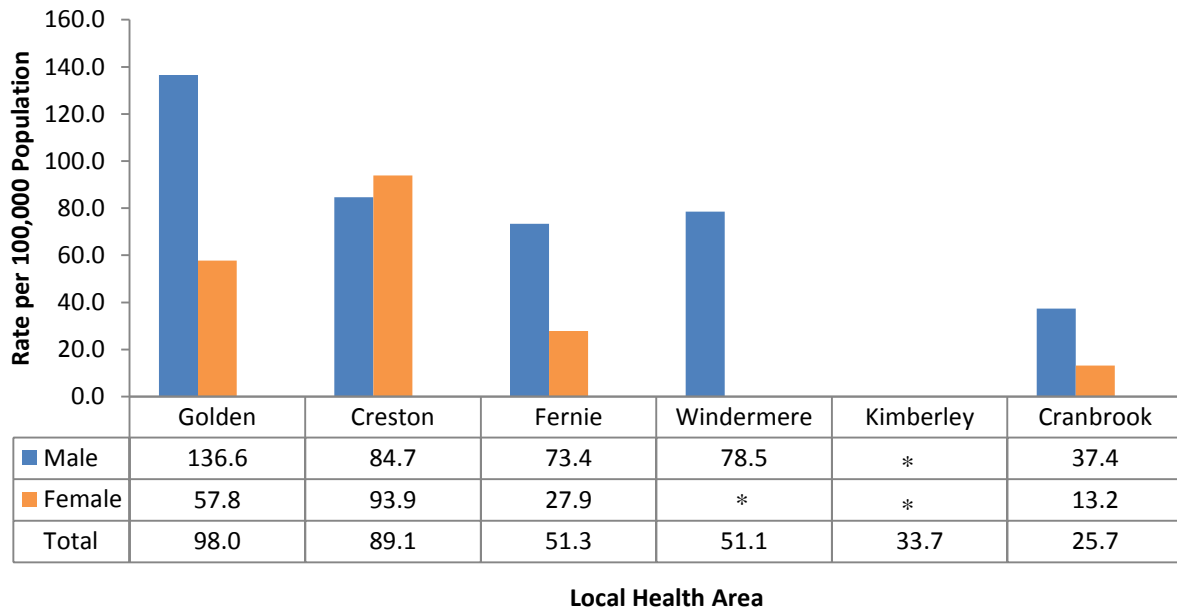
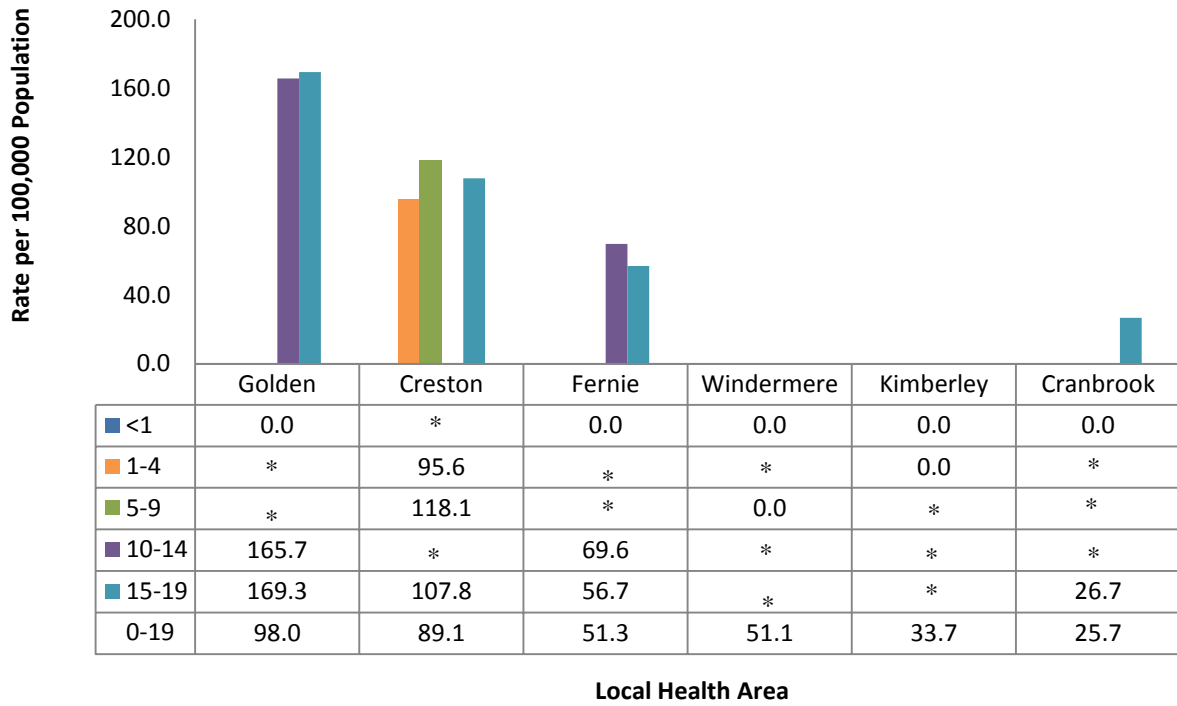


Figure 19: Concussion hospitalization rates by local health area and sex, ages 0-19 years, Interior Health: East Kootenay, 2001/02-2013/14.



Note: * Represents fewer than 5 cases

Figure 20: Concussion hospitalization rates by local health area and age group, ages 0-19 years, Interior Health: East Kootenay, 2001/02-2013/14.



Note: * Represents fewer than 5 cases

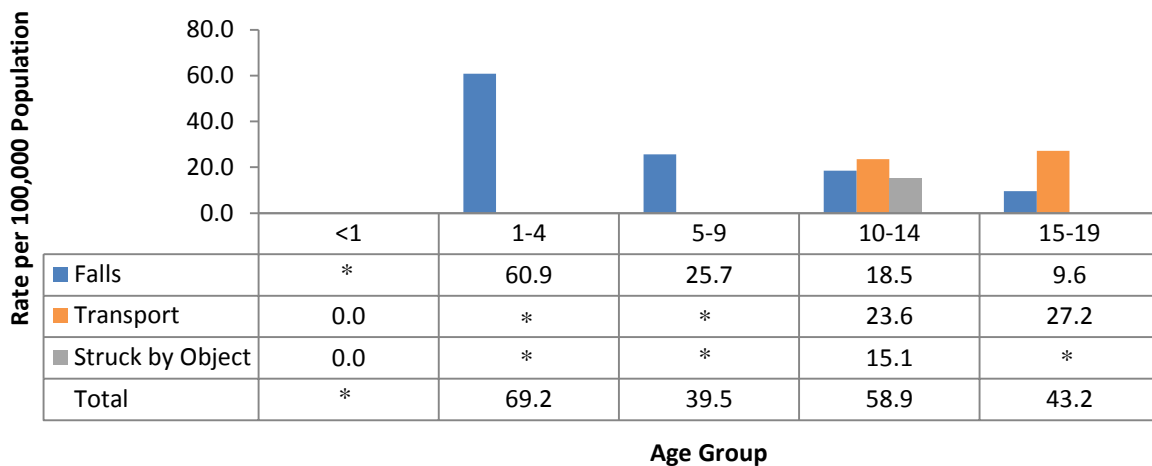
Concussion Hospitalization by Health Service Delivery Area: Kootenay Boundary

A total of 110 concussion hospitalizations were reported for Kootenay Boundary between 2001/02 and 2013/14. Among all age groups, 10 to 14 year olds had the highest rate of concussion, most of which comprised of transport-related cases. Rates of transport-related concussion hospitalization were highest among youth aged 15 to 19 years (27.2/100,000) (Figure 21).

Within Kootenay Boundary, rates of fall-related concussion hospitalizations were highest among children aged 1 to 4 years (60.9/100,000) (Figure 21).

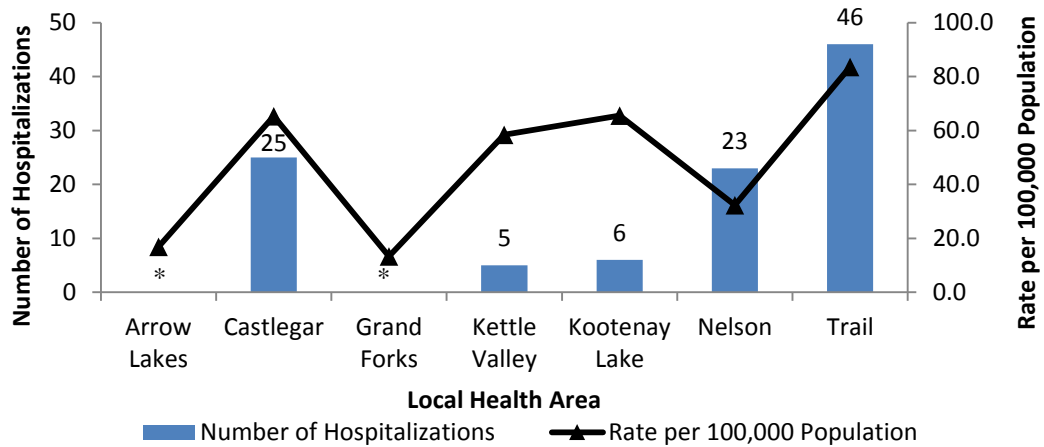
Kootenay Boundary is split into seven LHAs: Arrow Lakes, Castlegar, Kettle Valley, Kootenay Lake, Nelson, Grand Forks and Trail. Rates of concussion hospitalizations were highest in Trail (83.7/100,000) and lowest in Grand Forks. The total number of hospitalization cases within Kootenay Boundary was lowest in Grand Forks and Arrow Lakes (Figure 22).

Figure 21: Concussion hospitalization rates by cause and age group, ages 0-19 years, Interior Health: Kootenay Boundary, 2001/02-2013/14.



Note: * Represents fewer than 5 cases

Figure 22: Concussion hospitalization rates and counts by local health area, ages 0-19 years, Interior Health: Kootenay Boundary, 2001/02-2013/14.



Note: * Represents fewer than 5 cases

Trail, Castlegar and Nelson exhibited total number of cases high enough to further investigate sex and age differences. Further breakdown of these areas can be seen within Figures 23-28.

Trail had high rates of concussion hospitalizations across all age groups, except for infants under the age of one year. Rates of concussion hospitalization were particularly high among 1 to 4 and 10 to 14 year olds (145.5/ 100,000 and 86.4/100,000, respectively) and among males (129.6/100,000) in Trail (Figure 23 and Figure 24).

Castlegar also reported high concussion hospitalization rates among the majority of age groups (Figure 25). Fewer than five cases were

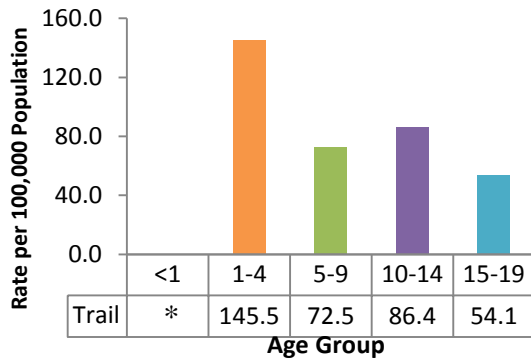
reported for 5-9 year olds and infants under the age of one year. High rates of concussion hospitalization were found among females in Castlegar (44.1/ 100,000) (Figure 26).

Highest rates of concussion hospitalization in Nelson were among children aged 5 to 9 years (36.0/100,000) (Figure 27). High rates of concussion hospitalization were found among males in Nelson (48.8/ 100,000) (Figure 28).

All LHAs within Kootenay Boundary reported low concussion hospitalization rates among infants less than one year of age. Concussion hospitalization rates were higher among males than females within all Kootenay Boundary LHAs.

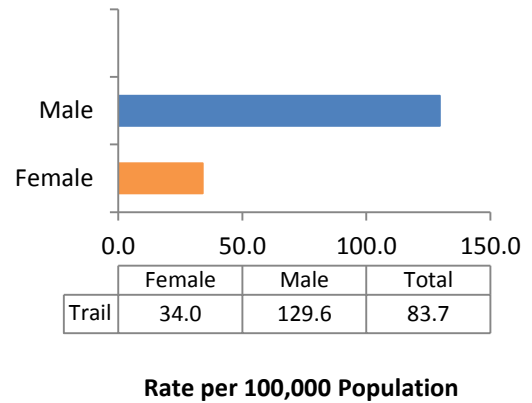
Trail

Figure 23: Concussion hospitalization rates by age group, ages 0-19 years, Interior Health: Kootenay Boundary: Trail, 2001/02-2013/14.



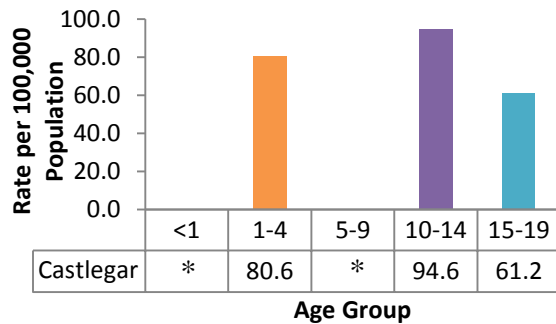
Note: * Represents fewer than 5 cases

Figure 24: Concussion hospitalization rates by sex, ages 0-19 years, Interior Health: Kootenay Boundary: Trail, 2001/02-2013/14.



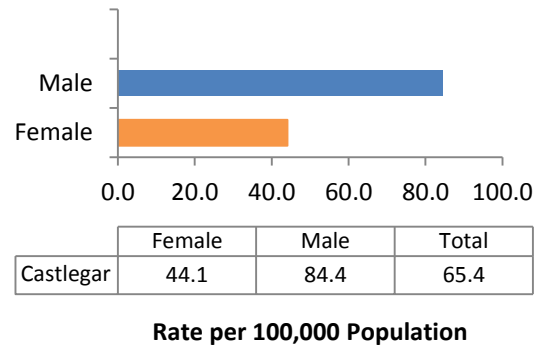
Castlegar

Figure 25: Concussion hospitalization rates by age group, ages 0-19 years, Interior Health: Kootenay Boundary: Castlegar, 2001/02-2013/14.



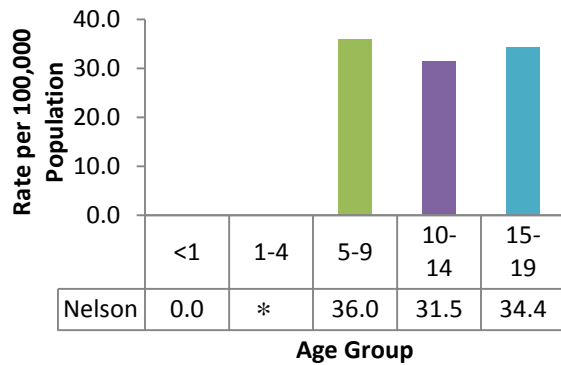
Note: * Represents fewer than 5 cases

Figure 26: Concussion hospitalization rates by sex, ages 0-19 years, Interior Health: Kootenay Boundary: Castlegar, 2001/02-2013/14.



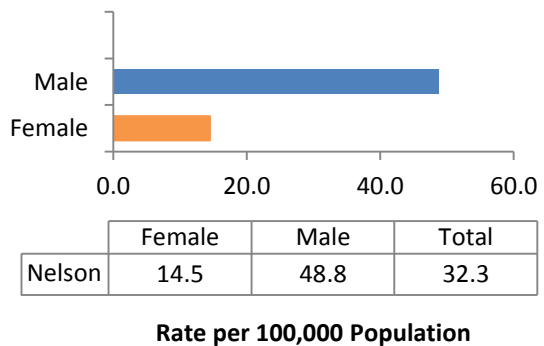
Nelson

Figure 27: Concussion hospitalization rates by age group, ages 0-19 years, Interior Health: Kootenay Boundary: Nelson, 2001/02-2013/14.



Note: * Represents fewer than 5 cases

Figure 28: Concussion hospitalization rates by sex, ages 0-19 years, Interior Health: Kootenay Boundary: Nelson, 2001/02-2013/14.

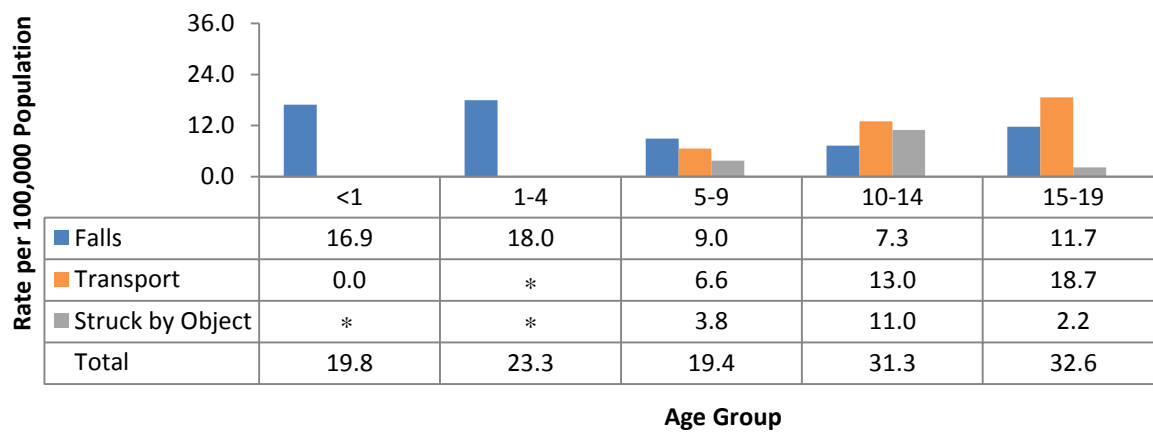


Concussion Hospitalization by Health Service Delivery Area: Okanagan

A total of 249 concussion hospitalizations were reported for Okanagan between 2001/02 and 2013/14. Among all age groups, 15 to 19 year olds had the highest rate of concussion, most of which comprised of transport-related cases. The rate for transport-related concussion hospitalizations among youth aged 15 to 19 years was 18.7 per 100,000 (Figure 29).

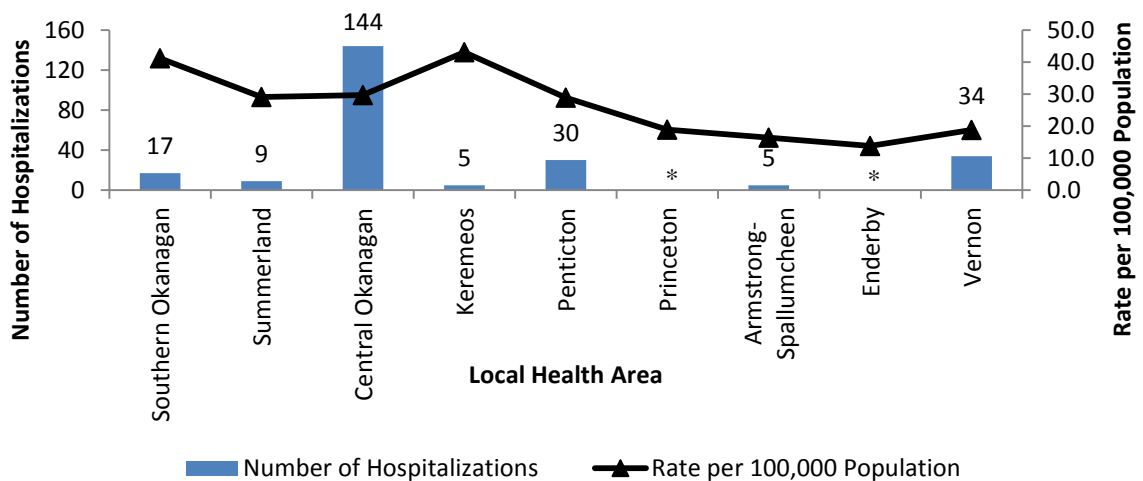
Rates of fall-related concussion hospitalizations were highest among children in the Okanagan aged 1 to 4 years (18.0/ 100,000), as well as among infants less than one year of age (16.9/100,000). Okanagan is split into nine LHAs: Southern Okanagan, Summerland, Central Okanagan, Keremeos, Penticton, Princeton, Armstrong- Spallumcheen, Enderby and Vernon. Concussion hospitalizations rates were highest in Keremeos (43.0/100,000) and lowest in Enderby (13.9/ 100,000) (Figure 30).

Figure 29: Concussion hospitalization rates by cause and age group, ages 0-19 years, Interior Health: Okanagan, 2001/02-2013/14.



Note: * Represents fewer than 5 cases

Figure 30: Concussion hospitalization rates and counts by local health area, ages 0-19 years, Interior Health: Okanagan, 2001/02-2013/14.



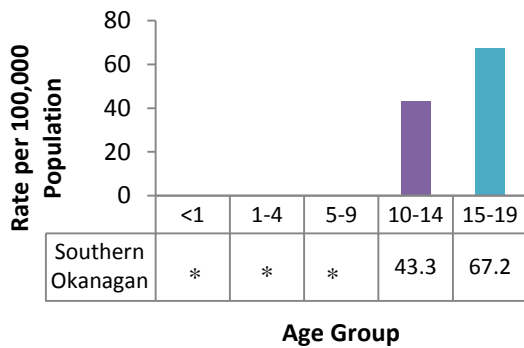
Note: * Represents fewer than 5 cases

Southern Okanagan, Central Okanagan, Penticton and Vernon exhibited total numbers of cases high enough to further investigate sex and age differences. Further breakdown of these areas can be seen within Figures 31-38.

High rates among 10 to 19 year olds in Okanagan were found in Southern Okanagan, Central Okanagan, Penticton and Vernon (Figures 31, 33, 35 and 37). High rates among both males and females were in Southern

Southern Okanagan

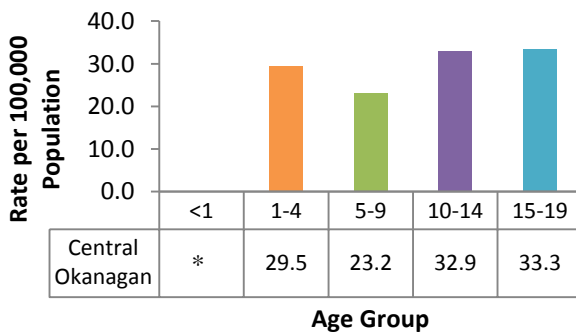
Figure 31: Concussion hospitalization rates by age group, ages 0-19 years, Interior Health: Okanagan: Southern Okanagan, 2001/02-2013/14.



Note: * Represents fewer than 5 cases

Central Okanagan

Figure 33: Concussion hospitalization rates by age group, ages 0-19 years, Interior Health: Okanagan: Central Okanagan, 2001/02-2013/14.

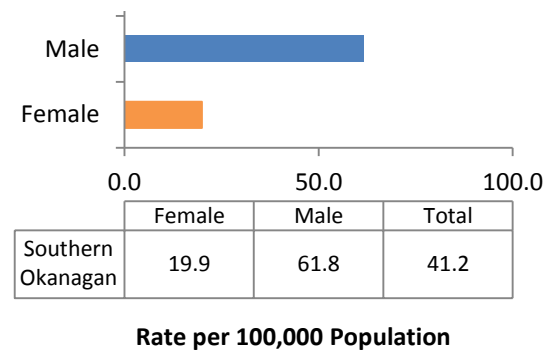


Okanagan, at 61.8 per 100,000 and 19.9 per 100,000, respectively (Figure 32).

Concussion hospitalization rates were highest in Central Okanagan among children under the age of 10 years, with all other LHAs reporting fewer than five cases within this age range (Figure 33).

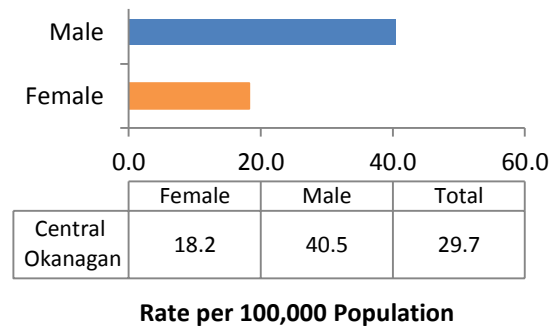
Concussion hospitalization rates were higher among males than females within all Okanagan LHAs.

Figure 32: Concussion hospitalization rates by sex, ages 0-19 years, Interior Health: Okanagan: Southern Okanagan, 2001/02-2013/14.



Note: * Represents fewer than 5 cases

Figure 34: Concussion hospitalization rates by sex, ages 0-19 years, Interior Health: Okanagan: Central Okanagan, 2001/02-2013/14.



Penticton

Figure 35: Concussion hospitalization rates by age group, ages 0-19 years, Interior Health: Okanagan: Penticton, 2001/02-2013/14.

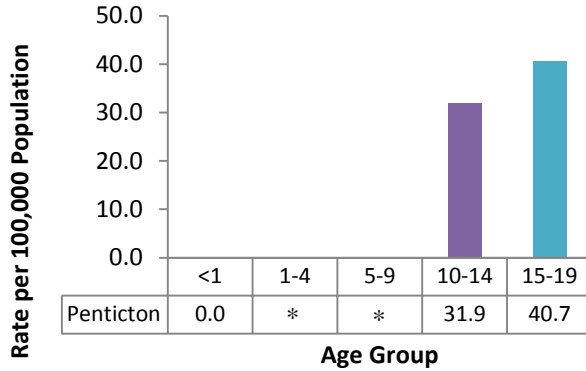
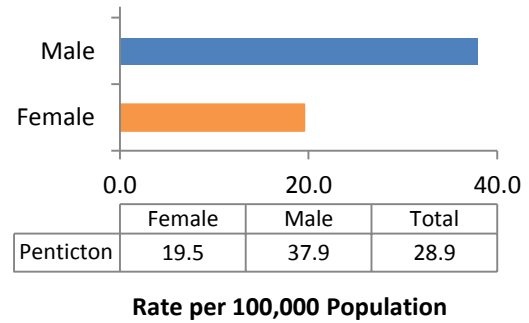


Figure 36: Concussion hospitalization rates by sex, ages 0-19 years, Interior Health: Okanagan: Penticton, 2001/02-2013/14.



Note: * Represents fewer than 5 cases

Vernon

Figure 37: Concussion hospitalization rates by age group, ages 0-19 years, Interior Health: Okanagan: Vernon, 2001/02-2013/14.

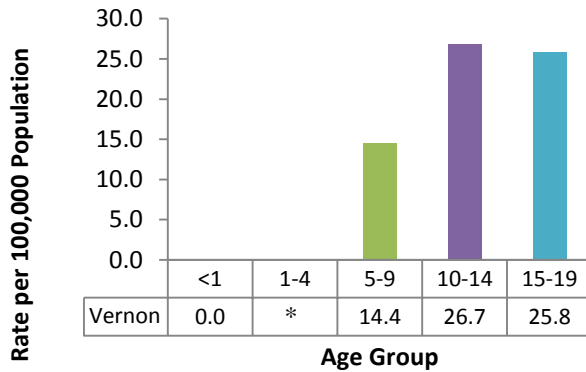
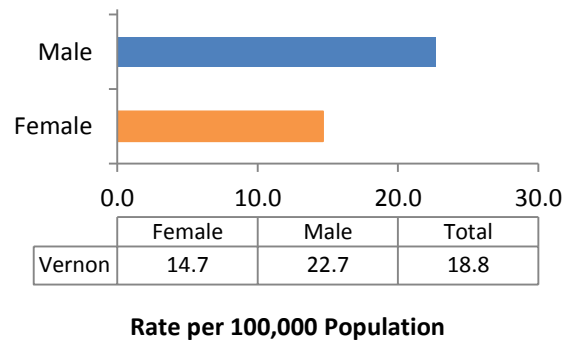


Figure 38: Concussion hospitalization rates by sex, ages 0-19 years, Interior Health: Okanagan: Vernon, 2001/02-2013/14.



Note: * Represents fewer than 5 cases

Concussion Hospitalization by Health Service Delivery Area: Thompson Cariboo Shuswap

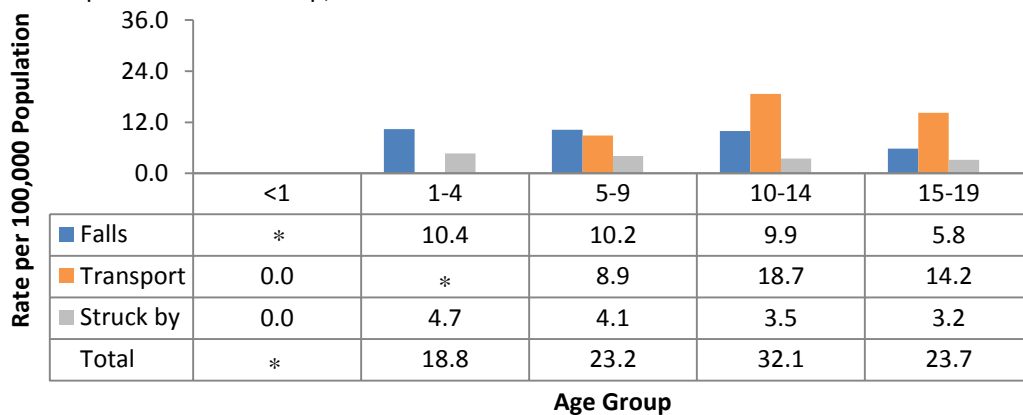
A total of 156 concussion hospitalizations were reported for Thompson Cariboo Shuswap between 2001/02 and 2013/14. Among all age groups, 10 to 14 year olds had the highest rate of concussion, most of which comprised of transport-related cases. Rates for transport-related concussion hospitalization among youth aged 10 to 14 years was 18.7 per 100,000 (Figure 39).

Rates of fall-related concussion hospitalizations within Thompson Cariboo Shuswap were

highest among children aged 1 to 4 years (10.4/100,000) (Figure 39).

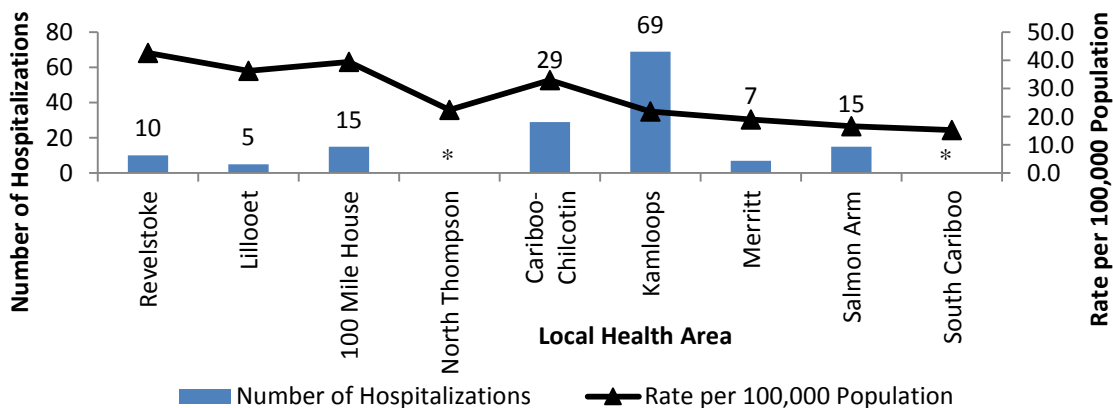
Thompson Cariboo Shuswap is split into nine LHAs: Revelstoke, Lillooet, 100 Mile House, North Thompson, Cariboo-Chilcotin, Kamloops, Merritt, Salmon Arm and South Cariboo. Concussion hospitalizations rates were highest in Revelstoke (42.6/100,000) and lowest in South Cariboo (Figure 40). The highest number of hospitalizations occurred within Kamloops, with 69 reported concussion hospitalizations.

Figure 39: Concussion hospitalization rates by cause and age group, ages 0-19 years, Interior Health: Thompson Cariboo Shuswap, 2001/02-2013/14.



Note: * Represents fewer than 5 cases

Figure 40: Concussion hospitalization rates and counts by local health area, ages 0-19 years, Interior Health: Thompson Cariboo Shuswap, 2001/02-2013/14.



Note: * Represents fewer than 5 cases

Cariboo-Chilcotin and Kamloops exhibited total number of cases high enough to further investigate sex and age differences. Further breakdown of these areas can be seen within Figures 41-44.

Concussion hospitalization rates were lowest among infants less than one year of age and children 1 to 4 years across all LHA's within Thompson Caribou Shuswap. Revelstoke

exhibited high rates of concussion hospitalizations within the 10 to 14 year old age group (97.0/100,000, n=10) (chart not shown).

Concussion hospitalization rates were higher among males than females within all Thompson Cariboo Shuswap LHAs. Out of all Thompson Cariboo Shuswap LHAs, the highest rates were in Revelstoke for males (74.0/100,000, n=9) and in 100 Mile House for females (37.5/ 100,000, n=7) (chart not shown).

Cariboo-Chilcotin

Figure 41: Concussion hospitalization rates by age group, ages 0-19 years, Interior Health: Thompson Cariboo Shuswap: Cariboo-Chilcotin, 2001/02-2013/14.

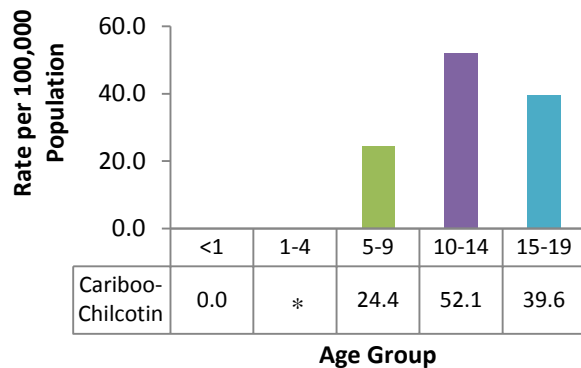
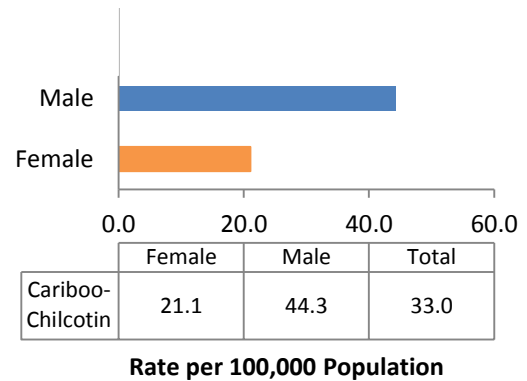


Figure 42: Concussion hospitalization rates by sex, ages 0-19 years, Interior Health: Thompson Cariboo Shuswap: Cariboo-Chilcotin, 2001/02-2013/14.



Note: * Represents fewer than 5 cases

Kamloops

Figure 43: Concussion hospitalization rates by age group, ages 0-19 years, Interior Health: Thompson Cariboo Shuswap: Kamloops, 2001/02-2013/14.

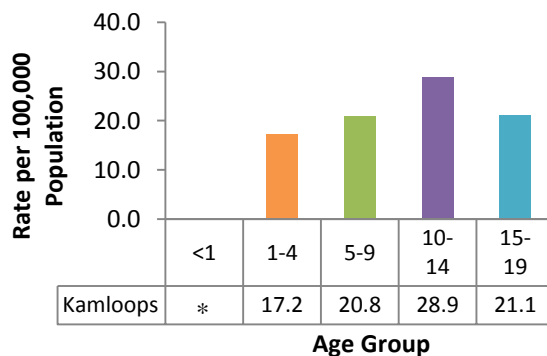
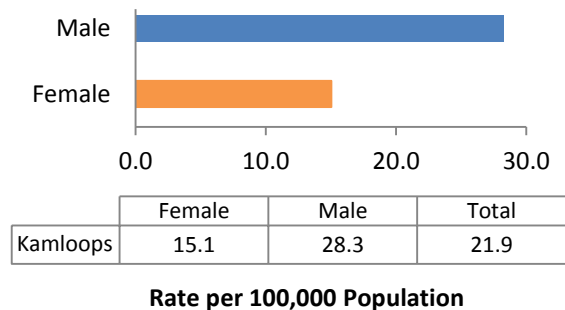


Figure 44: Concussion hospitalization rates by sex, ages 0-19 years, Interior Health: Thompson Cariboo Shuswap: Kamloops, 2001/02-2013/14.



Note: * Represents fewer than 5 cases

CONCUSSION EMERGENCY DEPARTMENT VISIT RATES

Emergency department visit data was only available for Royal Inland Hospital. Rates for Royal Inland Hospital was calculated per 100,000 emergency department visits for all diagnoses.

There were a total of 112 child and youth concussion emergency department visits at Royal Inland Hospital between April 1, 2013 and December 31, 2013. During this period, the rate of concussion emergency department visits per

100,000 emergency department visits at Royal Inland Hospital was 923.9 per 100,000 visits (Figure 45). Males exhibited higher rates than females, with male concussion rates totalling 1,185.3 per 100,000 visits and female concussion rates totalling 653.9 per 100,000 emergency department visits.

Within 2013/2014, Royal Inland Hospital reported 116 concussion emergency department visits among children and youth aged 0 to 19 years (Figure 46).

Figure 45: Concussion emergency department visit rates by hospital and sex, ages 0-19 years, Interior Health: Royal Inland Hospital, NACRS, April 1 2013- December 31, 2013

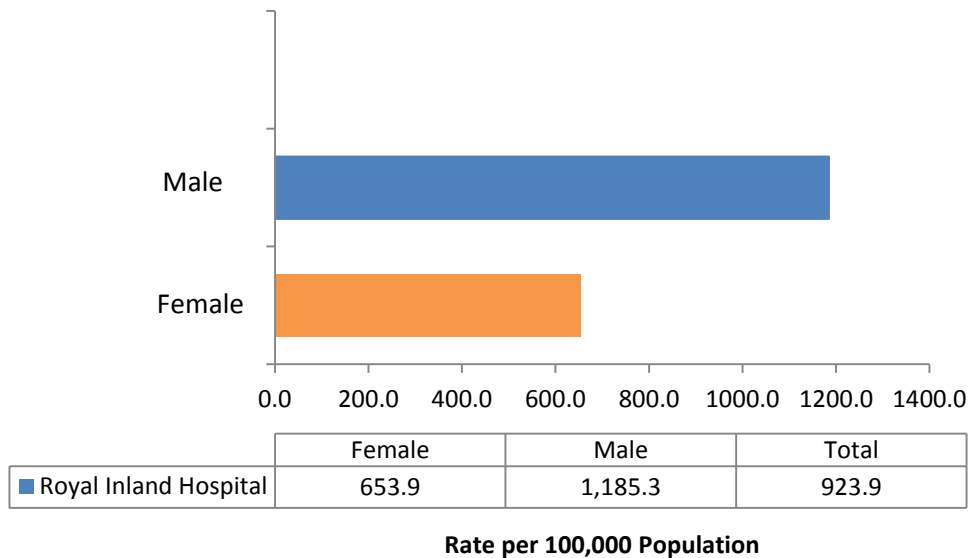
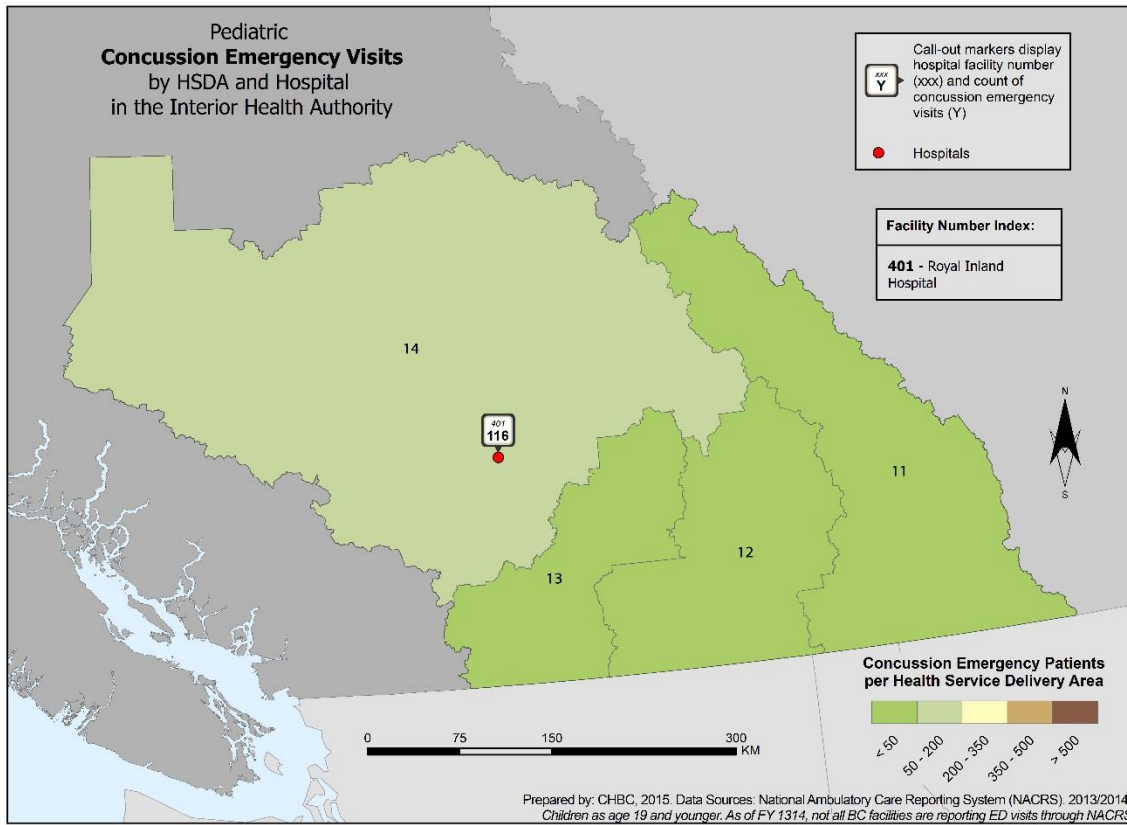


Figure 46: Pediatric concussion emergency department visits by local health area and hospital in the Interior Health Authority, NACRS, 2013/14-2014/15



Note: 11: East Kootenay, 12: Kootenay Boundary, 13: Okanagan, 14: Thompson Cariboo Shuswap

CONCLUSION

The Interior Health region exhibited high overall rates of child and youth concussion hospitalization. The highest rates of concussion hospitalizations were seen among the 10 to 14 and 15 to 19 year old age groups, largely due to transport-related causes. The majority of these hospitalizations involved pedal cyclists, motor vehicle occupants or off-road vehicles. Among children under the age of five years, falls remained the leading cause of concussion hospitalizations. The leading causes of falls within this age group were falls from skates, skis or skateboards and falls from furniture.

Males within Interior Health exhibited higher rates of concussion hospitalizations than females across all ages between 0 and 19 years. Sport and recreation-related concussion hospitalizations were seen mostly among males between the ages of 10 and 19 years.

Transport-related concussion hospitalizations maintained similar patterns and trends across all HSDAs within Interior Health, with rates increasing as age increased. East Kootenay and Thompson Cariboo Shuswap displayed the higher rates of transport-related concussion hospitalization among 10 to 14 year olds than among 15 to 19 year olds, while Kootenay Boundary and Okanagan displayed the higher rates for this cause among 15 to 19 year olds than among 10 to 14 year olds.

Fall-related concussion hospitalization rates varied with age within each HSDA. All HSDAs within Interior Health displayed highest rates of fall-related concussion hospitalizations among the 1 to 4 years age group. Out of all the HSDAs in the Interior, Okanagan displayed the highest rates of fall-related concussion hospitalizations within infants less than one year of age.

Out of all the LHAs in Interior Health, the LHAs of Golden, Trail, Creston and Castlegar exhibited much higher rates of concussion hospitalizations than most other regions in Interior Health, while Arrow Lakes and South

Cariboo reported very few cases of concussion hospitalizations.

Emergency department visit data were only available for Royal Inland Hospital. Emergency department visits related to concussion rates were higher among males than females, who visited Royal Inland Hospital from April 1 2013 to December 31, 2013.

This report provides a comprehensive glance at the burden of concussion among children and youth within Interior Health. With this information, Interior Health can work towards reducing the occurrence and burden of concussions among children and youth in BC.

REFERENCES

1. Guskiewicz KM & Valovich McLeod TC. (2011). Pediatric Sports-related Concussion. *PM&R* 2011;3(4):353-364.
2. Cassidy JD, Carroll L, Peloso P, Borg J, Von Holst H, Holm L., Kraus J, Coronado VG. Incidence, risk factors and prevention of mild traumatic brain injury: results of the WHO Collaborating Centre Task Force on Mild Traumatic Brain Injury. *J Rehabil Med* 2004; Suppl. 43: 28–60.
3. Kelly KD, Lissel HL, Rowe BH, Vincenten JA, Voaklander DC. Sport and Recreation-Related Head Injuries Treated in the Emergency Department. *Clin J Sport Med* 2001;11(2): 77-81.
4. Bakhos LL, Lockhart GR, Myers R, Linakis JG. Emergency Department Visits for Concussion in Young Child Athletes. *Pediatrics* 2010; 126(3): 550-556.
5. McCrory P, Meeuwisse W, Aubry M, Cantu R, Dvorak Jj, Echemendia R, Engebretsen L et al. Consensus Statement on Concussion in Sport – The 4th International Conference on Concussion in Sport Held in Zurich, November 2012. *Clin J Sport Med* 2013; 47:250-258.
6. Erlanger D, Kaushik T, Cantu R, Barth JT, Broshek DK, Freeman JR, Webbe FM. Symptom-Based Assessment of the Severity of a Concussion. *J Neurosurg* 2003;98(3):477-484.
7. Guskiewicz, K.M., Weaver, N.L., Padua, D.A., Garrett, W.E Jr. Epidemiology of concussion in collegiate and high school football players. *Am J Sports Med* 2000;28(5):643-650.
8. CBC News. Kelly Crow. Q&A Concussion: Q&A with Dr. Charles Tator. Posted Feb 22, 2011.
9. Walsh SS & Jarvis SN. Measuring the frequency of “severe” accidental injury in childhood. *J Epidemiol Community Health* 1992;46:26-32.
10. Chevalier S, Choiniere R, Ferland M, Pageau M, Sauvageau Y. *Community Health Indicators: Definitions and Interpretations*. Ottawa: Canadian Institute for Health Information; 1995.