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CONCUSSION AMONG CHILDREN & YOUTH: NORTHERN HEALTH AUTHORITY

BC INJURY research and
prevention unit

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".

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KEY HIGHLIGHTS

The purpose of this report is to provide details on the burden of concussion hospitalizations among children and youth in Northern Health. 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 or treated at all.

Highlights include but are not limited to the following:

- From 2001/02 - 2013/14 there were 363 concussion hospitalizations among children and youth aged 0 to 19 years who reside within Northern Health.
- Male children and youth had higher rates of concussion hospitalizations than females (46.1/100,000 vs. 24.1/100,000).
- The leading causes of child and youth concussion hospitalizations in Northern Health were due to transport-related events (47%) and falls (33%).
- Among children and youth in Northern Health, those under five years of age had the highest rates of fall-related concussion hospitalizations (16.0/100,000) and older youth aged 15 to 19 years had the highest rates for transport-related concussions (30.4/100,000).
- Older youth experienced a larger proportion of sports and recreation-related concussion hospitalizations as compared to younger children, with a greater rate of occurrence among males rather than females.
- Cycling (32.6%), all-terrain vehicle (18.9%) and hockey (7.6%) activities were the greatest contributors for sport and recreation-related concussion hospitalizations among both males and females.
- Child and youth residents within the Northwest Health Service Delivery Area had the highest rates of concussion hospitalizations (43.8/100,000), with 95.9 % admitted to Northern Health hospitals.
- Leading causes of child and youth fall-related concussion hospitalizations in Northern Health were 'fall on the same level' (16.5%) and 'fall involving skates, skis and skateboards' (13.2%).
- Leading causes of child and youth transport-related concussion hospitalizations in Northern Health were 'pedal cyclist' (30.8%) and 'motor vehicle occupant' (33.7%).
- The local health areas of Smithers (73.7/100,000), Upper Skeena (59.8/100,000), Queen Charlotte (53.1/100,000), Burns Lake (62.1/100,000) and Nechako (55.2/100,000) exhibited high rates of concussion hospitalizations.
- The University Hospital of Northern British Columbia saw 221 concussion emergency department visits in 2013/14.

Concussions remain a significant health issue for children and youth in Northern Health, and require further attention given the potential long-lasting effects. This may include concussion prevention, education and awareness, standardizing care, and 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 per cent 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 per cent of all concussions suffered by youth between the ages of 8 and 19 [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 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 Northern 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 include 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. Unintentional 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 patients, therefore multiple admissions of the same patient for the same injury would be 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 Health Services Authority (PHSA) for the University Hospital of Northern British Columbia from 2013/14 to 2014/15.

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 Northern Health. Rates presented by region are based on the patient's residence and not the location of injury occurrence.

Emergency department rates for the University Hospital of Northern British Columbia 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].

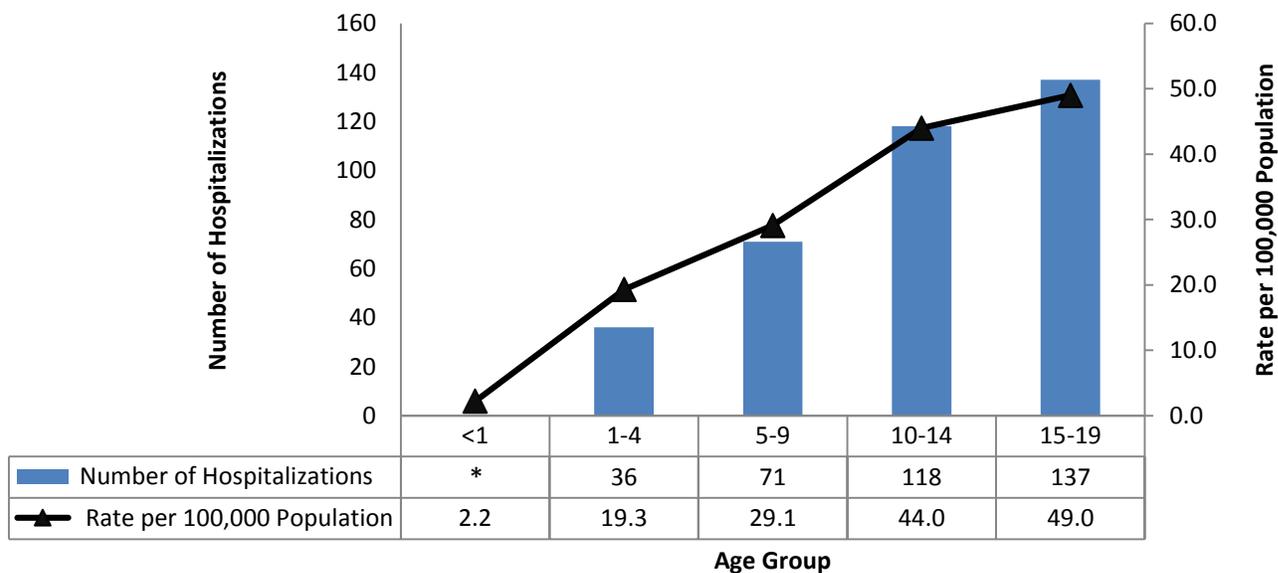
Emergency department data from NACRS were only available for the University Hospital of Northern British Columbia. As a result, emergency department visit data for concussion in Northern Health has been underestimated. In addition, there is further underestimation of the emergency department visits relating to concussion as according to analysis conducted by the NACRS leads, the compliance rate for NACRS data from the University Hospital of Northern British Columbia is ranged from 60 to 70 percent.

CONCUSSION HOSPITALIZATION

There were 363 hospitalizations among children and youth aged 0 to 19 years resulting from concussion within Northern 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 (2.2/100,000), and highest among youth 15 to 19 years old (49.0/100,000), followed by 10 to 14 year olds (44.0/100,000) (Figure 1).

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



Note: * Represents fewer than 5 cases

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 65.7 per 100,000 and were lowest in 2013/14 at 13.8 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 2001/02 at 90.2 per 100,000, and were lowest in 2013/14 at 15.9 per 100,000 (Figure 2). Rates peaked for

females in 2002/03 at 40.7 per 100,000 and were lowest in 2009/10 at 11.1 per 100,000.

Males accounted for 67.2 percent (n=244) of all concussion hospitalizations among children and youth. Rates for males were higher than for females in all age groups, except among infants less than one year of age (Figure 3). As age increased, males accounted for a greater proportion of all concussion hospitalization rates.

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

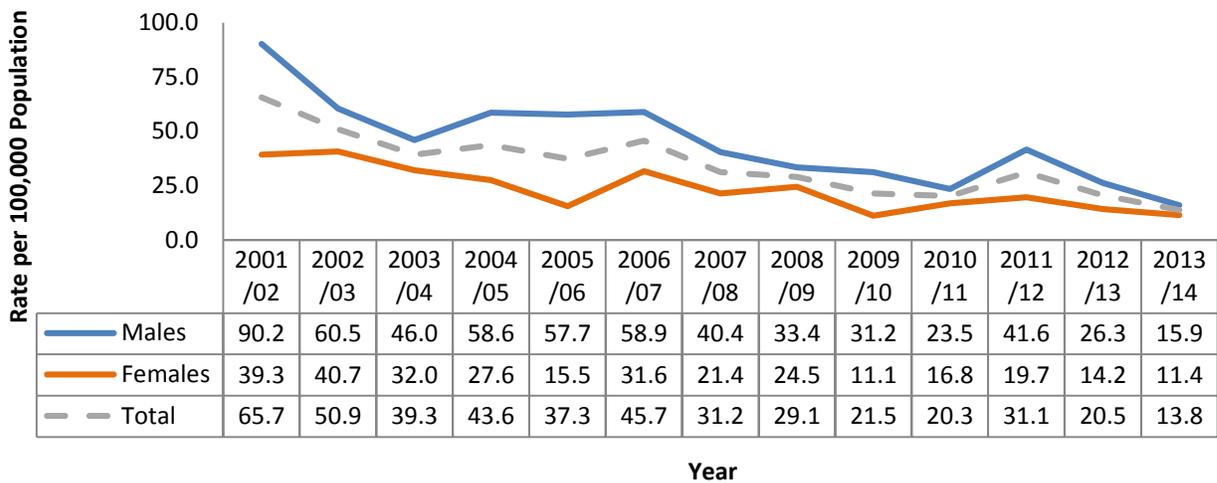
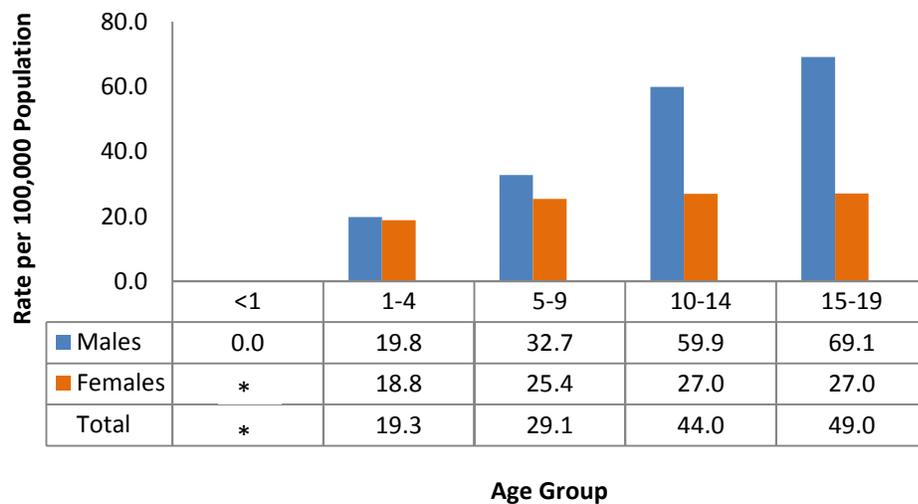


Figure 3: Concussion hospitalization rates by age group and sex, ages 0-19 years, Northern Health, 2001/02-2013/14.

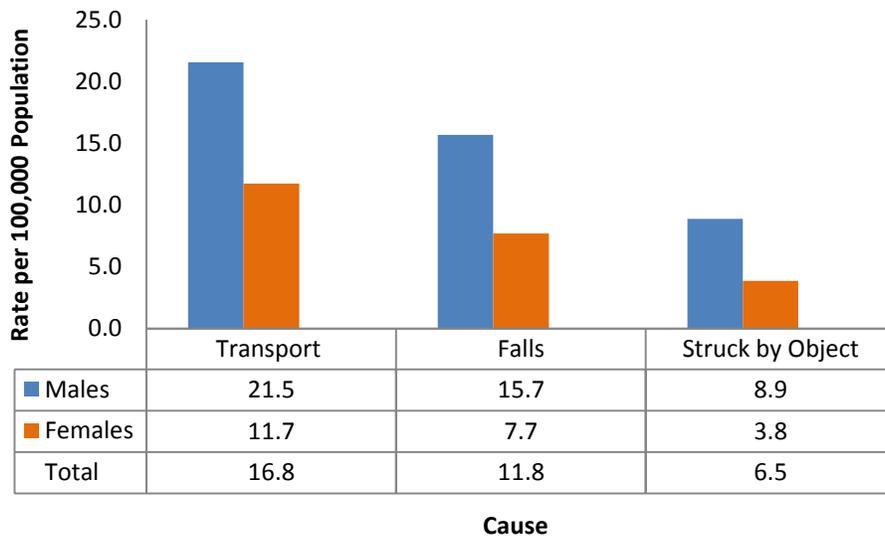


Note: * Represents fewer than 5 cases

Leading causes of concussion hospitalization among children and youth included transport-related events, falls, and struck by/against an object (Figure 4). Transport-related concussion hospitalization was the leading cause for both males and females at 21.5 per 100,000 and 11.7 per 100,000 respectively. Of those concussions caused by struck by/against an object, 55.4 percent occurred during sport and recreation activities.

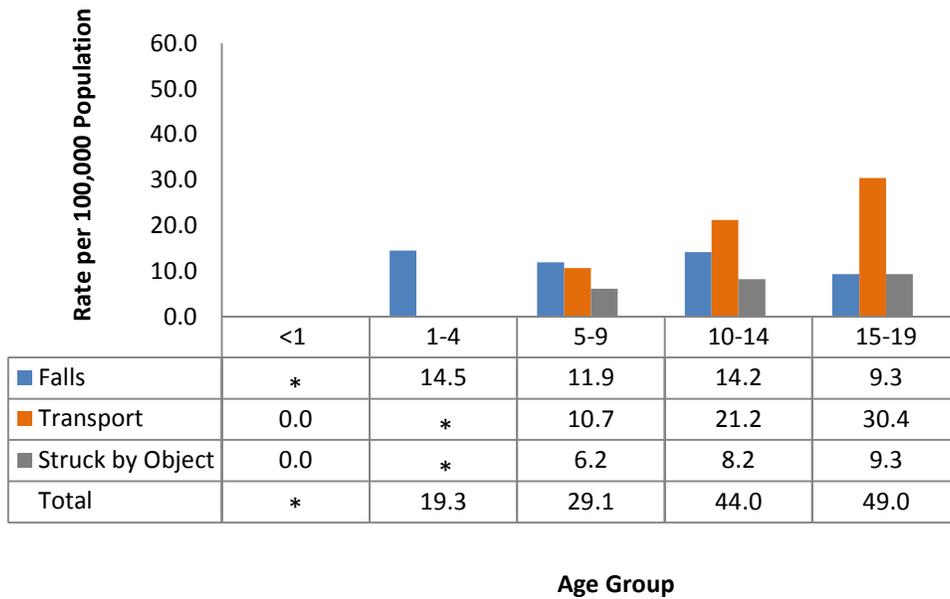
Falls were the leading cause for children 0 to 9 years old, while transport-related events were the leading cause of concussion hospitalizations for 10 to 19 year olds (Figure 5). Concussion hospitalization rates for falls were highest among 1 to 4 year olds (14.5/100,000), while transport-related concussion rates were highest among 15 to 19 year olds (30.4/100,000). The rate for transport-related concussion among 15 to 19 year olds was significantly higher than the rates among children aged 10 to 14 years (p -value < 0.05).

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



Note: 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 leading cause and age group, ages 0-19 years, Northern Health, 2001/02 - 2013/14.



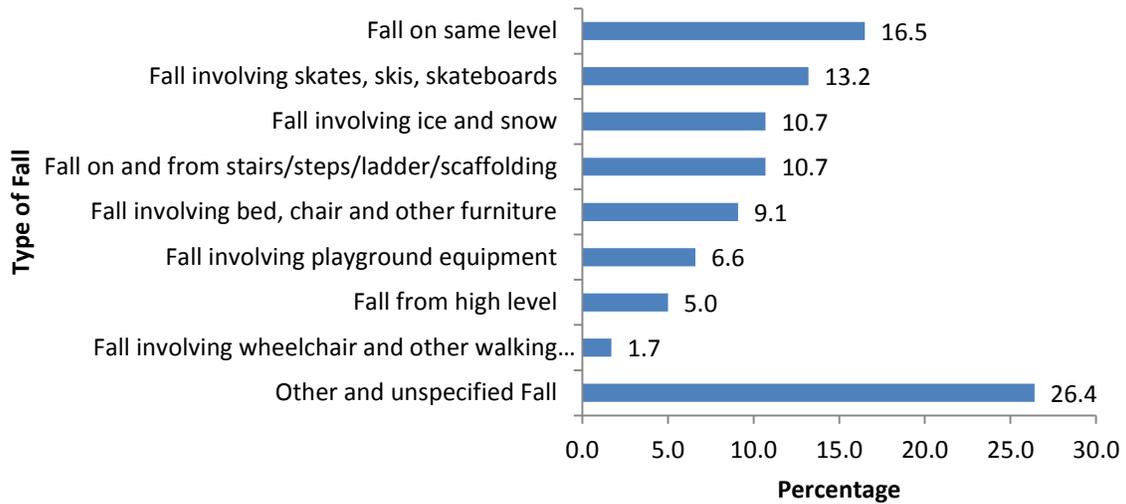
Note: * Represents fewer than 5 cases. Total also includes other causes of concussion hospitalizations, which are not shown as there are no or fewer than 5 cases.

Fall-related Concussion Hospitalization

Concussion hospitalizations among children and youth resulting from a fall were primarily the result of a fall on the same level (16.5%, n=20), falls involving skates, skis and skateboards (13.2%, n=16), falls from ice and snow (10.7%,

n=13), and fall on and from stairs/steps/ladders/scaffolding (10.7%, n=13) (Figure 6). Approximately one quarter of cases were classified as “other and unspecified” falls (26.4%, n=32).

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

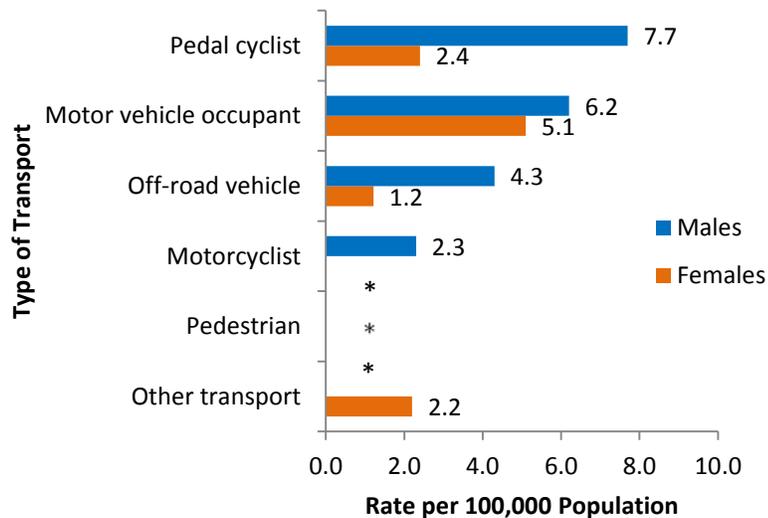


Transport-related Concussion Hospitalization

Concussion hospitalization rates from transport-related injuries among children and youth were generally higher among males than females, except for the 'other transport' category (Figure 7).

Rates among males were highest for pedal cyclists (7.7/100,000) and motor vehicle occupants (6.2/100,000), while rates among females were highest for motor vehicle occupants (5.1/100,000) followed by pedal cyclists (2.4/100,000).

Figure 7: Transport-related concussion hospitalization rates by type of transport and sex, ages 0-19 years, Northern Health, 2001/02 - 2013/14.

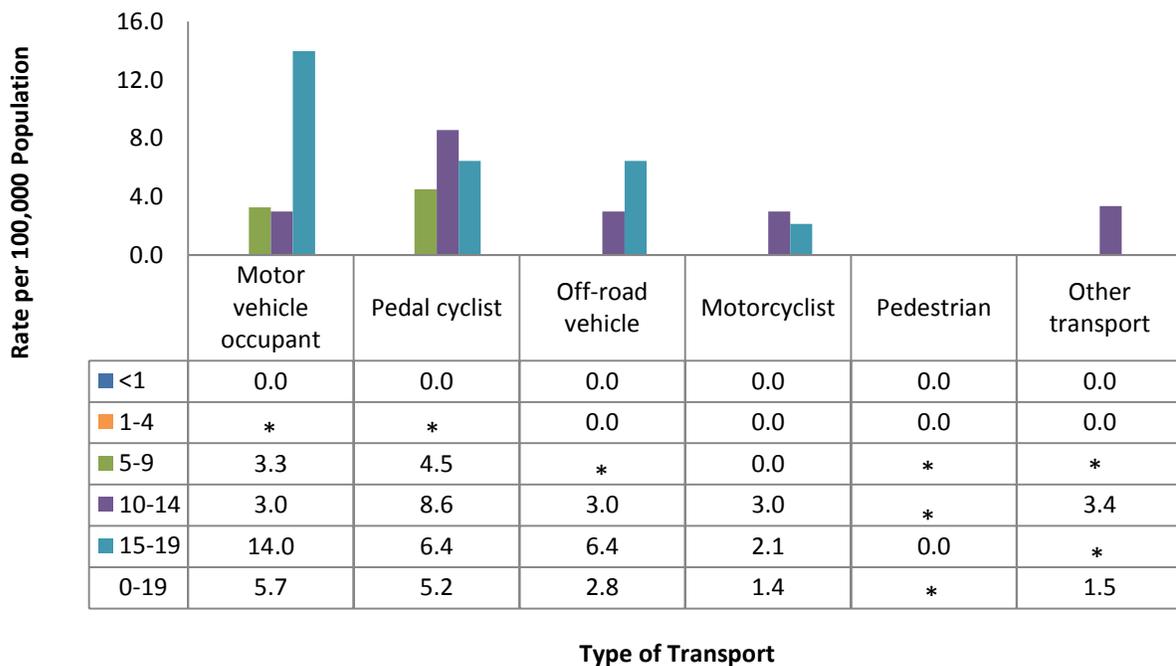


Note: * Represents fewer than 5 cases; 'Other transport' includes concussion hospitalizations due to air and space transport, other land transport, and other unspecified transport.

The majority of transport-related concussion hospitalizations were among children aged 10 to 19 years. Rates of motor vehicle occupant concussion hospitalization were highest among youth aged 15 to 19 years (14.0/100,000) while pedal cyclist rates were highest among 10 to 14 year olds (8.6/100,000) (Figure 8). Across age groups from 0 to 14 years, pedal cyclist-related concussion hospitalizations had the highest rates compared to any other transport type.

Among 10 to 14 year olds, concussion hospitalizations involving off-road vehicles, motorcyclists and motor vehicle occupants exhibited the same rates (3.0/100,000). There were fewer than five cases across all age groups for concussion hospitalizations among pedestrians. Off-road and motorcyclist concussion hospitalizations affected the older age groups, while younger age groups exhibited few cases across all types of transport (Figure 8).

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



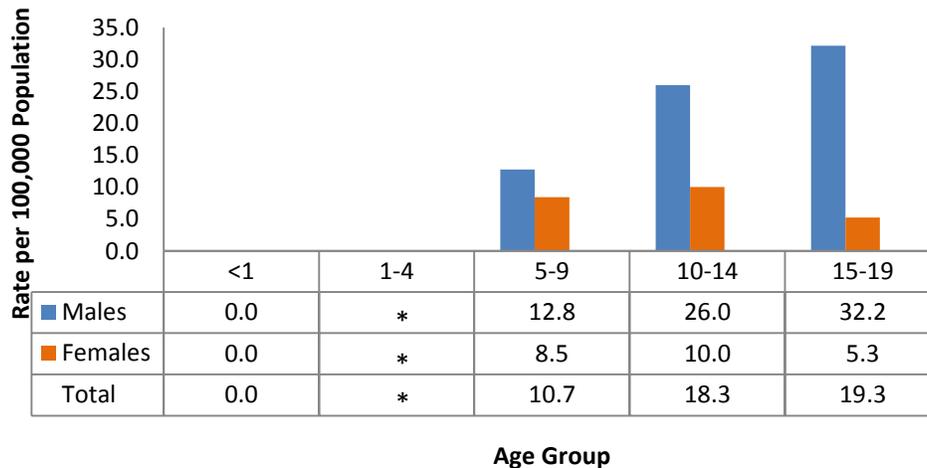
Note: * Represents fewer than 5 cases; 'Other transport' includes concussion hospitalizations due to off-road vehicle, other land transport, and water transport.

Sport and Recreation-related Concussion Hospitalization

Sport and recreation-related concussion hospitalization rates for children and youth were generally higher among males than females. Highest rates were among males aged 15 to 19 years (32.2/100,000) and 10 to 14 years (26.0/100,000) (Figure 9). Rates for females were highest for children aged 10 to 14 years at 10.0 per 100,000.

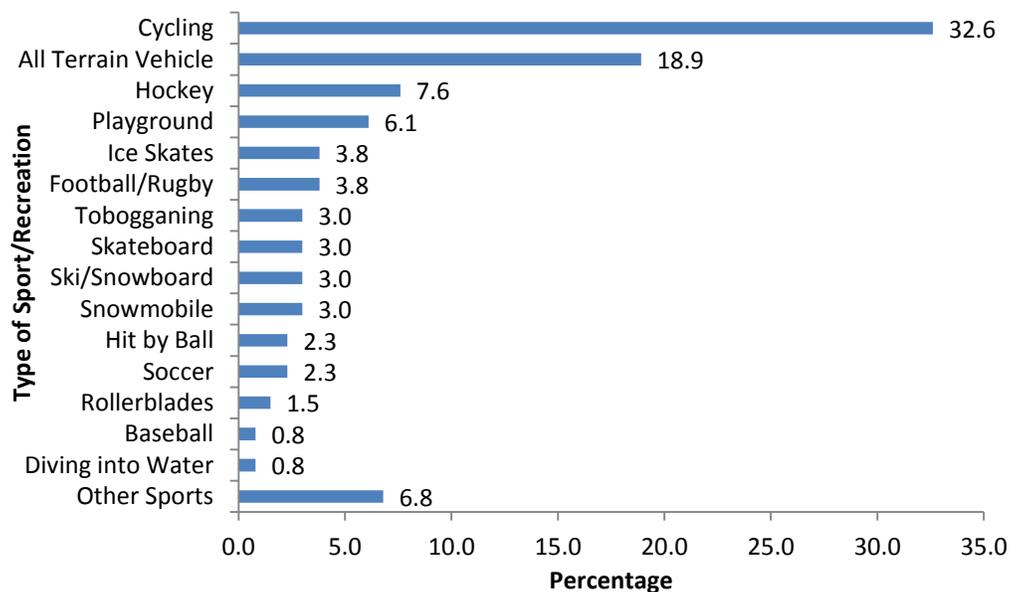
The highest proportion of sport and recreation-related concussion hospitalizations among children and youth was for cycling at 32.6 percent (n=43) (Figure 10). Other leading activities resulting in concussion hospitalization included all-terrain vehicle (18.9%), hockey (7.6%), and playground (6.1%).

Figure 9: Sport and recreation-related concussion hospitalization rates by age group and sex, ages 0-19 years, Northern Health, 2001/02 - 2013/14.



Note: * Represents fewer than 5 cases

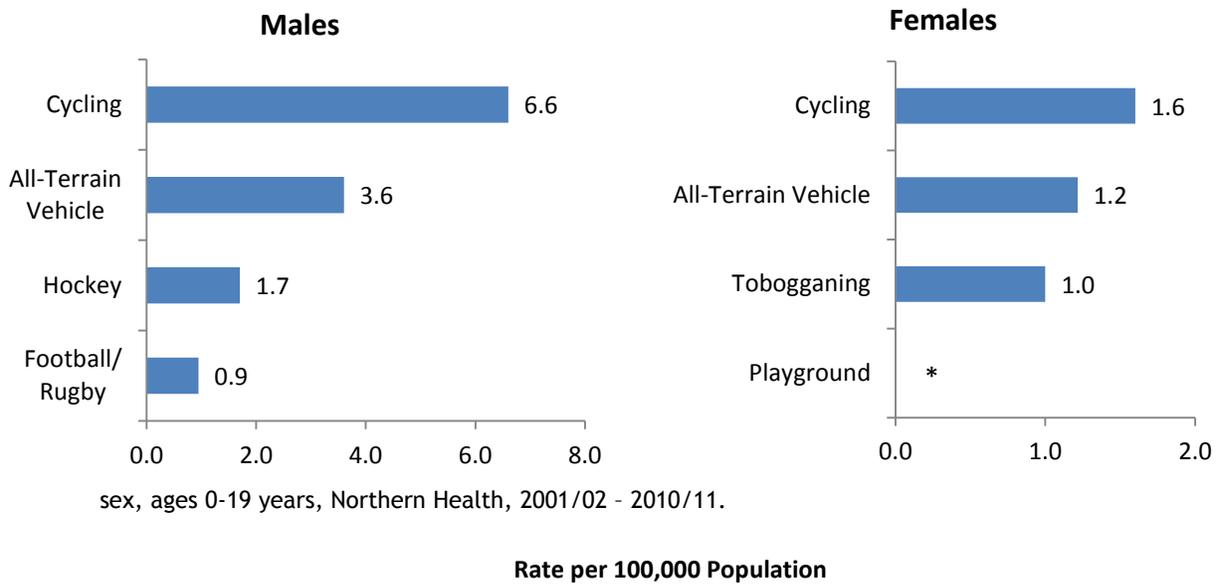
Figure 10: Sport and recreation-related concussion hospitalization rates by type of sport/recreation, ages 0-19 years, Northern Health, 2001/02 - 2013/14.



Patterns of sport and recreation-related concussion varied by sex. The highest sport and recreation-related rates among males were for cycling (6.6/100,000), followed by all-terrain vehicle (3.6/100,000) and hockey (1.7/100,000) (Figure 11). For females, highest rates were seen for cycling (1.6/100,000) and all-terrain vehicle (1.2/100,000).

Number of cases were too few to allow for further exploration by age group for sport and recreation-related concussion hospitalization among children under 10 years of age. Children aged 10 to 14 years experienced highest rates for cycling (4.8/100,000), followed by all-terrain vehicle (2.6/100,000) (chart not shown). Among youth aged 15 to 19 years, highest rates were for all-terrain vehicle (4.7/100,000), followed by cycling (3.6/100,000) (chart not shown).

Figure 11: Sport and recreation-related concussion hospitalization rates by leading type of sport/recreation and



Note: * Represents fewer than 5 cases

Concussion Hospitalization between Health Service Delivery Areas

Northern Health consists of three Health Service Delivery Areas (HSDA): Northwest, Northern Interior, and Northeast. The majority of Northern Health residents who were hospitalized for concussion sought treatment within Northern Health (Table 1). About 96 percent of Northwest residents hospitalized for concussion were admitted to hospitals within Northern Health; this is a higher proportion than for residents of both Northern Interior and Northeast (91.7% and 88.9%, respectively). Interior Health was the next leading Health Authority providing hospital care for Northern Health residents with concussion from 2001/02 to 2013/14 (n=7).

Concussion hospitalization rates were highest among residents of Northwest (43.8/100,000) and lowest among residents of Northeast (28.9/100,000) (Figure 12). The highest number of concussion hospitalizations was within Northern Interior (n=168). Statistical testing demonstrated significant differences between Northwest and Northern Interior (p -value <0.05).

A breakdown by age group for all HSDAs showed that the highest concussion hospitalization rates were observed among youth aged 15 to 19 years within all HSDAs, with the highest rate being in Northwest (59.2/100,000), followed by the Northeast (48.4/100,000) and Northern Interior (43.8/100,000) (Figure 13).

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, Northern Health, 2001/02-2013/14.

Health Authority in which treatment sought	Health Service Delivery Area of patient's residence		
	Northwest	Northern Interior	Northeast
Northern Health	118 (95.9%)	154 (91.7%)	64 (88.9%)
Fraser Health	*	*	0
Interior Health	0	7	0
Out-Of-Province	0	*	*
Provincial Health Services ⁺	0	*	*
Vancouver Coastal Health	0	*	*
Island Health	*	0	0
Grand Total	123	168	72

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

Figure 12: Concussion hospitalization counts and rates by health service delivery area, ages 0-19 years, Northern Health, 2001/02-2013/14.

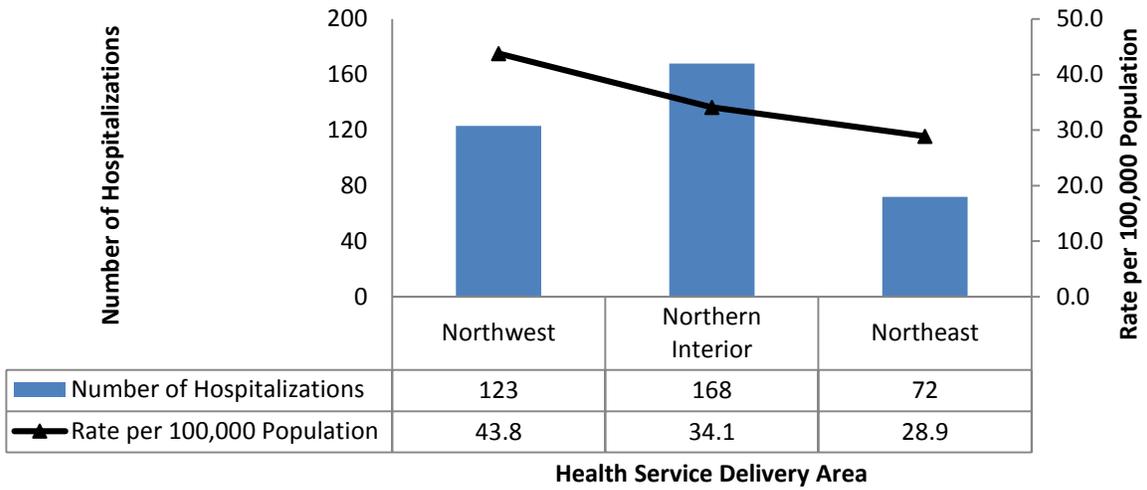
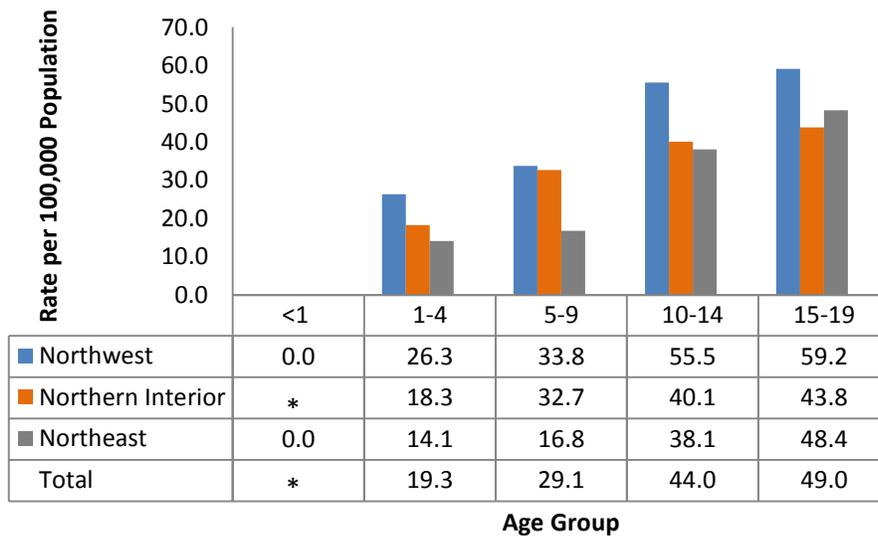


Figure 13: Concussion hospitalization rates by health service delivery area and age group, ages 0-19 years, Northern Health, 2001/02-2013/14.

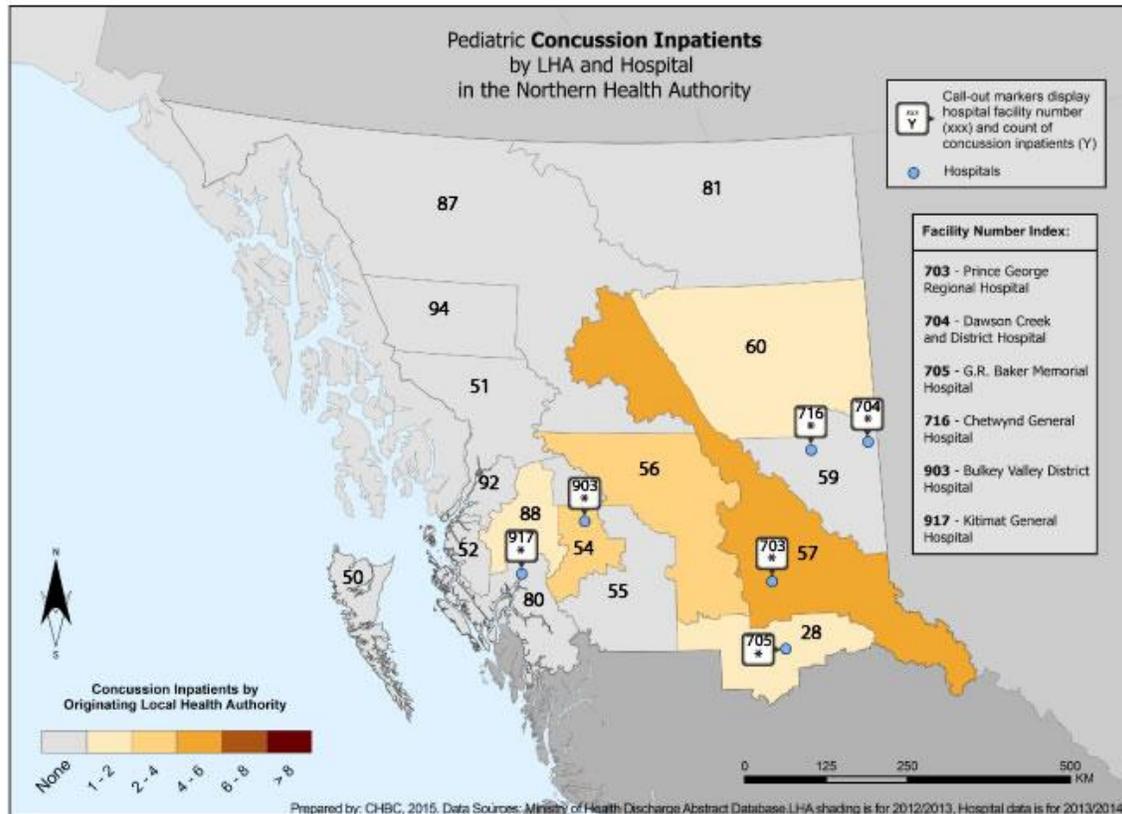


Note: * Represents fewer than 5 cases

The number of child and youth concussion inpatients was highest in the Northern Interior residence in 2013/14 (Figure 14). In contrast, the Northeast residence and Northwest residence reported few cases.

There were fewer than five cases of pediatric concussion inpatients at each hospital within Northern Health. However, residents of Prince George had the highest number of concussion inpatients (Figure 14).

Figure 14: Pediatric Concussion Inpatients by local health area and hospital, Northern Health, 2013/14.



Note: * Represents fewer than 5 cases

Note: 50: Queen Charlotte, 51: Snow Country, 52: Prince Rupert, 53: Upper Skeena, 54: Smithers, 80: Kitimat, 87: Stikine, 88: Terrace, 92: Nisga'a, 94: Telegraph Creek, 28: Quesnel, 55: Burns Lake, 56: Nechako, 57: Prince George, 59: Peace River South, 60: Peace River North, 81: Fort Nelson

Concussion Hospitalization by Health Service Delivery Area: Northwest

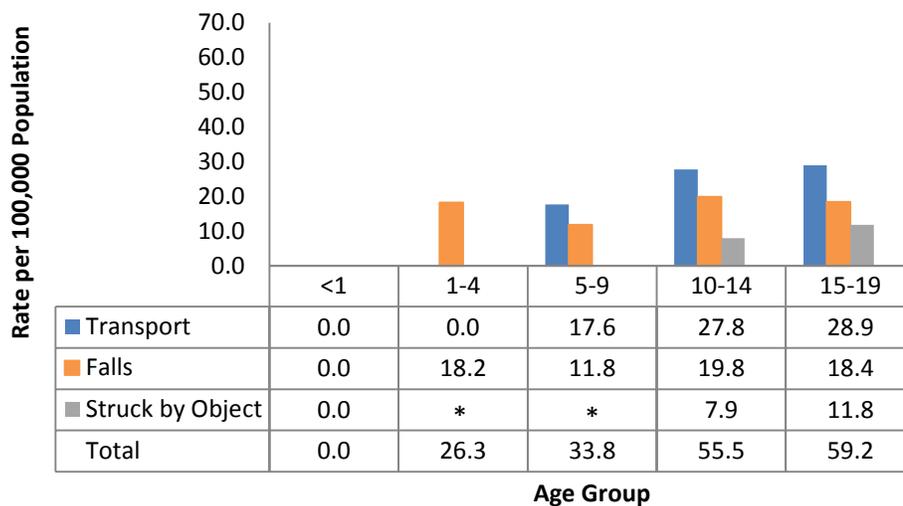
A total of 123 concussion hospitalizations were reported for Northwest between 2001/02 and 2013/14. Among all age groups, 15 to 19 year olds had the highest rate of concussion, most of which comprised of transport-related cases.

Fall-related concussion hospitalization rates were highest among children aged 10 to 14 years (19.8/100,000). Transport-related

concussion hospitalization rates gradually increased with older age groups (Figure 15).

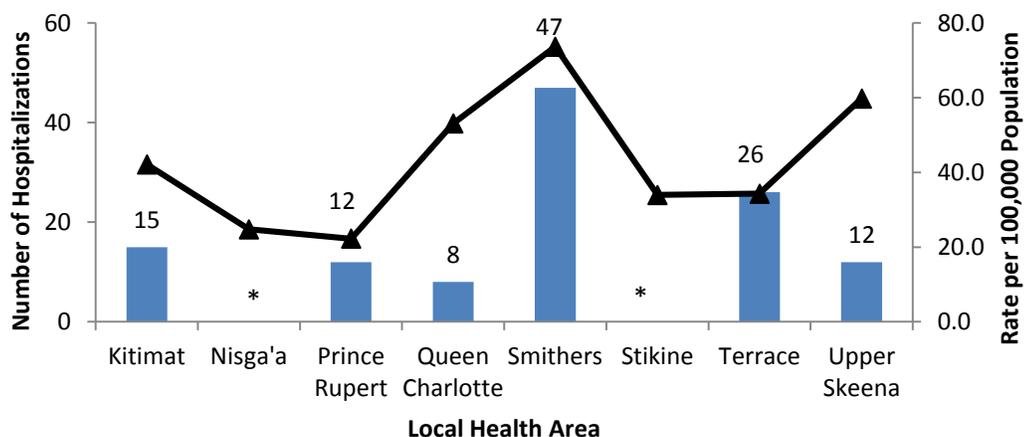
The Northwest area of Northern Health is split into eight Local Health Areas (LHAs): Kitimat, Nisga'a, Prince Rupert, Queen Charlotte, Smithers, Stikine, Terrace and Upper Skeena. Concussion hospitalization rates were highest in Smithers (73.7/100,000) and lowest in Prince Rupert (22.2/100,000) (Figure 16).

Figure 15: Concussion hospitalization rates by cause and age group, ages 0-19 years, Northern Health: Northwest, 2001/02-2013/14.



Note: * Represents cases fewer than 5; Total includes all causes of concussion hospitalizations

Figure 16: Concussion hospitalization count and rate by local health area, ages 0-19 years, Northern Health: Northwest, 2001/02-2013/14.

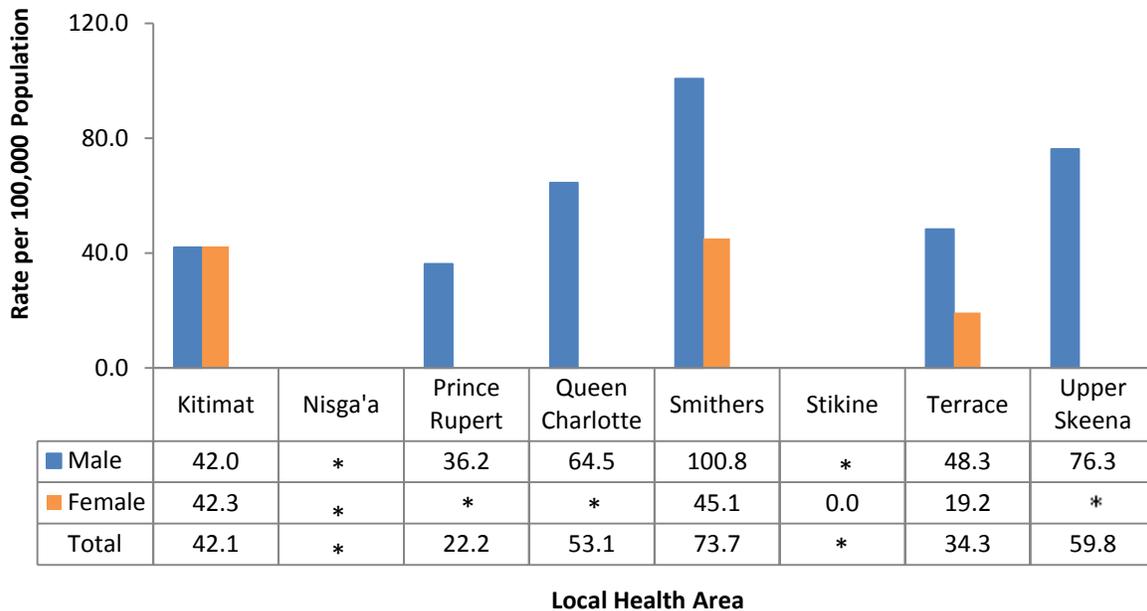


Note: * Represents fewer than 5 cases

Concussion hospitalization rates were higher among males than females within all LHAs, except for Kitimat and Nisga'a, with the highest rates among males in Smithers (100.8/100,000) and the lowest rates among males in Prince Rupert (36.2/100,000). The highest rates among females were in Smithers (45.1/100,000), while Stikine had the lowest occurrence of concussions with fewer than five cases in total (Figure 17).

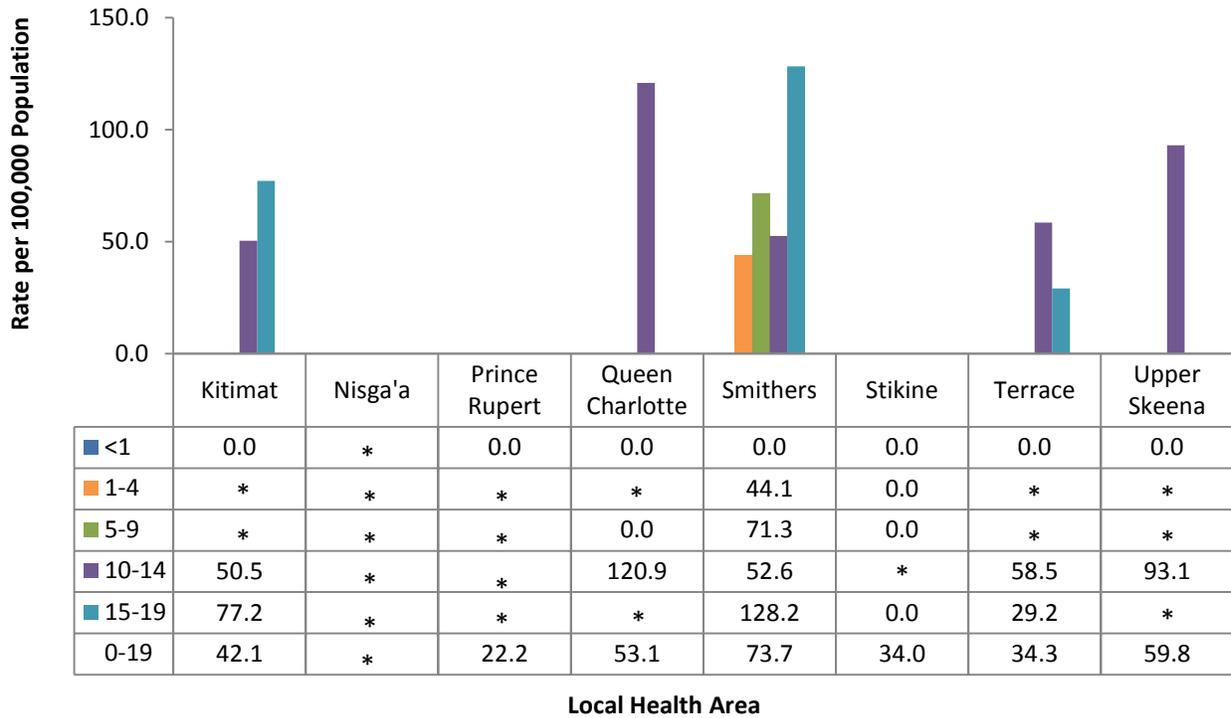
Within Smithers and Kitimat, the highest rates of concussion hospitalization among children and youth were seen among those aged 15 to 19 years (128.2/100,000 and 77.2/100,000, respectively), while Queen Charlotte, Upper Skeena, Terrace and Smithers had the highest rates among children aged 10 to 14 years (120.9/100,000, 93.1/100,000, 58.5/100,000 and 52.6/100,000, respectively) (Figure 18)

Figure 17: Concussion hospitalization rates by local health area and sex, ages 0-19 years, Northern Health: Northwest, 2001/02-2013/14.



Note: * Represents fewer than 5 cases

Figure 18: Concussion hospitalization rates by local health area and age group, ages 0-19 years, Northern Health: Northwest, 2001/02-2013/14.



Note: * Represents fewer than 5 cases

Concussion Hospitalization by Health Service Delivery Area: Northeast

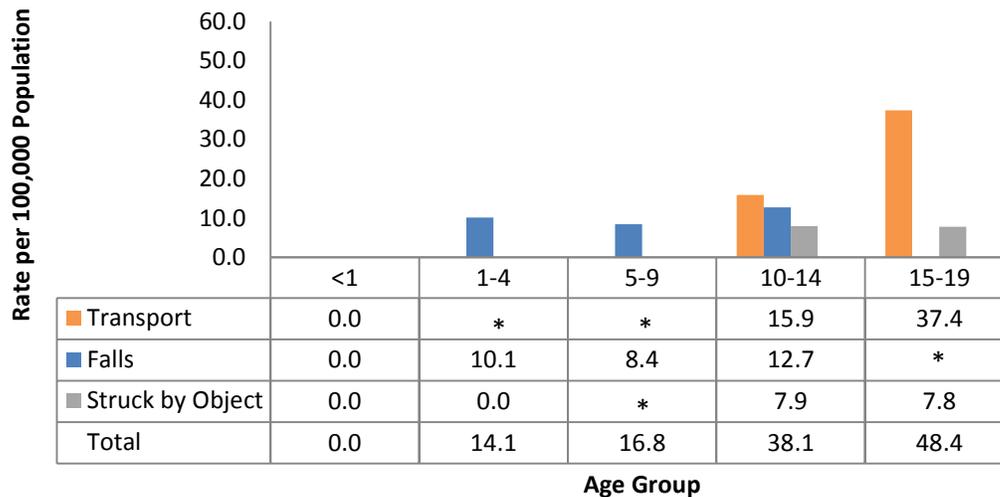
A total of 72 concussion hospitalizations were reported for Northeast between 2001/02 and 2013/14. Among all age groups, 15 to 19 year olds had the highest rate of concussion, most of which comprised of transport-related cases.

In Northeast, rates of fall-related concussion hospitalizations were highest among children aged 10 to 14 years (12.7/100,000), and rates of transport-related concussion hospitalization were highest among youth aged 15 to 19 years (37.4/100,000). High rates were also observed

for struck by object among 10 to 14 year olds (7.9/100,000) (Figure 19).

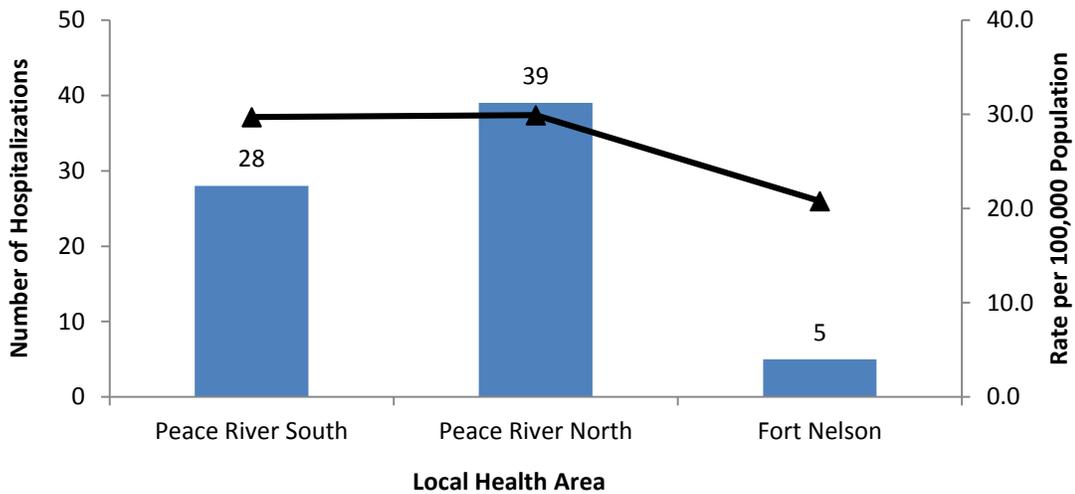
Northeast is split into three LHAs: Peace River South, Peace River North and Fort Nelson. Concussion hospitalizations rates were highest in Peace River North (29.9/100,000) and lowest in Fort Nelson (20.8/100,000). The total number of hospitalization cases was highest in Peace River North with 39 hospitalization cases (Figure 20).

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



Note: * Represents fewer than 5 cases; Total includes all causes of concussion hospitalizations

Figure 20: Concussion hospitalization counts and rates by local health area, ages 0-19 years, Northern Health: Northeast, 2001/02-2013/14.

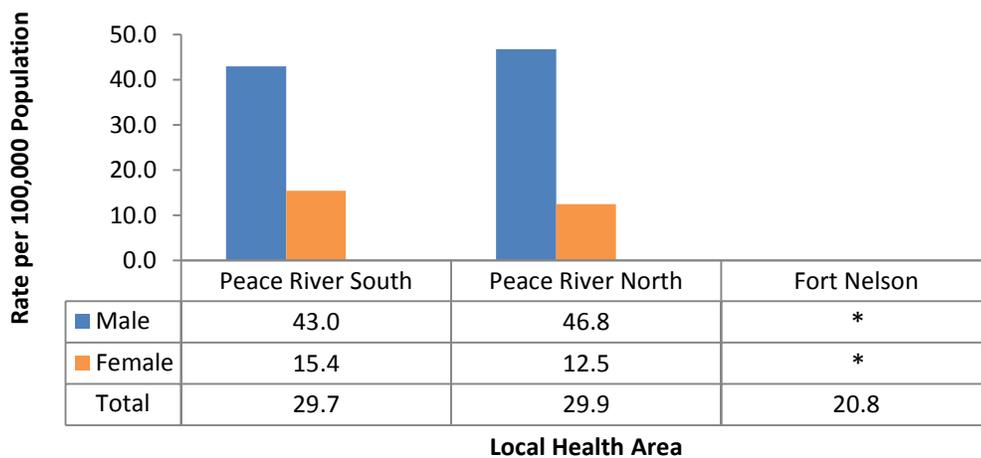


Concussion hospitalization rates were higher among males than females within all LHAs of Northeast. The highest rates among males were in Peace River North (46.8/100,000) and among females in Peace River South (15.4/100,000) (Figure 21).

LHAs within Northeast reported no cases of concussion hospitalizations among infants less than one year of age (Figure 22). Concussion hospitalization rates were also low among

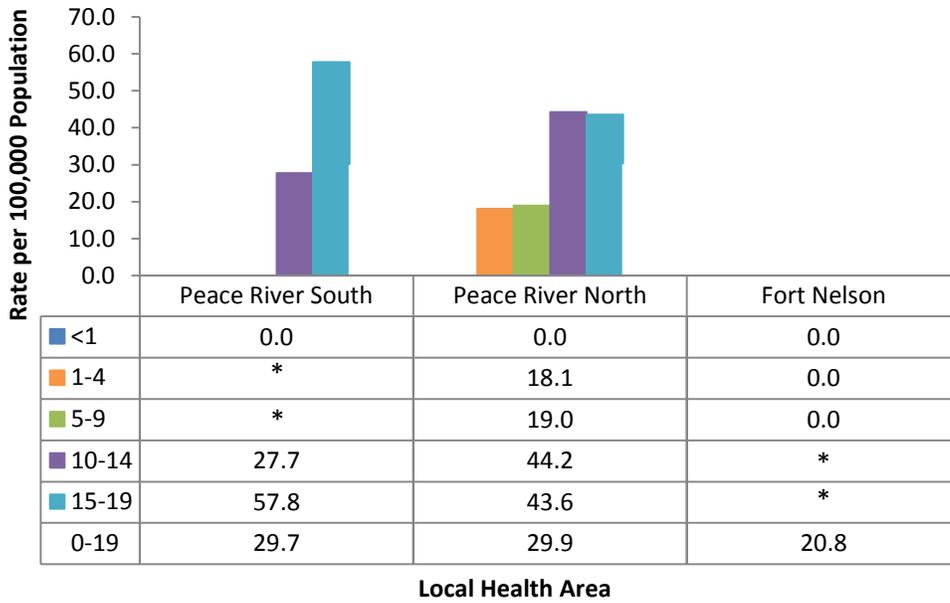
children aged 1 to 4 years across all LHAs, with the exception of Peace River North. Peace River South reported high rates of concussion hospitalizations among 15 to 19 year olds (57.8/100,000). Peace River North displayed the highest concussion hospitalizations rates among 10 to 14 year olds (44.2/100,000) (Figure 22). Fort Nelson had fewer than five cases across all age groups.

Figure 21: Concussion hospitalization rates by local health area and sex, ages 0-19 years, Northern Health: Northeast, 2001/02-2013/14.



Note: * Represents fewer than 5 cases

Figure 22: Concussion hospitalization rates by local health area and age group, ages 0-19 years, Northern Health: Northeast, 2001/02-2013/14.



Note: * Represents fewer than 5 cases

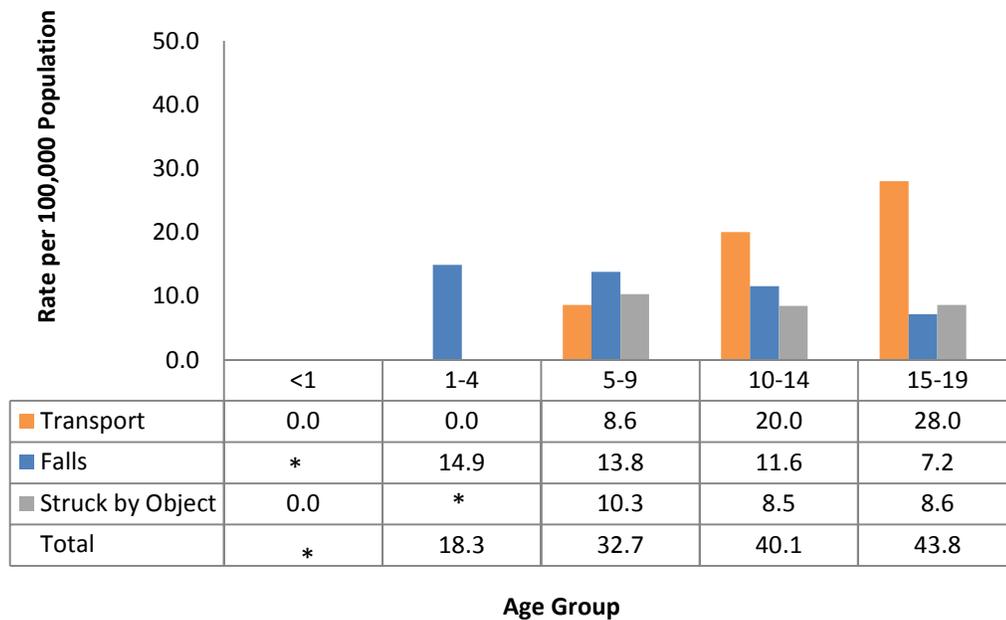
Concussion Hospitalization by Health Service Delivery Area: Northern Interior

A total of 168 concussion hospitalizations were reported for Northern Interior between 2001/02 and 2013/14. Among all age groups, 15 to 19 year olds had the highest rate of concussion with a majority comprising of transport-related concussions.

In Northern Interior, rates of fall-related concussion hospitalizations were highest among children aged of 1 to 4 years (14.9/100,000), and rates of transport-related concussion hospitalization rates were highest among youth aged 15 to 19 years (28.0/100,000) (Figure 23).

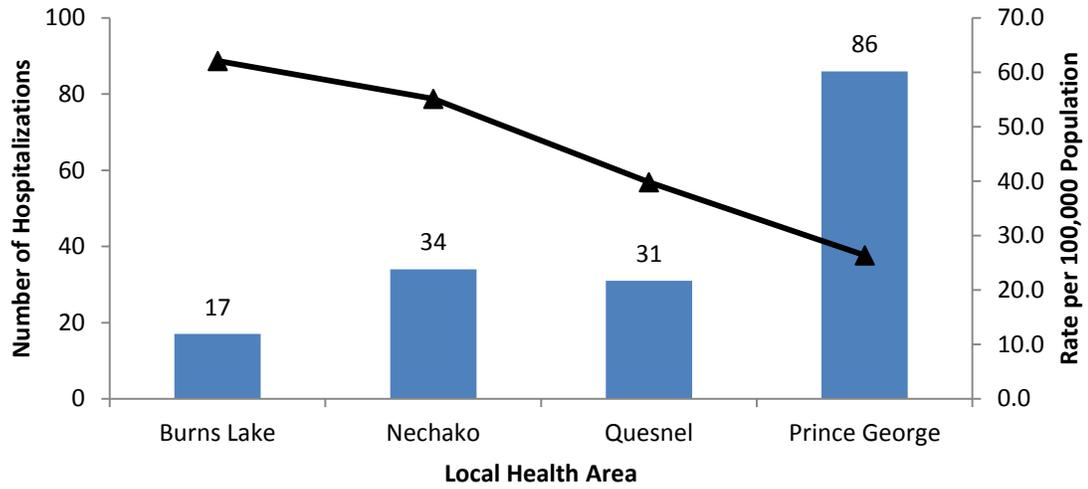
Northern Interior is split into four LHAs: Burns Lake, Nechako, Quesnel and Prince George. Rates of concussion hospitalizations were highest in Burns Lake (62.1/100,000) and lowest in Prince George (26.4/100,000). However, the highest number of total hospitalization cases was seen in Prince George with 86 reported concussion hospitalizations (Figure 24).

Figure 23: Concussion hospitalization rates by cause and age group, ages 0-19 years, Northern Health: Northern Interior, 2001/02-2013/14.



Note: * Represents fewer than 5 cases; Total also includes other causes of concussion hospitalizations that are not shown as there are fewer than 5 cases

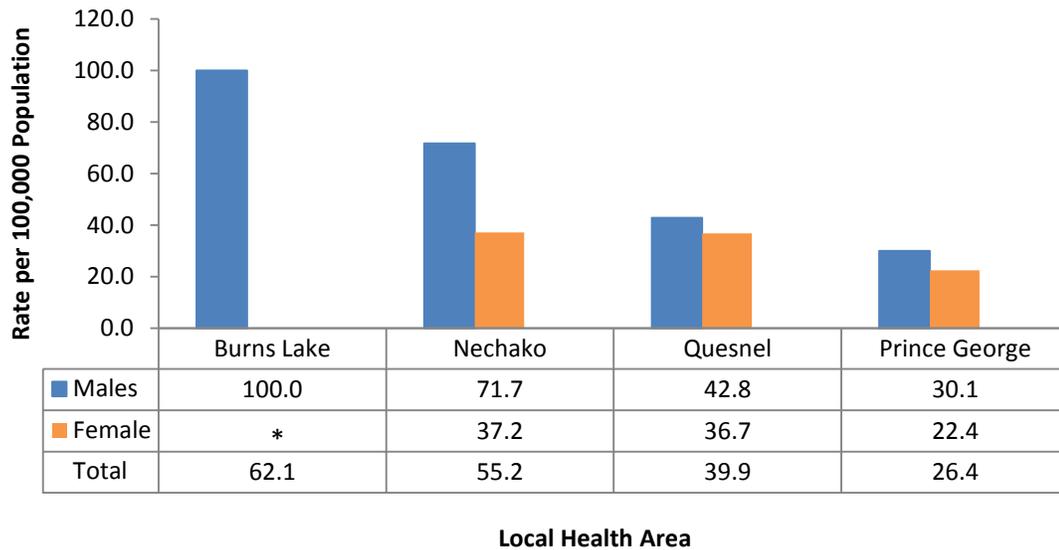
Figure 24: Concussion hospitalization counts and rates by local health area, ages 0-19 years, Northern Health: Northern Interior, 2001/02-2013/14.



Concussion hospitalization rates were higher among males than females within all LHAs of Northern Interior. The highest rates among males were in Burns Lake (100.0/100,000) and the lowest rates were found in Prince George (30.1/100,000) (Figure 25). Among females, highest rates were seen in Nechako (37.2/100,000) and the lowest rates of concussion hospitalizations were found in Burns Lake (Figure 25).

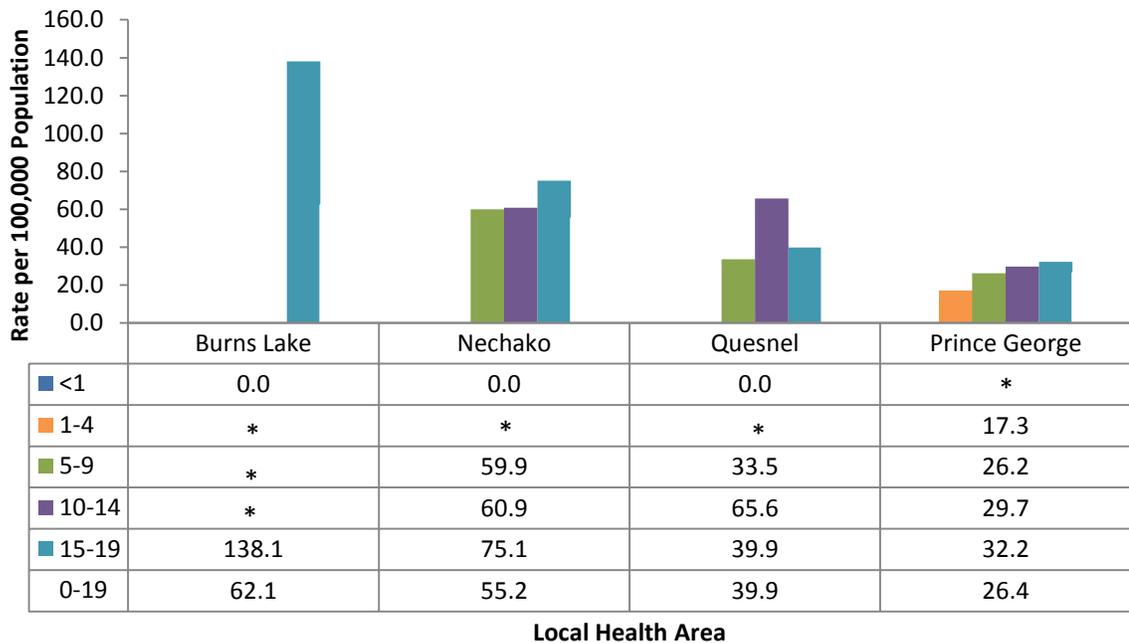
Burns Lake reported the highest rates of concussion hospitalizations among youth aged 15 to 19 years (138.1/100,000) (Figure 26). Rates in Northern Interior were lowest, across all LHAs, among children less than 5 years of age. The highest concussion hospitalization rates among children aged 10 to 14 years were in Nechako and Quesnel (60.9/100,000 and 65.6/100,000, respectively) (Figure 26).

Figure 25: Concussion hospitalization rates by local health area and sex, ages 0-19 years, Northern Health: Northern Interior, 2001/02-2013/14.



Note: * Represents fewer than 5 cases

Figure 26: Concussion hospitalization rates by local health area and age group, ages 0-19 years, Northern Health: Northern Interior, 2001/02-2013/14.



Note: * Represents fewer than 5 cases

CONCUSSION EMERGENCY DEPARTMENT VISIT RATES

Northern Health has one principal hospital with recorded concussion emergency department visits: the University Hospital of Northern British Columbia. There were a total of 460 child and youth concussion emergency department visits to this hospital between the years 2013/14 and 2014/15. Emergency department rates for each hospital were calculated per 100,000 visits for all diagnoses. During this period, rates of concussion emergency department visits were 2,637.2 per 100,000 visits, with the higher rate occurring among males, compared to females (3,297.7/100,000 visits) (Figure 27).

When looking at emergency department visits from concussions by month between April 1, 2013 and March 31, 2015, the number of cases presented by month was highest in May (51 visits), June (47 visits) and April (46 visits). Rates

of concussion emergency department visits per 100,000 visits peaked in May (3,132.7/100,000). The number of concussion emergency department visits was lowest in February (27 visits) and September (32 visits). Lowest rates were also reported for February and September (1,938.3/100,000 and 2,322.2/100,000, respectively) (Figure 28).

At the University Hospital of Northern BC, the observed proportion of emergency department visits attributed to child and youth concussion was 2.64 percent in comparison to other causes of emergency department visits (Table 2). During the 2013/14 year alone, the University Hospital of Northern BC saw 221 emergency department visits related to concussion (Figure 29).

Figure 27: Concussion emergency department visit rates by hospital and sex, ages 0-19 years, Northern Health, NACRS, 2013/14-2014/15.

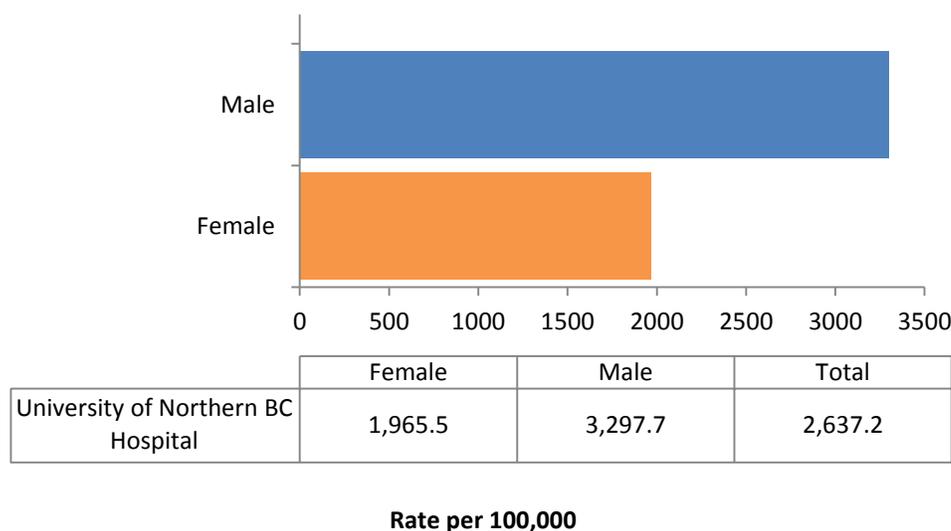


Figure 28: Concussion emergency department visit rates and number of cases by month, ages 0-19 years, University Hospital of Northern British Columbia, NACRS, 2013/14-2014/15.

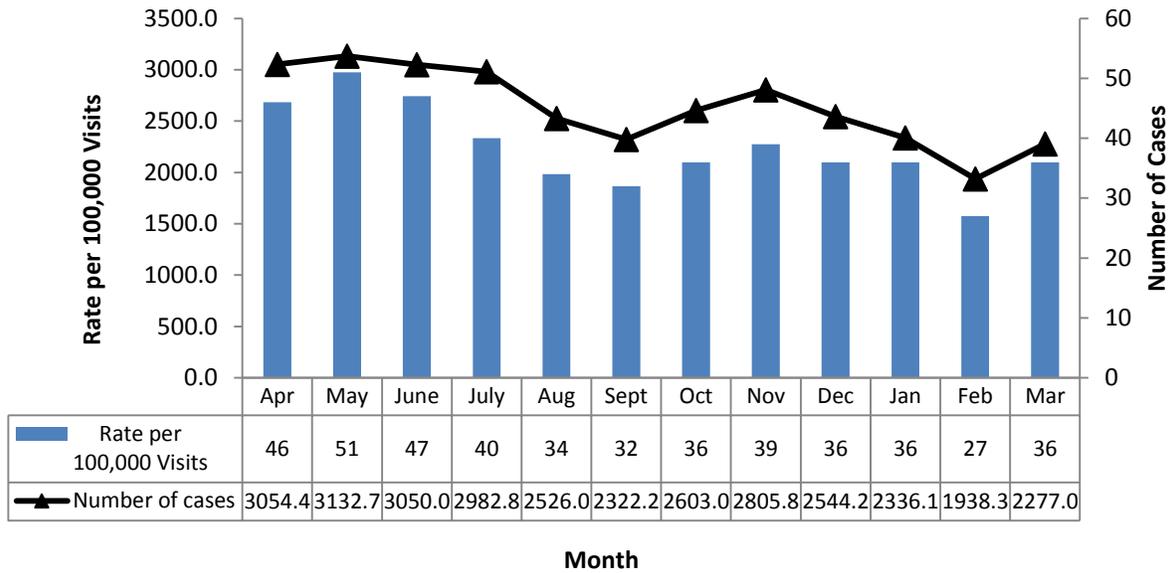
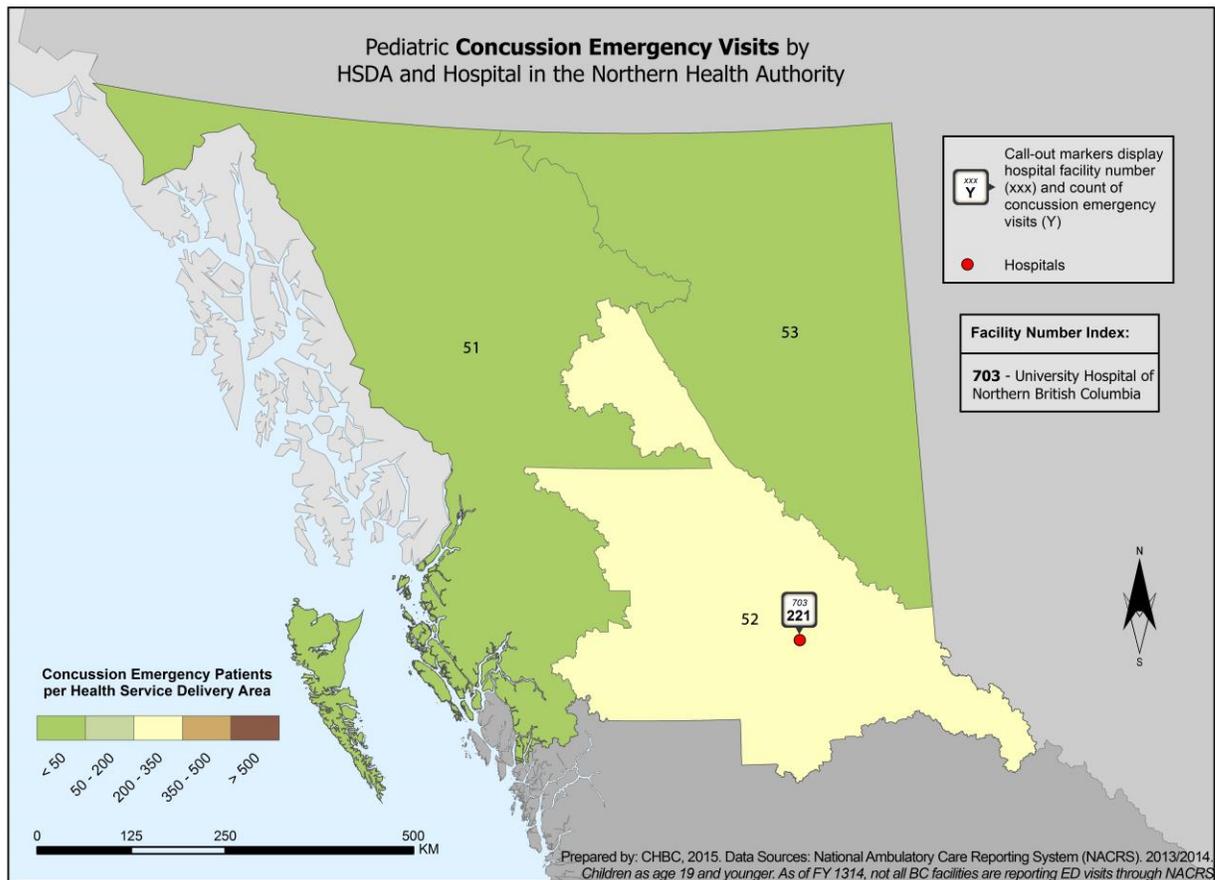


Table 2: Concussion emergency department visit proportions by hospital, ages 0-19 years, Northern Health, NACRS, 2013/14-2014/15.

	Number of ER concussion visits	Total ER visits	% of concussion ER visits
University Hospital of Northern British Columbia	460	17,443	2.64

Figure 29: Pediatric concussion emergency visits by local health area and hospital, Northern Health Authority, 2013/14.



Note: 51: Northwest, 52: Northern Interior, 53: Northeast

CONCLUSION

Northern Health exhibited low overall rates of child and youth concussion hospitalizations. However, there was a large variation in rates among local health areas. Smithers, Upper Skeena, Queen Charlotte, Peace River South, Peace River North, Burns Lake and Nechako exhibited much higher rates of concussion hospitalizations than most regions in BC, while Quesnel, Prince George, Fort Nelson, Prince Rupert and Terrace reported low rates of child and youth concussion hospitalizations.

The highest rates of concussion hospitalizations were seen among the 15 to 19 year old age group, largely due to transport-related causes. The majority of these hospitalizations were due to the involvement of motor vehicle occupants, pedal cyclists and off-road vehicles.

Among children under the age of 9 years, falls remained the leading cause of concussion hospitalization. The leading cause of falls within this age group was falls from furniture, except among 1 to 4 year olds where fall from stairs was the leading cause. Males within Northern Health exhibited higher rates of concussion hospitalizations than females across all ages between 0 to 19 years.

Sport and recreation-related concussion hospitalizations were mostly observed among males aged 10 to 19 years. Involvement of cycling and all-terrain vehicles were observed to be the most frequent sport and recreation-related concussion hospitalization in both sexes.

Transport-related concussion hospitalizations maintained similar patterns and trends across all HSDA within Northern Health, with rates increasing as age increases. Northwest displayed the highest rates of transport-related concussion hospitalization across most age groups.

Fall-related concussion hospitalization rates varied with age within each HSDA. Children aged 10 to 14 years displayed the highest rate of fall-related concussion hospitalization within Northeast and Northwest. In comparison, Northern Interior had the highest rate of fall-related concussion hospitalization for children aged 1 to 4 years.

There were no cases reported for fall-related concussion hospitalization among infants less than one year of age within any of the three HSDAs. The highest fall-related concussion hospitalization rate were seen in Northwest, compared to the other HSDAs.

An analysis of the emergency department visit data from the University Hospital of Northern BC showed that between April 1, 2013 and March 31, 2015, higher rates of concussion emergency department visits were seen for males than females (3,297.7/100,000 and 1,965.5/100,000 visits, respectively).

The months of May and April saw the highest rates of concussion-related emergency department visits per 100,000 visits, while May and June recorded the highest numbers of concussion emergency department visits.

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

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