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 Island 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 and treated at all.

Highlights include but are not limited to the following:

- From 2001/02-2013/14 there were 452 concussion hospitalizations among children and youth aged 0 to 19 years who reside within Island Health.
- Male children and youth had twice the rates of concussion hospitalizations as females (31.7/100,000 vs. 14.2/100,000).
- The leading causes of child and youth concussion hospitalizations in Island Health were due to falls (45%) and transport-related events (38%).
- Children aged 1 to 4 years had the highest rates of fall-related concussion hospitalizations (20.9/100,000) while older youth aged 15 to 19 years had the highest rates for transport-related concussions (14.3/100,000).
- Older children in Island Health experienced a larger proportion of sports-related concussion hospitalizations as compared to younger children, with a greater rate of occurrence among males rather than females.
- Cycling (47.4%), skateboard (9.9%) and playground (7.6%) activities were the greatest contributors for sport and recreation-related concussion hospitalizations among both males and females of all ages 0 to 19 years.
- Child and youth residents within Central Vancouver Island had the highest rates of concussion hospitalizations (25.1/100,000), with 92.7% admitted to Island Health hospitals.
- Leading causes of child and youth fall-related concussion hospitalizations were 'fall on the same level' (18.0%) and 'fall from high level' (13.7%).
- Leading causes of child and youth transport-related concussion hospitalizations were 'pedal cyclist' (49.4%) and 'motor vehicle occupant' (26.5%).
- The local health areas of Gulf Islands (67.3/100,000) and Alberni (39.2/100,000) exhibited much higher rates of concussion hospitalizations than the other local health areas within Island Health.
- Royal Jubilee and Victoria General Hospital saw the highest proportion of concussion emergency department visits (2.7% and 2.6%, respectively) from July 1, 2013 to March 30, 2015.

Concussions remain a significant health issue for children and youth in Island Health, and require further attention given the potential for 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 concussion 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 concussion [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 case 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 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 unintentional concussion hospitalizations and emergency department visits among children and youth living within or attending any of the hospitals within the geographic area of Island 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 dataset 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. 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 Services Health Authority (PHSA) for Nanaimo Regional, Royal Jubilee and Victoria General Hospitals from July 1, 2013 to March 31, 2015.

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 Island Health. Rates presented by region are based on the patients' residence and not the location of injury occurrence.

Emergency department rates for each 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. In the report, *p*-values are represented for any analysis conducted that showed statistical significance.

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.

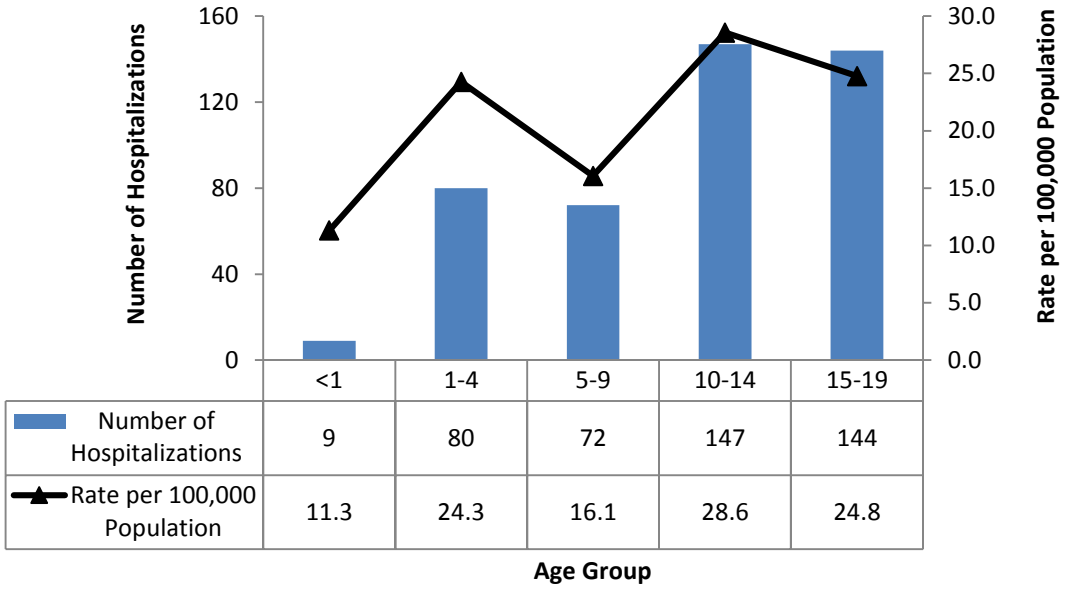
Hospitalization data can vary over time and between areas for factors not related to health, such as accessibility of treatment, and medical or administrative decisions that may affect the number of hospitalizations and lengths of hospital stay [9, 10].

Emergency department data from NACRS were not available for hospitals such as Campbell River, Cowichan District, Saanich Peninsula and St. Joseph's Comox. As a result, emergency department visit data for concussion in Island 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 Nanaimo Regional, Royal Jubilee and Victoria General Hospitals is ranged from 60 to 70 percent.

CONCUSSION HOSPITALIZATION

There were 452 hospitalizations among children and youth aged 0 to 19 years resulting from concussion within Island 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 (11.3/100,000), and highest among children aged 10 to 14 years (28.6/100,000), followed by 15 to 19 year olds (24.8/100,000) (Figure 1).

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

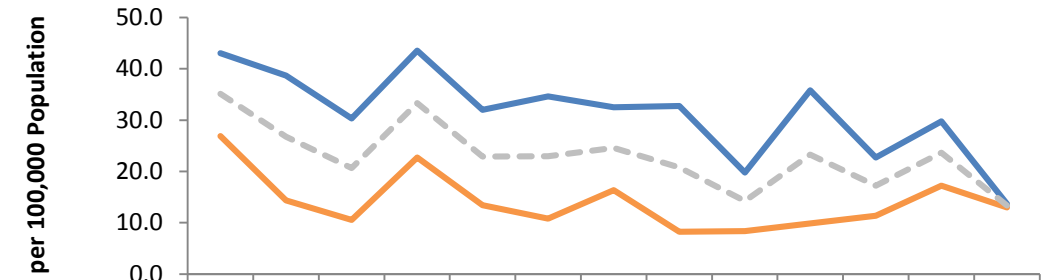


Concussion hospitalization rates among children and youth were seen to vary from 2001/02 to 2013/14 (Figure 2). Rates peaked in 2001/02 at 35.1 per 100,000 and were lowest in 2013/14 at 13.3 per 100,000. Concussion hospitalization rates were consistently higher among males than females from 2001/02 to 2013/14.

Concussion hospitalization rates peaked for males aged 0 to 19 years in 2004/05 at 43.5 per 100,000, and were lowest in 2013/14 at 13.7 per 100,000 (Figure 2). Rates peaked for females in 2001/02 at 26.9 per 100,000 and were lowest in 2008/09 at 8.3 per 100,000.

Males accounted for 70.1 percent (n=317) of all concussion hospitalizations among children and youth. Rates for males were higher than for females for all age groups (Figure 3). As age increased, males displayed higher rates than females for all concussion hospitalizations.

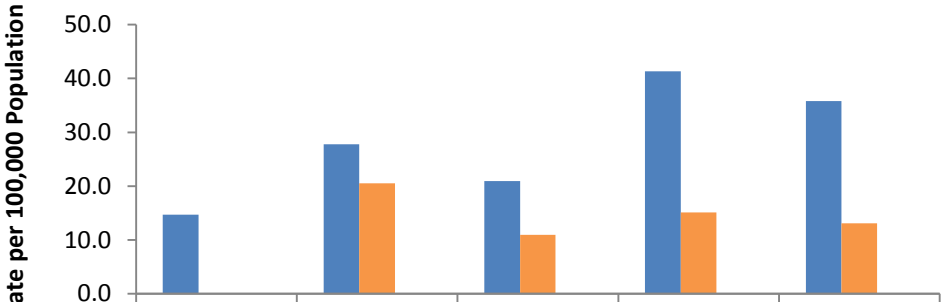
Figure 2: Concussion hospitalization rates by year and sex, ages 0-19 years, Island Health, 2001/02 - 2013/14.



	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
Males	43.0	38.7	30.3	43.5	32.0	34.6	32.5	32.7	19.8	35.8	22.7	29.7	13.7
Females	26.9	14.3	10.6	22.7	13.4	10.8	16.3	8.3	8.4	9.9	11.4	17.2	13.0
Total	35.1	26.8	20.7	33.3	22.9	23.0	24.6	20.8	14.2	23.2	17.2	23.7	13.3

Year

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



	<1	1-4	5-9	10-14	15-19
Males	14.7	27.8	21.0	41.3	35.8
Females	*	20.5	11.0	15.1	13.1
Total	11.3	24.3	16.1	28.6	24.8

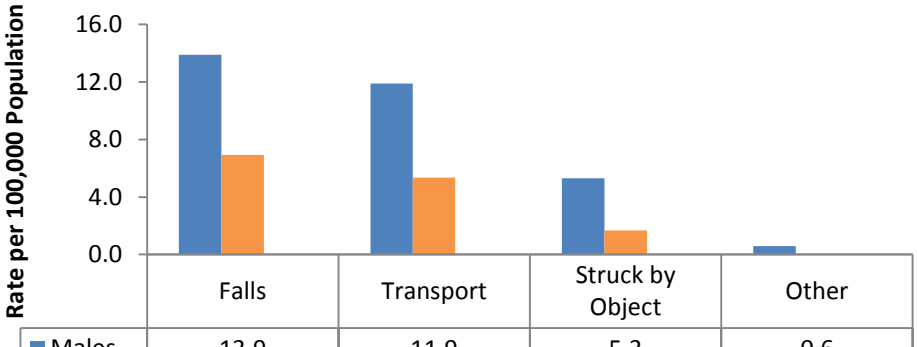
Age Group

*Note: * Represents fewer than 5 cases*

Leading causes of concussion hospitalization among children and youth included falls, transport-related events and struck by/against an object (Figure 4). Fall-related concussion hospitalization was the leading cause for both males and females at 13.9 per 100,000 and 6.9 per 100,000, respectively. Of those concussions caused by struck by/against an object, 65.2 percent occurred during sport and recreation activities.

Leading causes of concussion hospitalizations varied by age group, with falls being the leading cause for 0 to 9 year olds, while transport-related events were the leading cause for 10 to 19 year olds (Figure 5). Concussion hospitalization rates for falls were highest among 1 to 4 year olds (20.9/100,000), while transport-related concussion rates were highest among 15 to 19 year olds (14.3/100,000).

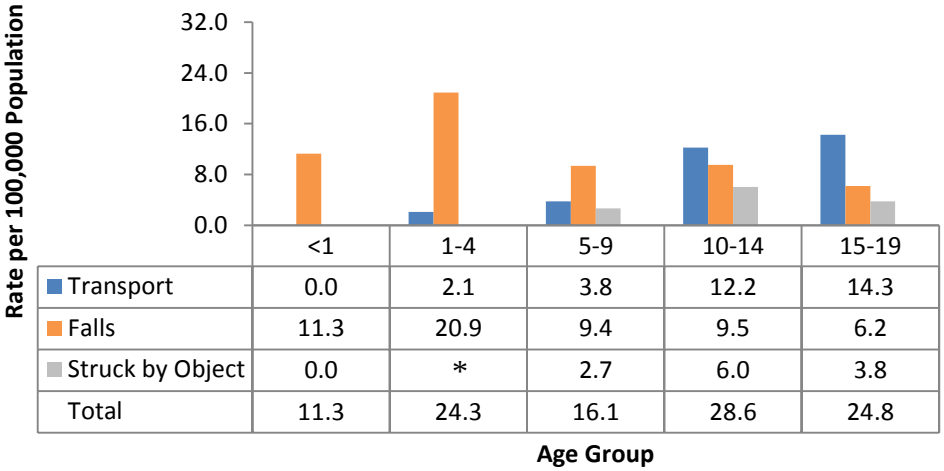
Figure 4: Concussion hospitalization rates by cause and sex, ages 0-19 years, Island Health, 2001/02 - 2013/14.



	Falls	Transport	Struck by Object	Other
Males	13.9	11.9	5.3	0.6
Females	6.9	5.4	1.7	*
Total	10.5	8.7	3.5	0.4

*Note: * Represents fewer than 5 cases*

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



	<1	1-4	5-9	10-14	15-19
Transport	0.0	2.1	3.8	12.2	14.3
Falls	11.3	20.9	9.4	9.5	6.2
Struck by Object	0.0	*	2.7	6.0	3.8
Total	11.3	24.3	16.1	28.6	24.8

*Note: *Represents fewer than 5 cases; Total also includes other causes of concussion hospitalizations, which are not shown as there were 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 (18.0%, n=37), falls from high level (13.7%, n=28), falls involving skates, skis and skateboards (13.2%, n=27), and falls involving bed, chair and other furniture (12.2%, n=25) (Figure 6). Nearly one third of cases were classified as "other and unspecified" falls (27.8%, n=57).

Among young children aged 1 to 4 years, falls from furniture and falls on the same level were the leading causes of fall-related concussion hospitalization (5.2/100,000 and 4.2/100,000, respectively) (Figure 7). Falls from high level resulting in a concussion hospitalization were more common among children aged 5 to 9 years (2.7/100,000). Falls involving skates, skis and skateboards resulting in a concussion were more common among older youth aged 10 to 14 years (2.9/100,000) and 15 to 19 years (1.7/100,000).

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

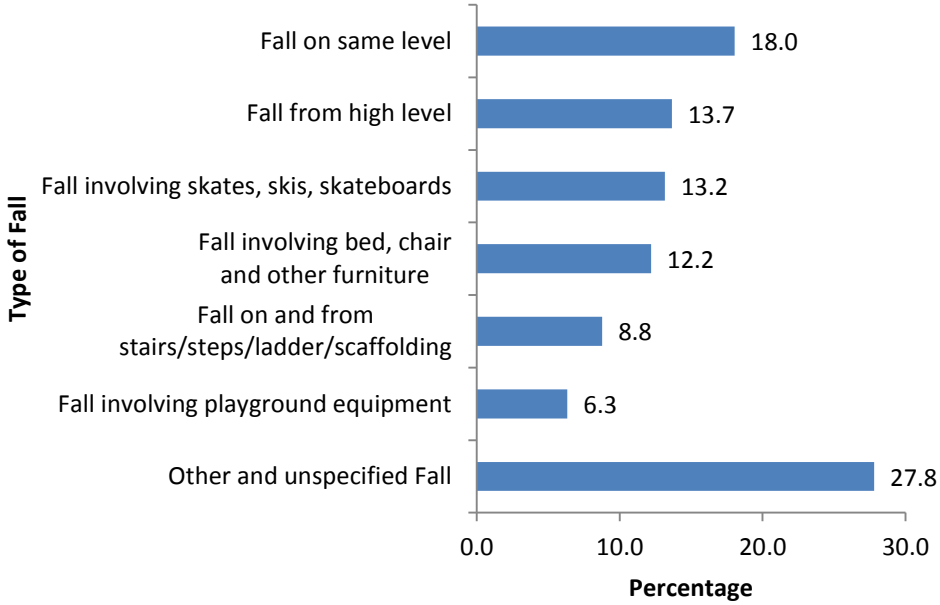
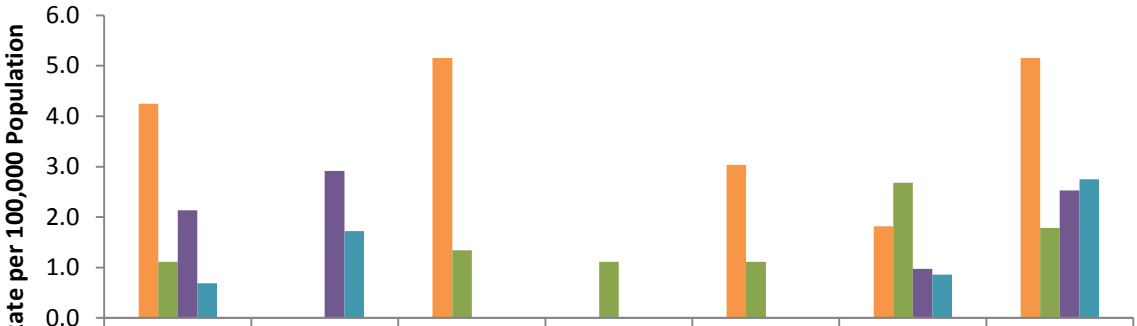


Figure 7: Fall-related concussion hospitalization rates by type of fall and age group, ages 0-19 years, Island Health, 2001/02 – 2013/14.



	Fall on same level	Fall involving skates, skis, skateboards	Fall involving bed, chair and other furniture	Fall involving playground equipment	Fall on and from stairs/steps/ ladder/ scaffolding	Fall from high level	Other and unspecified Fall
<1	*	0.0	*	0.0	*	0.0	*
1-4	4.2	*	5.2	*	3.0	1.8	5.2
5-9	1.1	*	1.3	1.1	1.1	2.7	1.8
10-14	2.1	2.9	0.0	*	*	1.0	2.5
15-19	0.7	1.7	0.0	0.0	*	0.9	2.8
0-19	1.9	1.4	1.3	0.7	0.9	1.4	2.9

Type of Fall

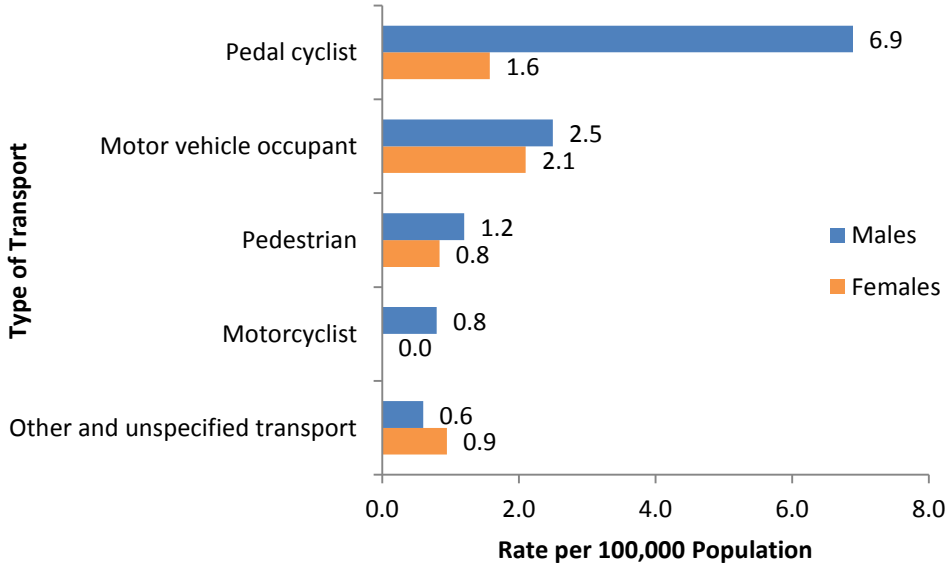
*Note: *Represents fewer than 5 cases*

Transport-related Concussion Hospitalization

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

Rates among males were highest for pedal cyclists (6.9/100,000) and motor vehicle occupants (2.5/100,000), while highest rates among females were for motor vehicle occupants (2.1/100,000) followed by pedal cyclists (1.6/ 100,000).

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

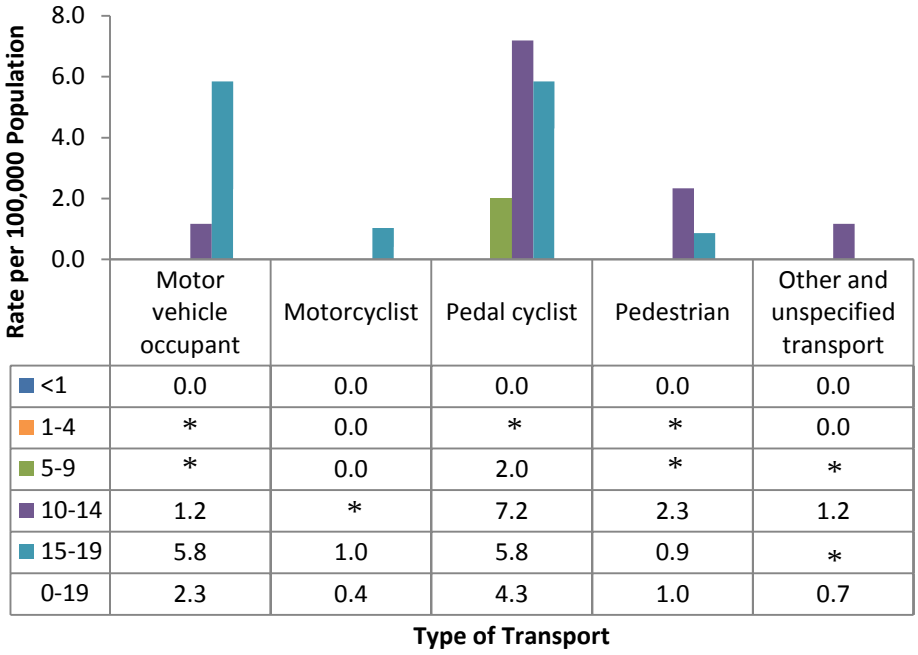


*Note: * Represents fewer than 5 cases; 'Other transport' includes concussion hospitalizations due to off-road vehicle, other land transport, and water transport.*

Across all age groups except for youth aged 15 to 19 years, highest rates were observed for pedal cyclist concussion hospitalizations as compared to any other transport type. Among youth aged 15 to 19 years, same rates were observed for both motor vehicle occupant and pedal cyclist concussion hospitalizations (both at 5.8/100,000) (Figure 9).

Rates of pedal cycle-related concussion hospitalization were highest among 10 to 14 year olds (7.2/100,000) (Figure 9).

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



	Motor vehicle occupant	Motorcyclist	Pedal cyclist	Pedestrian	Other and unspecified transport
<1	0.0	0.0	0.0	0.0	0.0
1-4	*	0.0	*	*	0.0
5-9	*	0.0	2.0	*	*
10-14	1.2	*	7.2	2.3	1.2
15-19	5.8	1.0	5.8	0.9	*
0-19	2.3	0.4	4.3	1.0	0.7

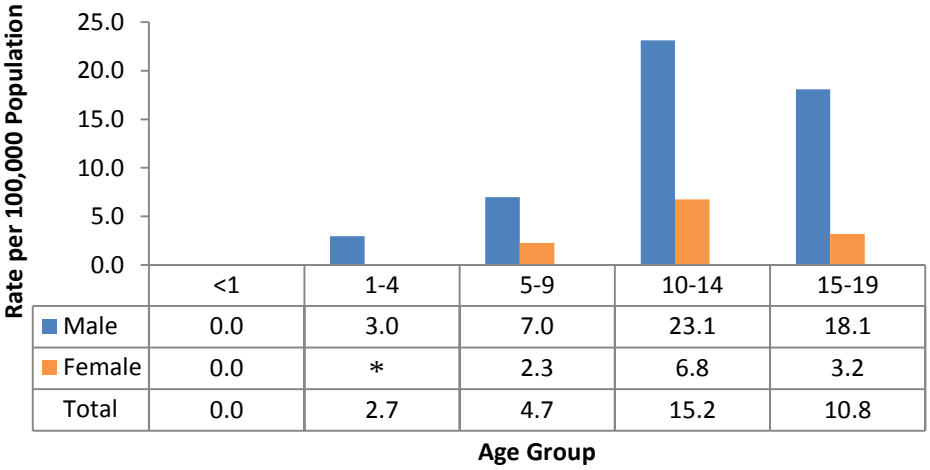
*Note: * Represents fewer than 5 cases; 'Other transport' includes concussion hospitalizations due to off-road vehicle, other land transport, and water transport.*

Sport and Recreation-related Concussion Hospitalization

Sport and recreation-related concussion hospitalization rates for children and youth were generally higher among males than females, with the highest rates being among males aged 10 to 14 years (23.1/100,000) and 15 to 19 years (18.1/ 100,000) (Figure 10). Rates for females were highest for children aged 10 to 14 years at 6.8 per 100,000.

Cycling was the sport and recreation activity with the highest proportion of concussion hospitalizations among children and youth, at 47.4 percent (n=81) (Figure 11). Other leading types included skateboards (9.9%), playground (7.6%), football/rugby (6.4%) and hockey (6.4%).

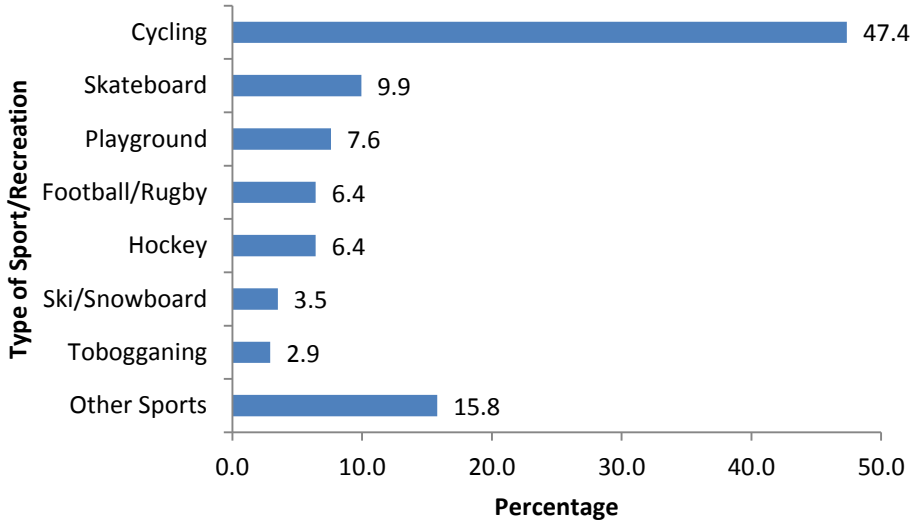
Figure 10: Sport and recreation-related concussion hospitalization rates by age group and sex, ages 0-19 years, Island Health, 2001/02 - 2013/14.



	<1	1-4	5-9	10-14	15-19
Male	0.0	3.0	7.0	23.1	18.1
Female	0.0	*	2.3	6.8	3.2
Total	0.0	2.7	4.7	15.2	10.8

*Note: * Represents fewer than 5 cases*

Figure 11: Sport and recreation-related concussion hospitalization rates by type of sport/recreation, ages 0-19 years, Island Health, 2001/02 - 2013/14.

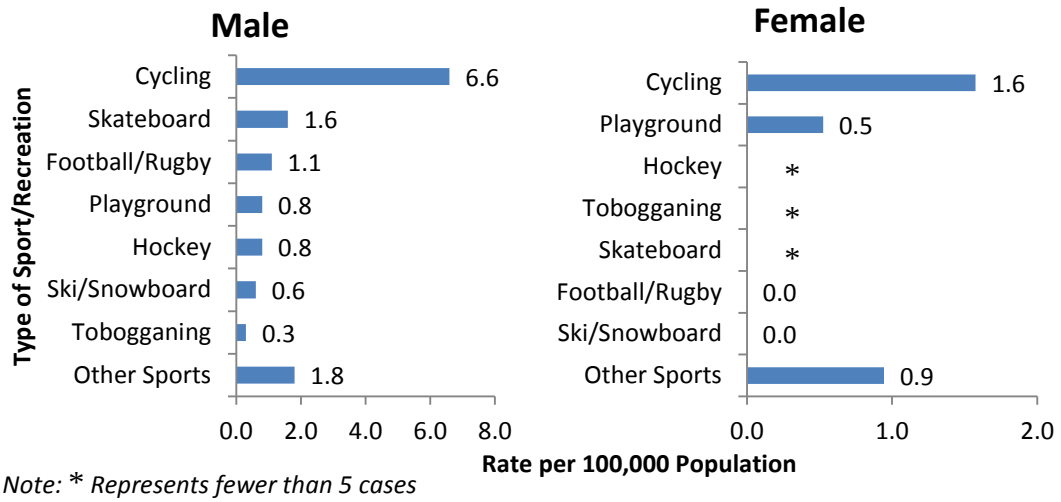


Note: 'Other sports' include all-terrain vehicle, diving into water, hit by ball or bat, baseball, soccer, ice skates, and scooter related activities.

The rate of cycling-related concussion hospitalizations for males was 6.6 per 100,000, followed by skateboard (1.6/100,000) and football/rugby (1.1/ 100,000) (Figure 12). For females, highest rates were seen for cycling (1.6/100,000) and playground (0.5/ 100,000).

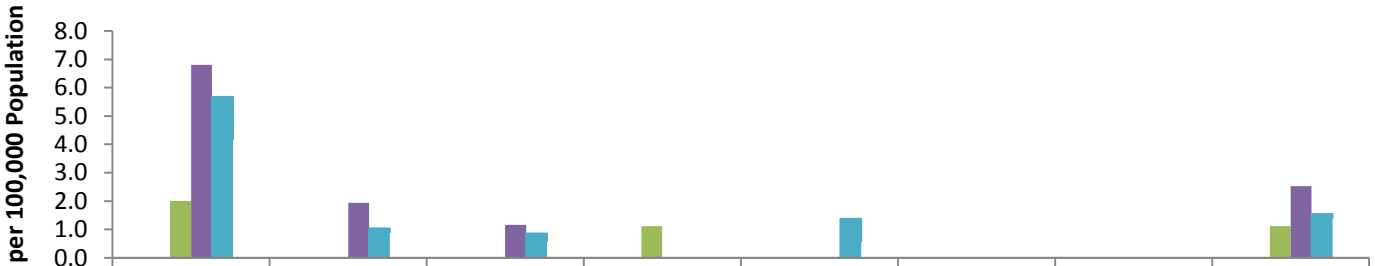
Rates of cycling-related concussion hospitalizations were highest among youth aged 10 to 14 years (6.8/ 100,000) and 15 to 19 years (5.7/100,000) (Figure 13). Playground concussion rates were higher among younger children, while generally sport concussion rates were highest among the older youth.

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



	Cycling	Skateboard	Football/ Rugby	Playground	Hockey	Ski/ Snowboard	Tobogganing	Other Sports
<1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1-4	*	*	0.0	*	0.0	0.0	0.0	0.0
5-9	2.0	0.0	0.0	1.1	0.0	0.0	*	1.1
10-14	6.8	1.9	1.2	*	*	*	*	2.5
15-19	5.7	1.0	0.9	0.0	1.4	*	0.0	1.5
0-19	4.1	0.9	0.6	0.7	0.6	0.3	0.3	1.4

Type of Sport/Recreation

*Note: * Represents fewer than 5 cases*

Concussion Hospitalization between Health Service Delivery Areas

Island Health consists of three Health Service Delivery Areas (HSDAs): Central Vancouver Island, North Vancouver Island and South Vancouver Island. The majority of Island Health child and youth residents who were hospitalized for concussion sought treatment within the Island Health (Table 1). About 98 percent of South Vancouver Island residents were admitted in hospitals within Island Health for concussion; a higher proportion than for residents of both Central Vancouver Island and North Vancouver Island (92.7% and 91.5%, respectively). Provincial Health Services Authority (PHSA) was the next leading Health Authority providing hospital care for Island Health residents with concussion.

Concussion hospitalization rates were highest among residents of Central Vancouver Island (25.1/100,000) and lowest among residents of South Vancouver Island (21.5/100,000) (Figure 14). The highest number of concussion hospitalization cases was within South Vancouver Island (193 cases). Statistical testing yielded significant differences between Central Vancouver Island and North Vancouver Island, and between South Vancouver Island and North Vancouver Island (p-value <0.05).

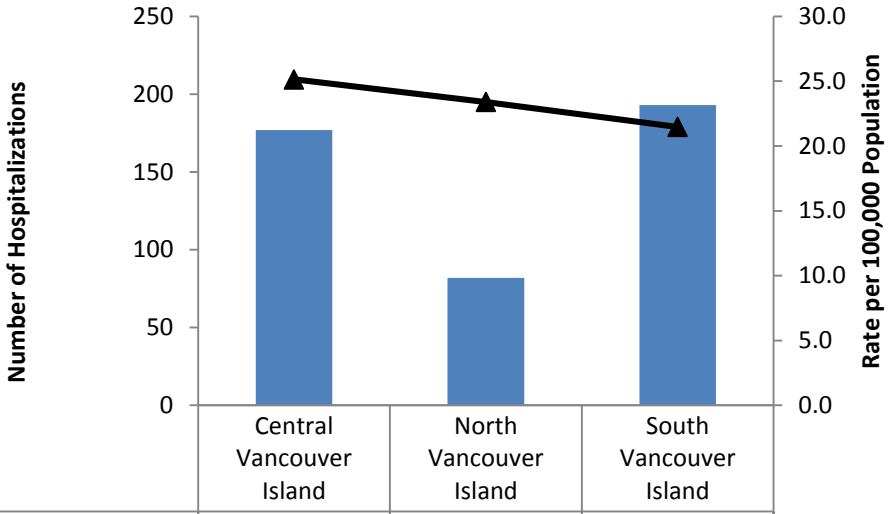
Concussion hospitalization rates within Central Vancouver Island and North Vancouver Island were highest among children aged 10 to 14 years (33.1/100,000 and 33.6/100,000, respectively) (Figure 15). Rates were highest among children aged 1 to 4 years in North Vancouver Island (27.5/100,000).

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

	Health Service Delivery Area of patient's residence		
Health Authority in which treatment sought	Central Vancouver Island	North Vancouver Island	South Vancouver Island
Island Health	164 (92.7%)	75 (91.5%)	189 (97.9%)
Fraser Health	*	*	*
Interior Health	*	*	0
Northern Health	*	0	0
Provincial Health Services [+]	6 (3.9%)	*	*
Out-of-province	*	0	*
Grand Total	177	82	193

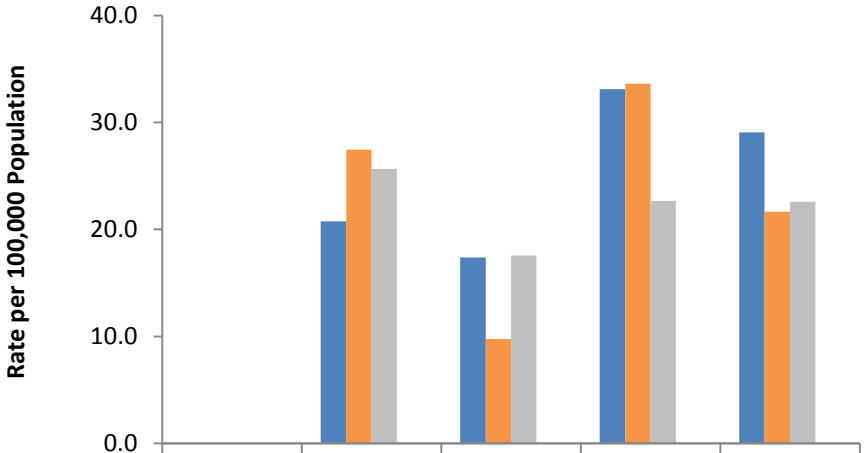
*Note: * Represents fewer than 5 cases; [+]Provincial Health Services Authority refers to BC Children's Hospital.*

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



	Central Vancouver Island	North Vancouver Island	South Vancouver Island
Number of Hospitalizations	177	82	193
Rate per 100,000 Population	25.1	23.4	21.5

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

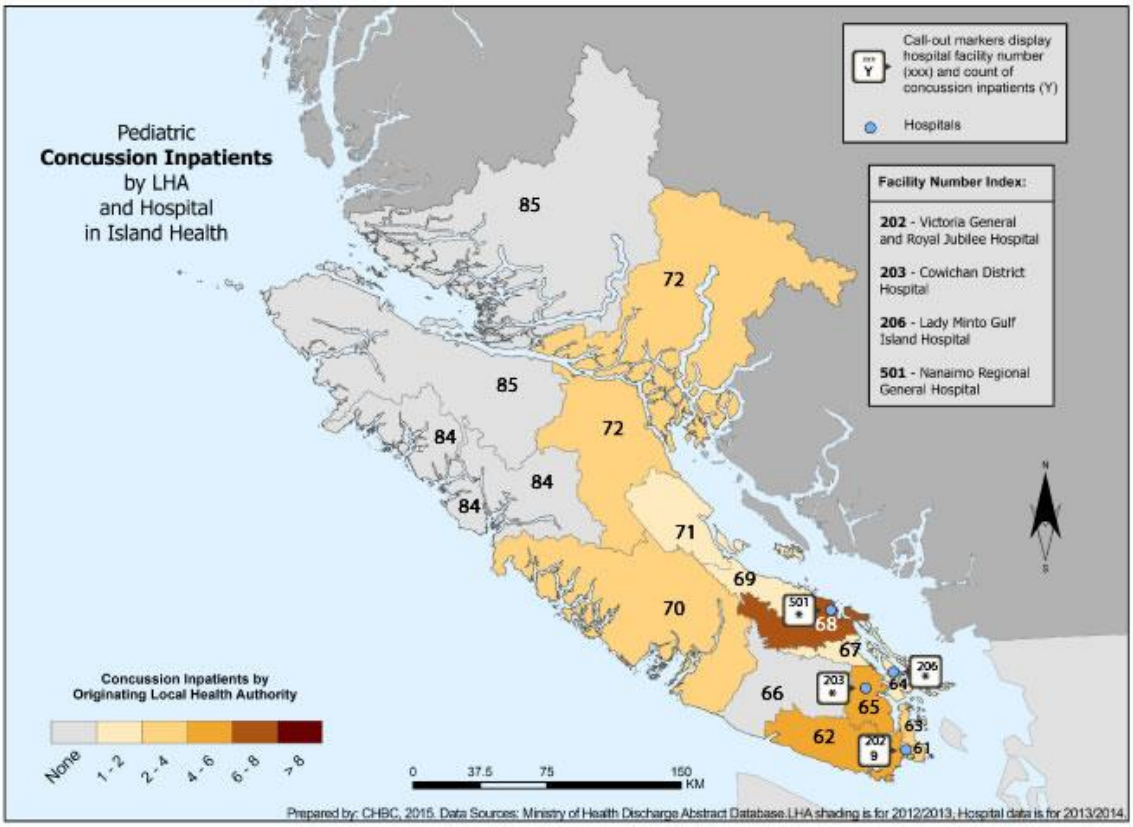


	<1	1-4	5-9	10-14	15-19
Central Vancouver Island	*	20.8	17.4	33.1	29.1
North Vancouver Island	*	27.5	9.8	33.6	21.7
South Vancouver Island	*	25.7	17.6	22.7	22.6
Total	11.3	24.3	16.1	28.6	24.8

*Note: * Represents fewer than 5 cases*

The number of concussion inpatients was highest at Victoria General and Royal Jubilee Hospitals (9 cases) (Figure 16). The rest of the hospitals reported fewer than 5 cases of concussion hospitalizations.

Figure 16: Pediatric Concussion Inpatients by local health area and hospital, Island Health, 2013/14.



*Note: * Represents fewer than 5 cases*
Note: 61: Greater Victoria, 62: Sooke, 63: Saanich, 64: Gulf Islands, 65: Cowichan, 66: Lake Cowichan, 67: Ladysmith, 68: Naniamo, 69: Qualicum, 70: Alberni, 71: Courtenay, 72: Campbell River, 84: Vancouver Island West, 85: Vancouver Island North

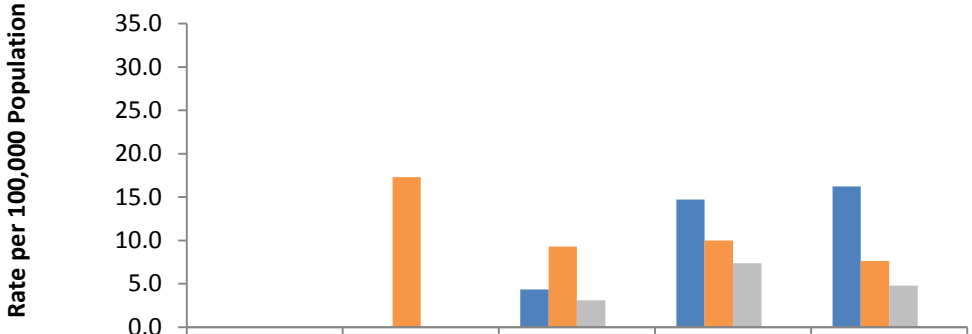
Concussion Hospitalization by Health Service Delivery Area: Central Vancouver Island

A total of 177 concussion hospitalizations were reported for Central Vancouver Island 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 fall-related child and youth concussion hospitalization in Central Vancouver Island were highest among infants and children under 5 years of age (Figure 17).

Central Vancouver Island is split into six Local Health Areas (LHAs): Alberni, Cowichan, Ladysmith, Lake Cowichan, Nanaimo and Qualicum. Rates of child and youth concussion hospitalization were highest in Alberni (39.2/100,000) and lowest in Ladysmith (13.1/100,000) (Figure 18).

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

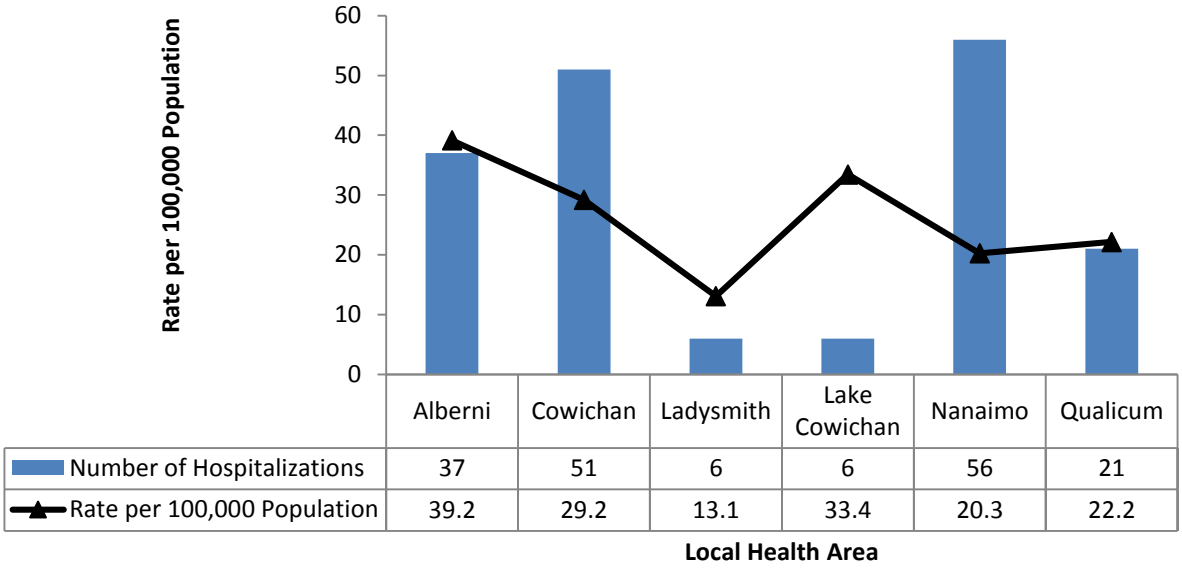


	<1	1-4	5-9	10-14	15-19
Transport	0.0	*	4.3	14.7	16.2
Falls	*	17.3	9.3	10.0	7.6
Struck by Object	0.0	*	3.1	7.4	4.8
Total	3.7	20.8	17.4	33.1	29.1

Age Group

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

Figure 18: Concussion hospitalization count and rate by local health area, ages 0-19 years, Island Health: Central Vancouver Island, 2001/02-2013/14.



	Alberni	Cowichan	Ladysmith	Lake Cowichan	Nanaimo	Qualicum
Number of Hospitalizations	37	51	6	6	56	21
Rate per 100,000 Population	39.2	29.2	13.1	33.4	20.3	22.2

Alberni, Cowichan and Nanaimo exhibited total numbers of cases high enough to further investigate sex and age differences. Further breakdown of these areas can be seen within Figures 19-24.

Alberni had high rates of concussion hospitalizations among the older children aged 5 to 19 years. Rates of concussion hospitalization were particularly high among those aged 15 to 19 years and 10 to 14 year olds in Alberni (51.7/ 100,000 and 51.5/100,000, respectively) (Figure 19). High rates were also observed in Alberni for both males (53.2/100,000) and for females (24.1/ 100,000) (Figure 20).

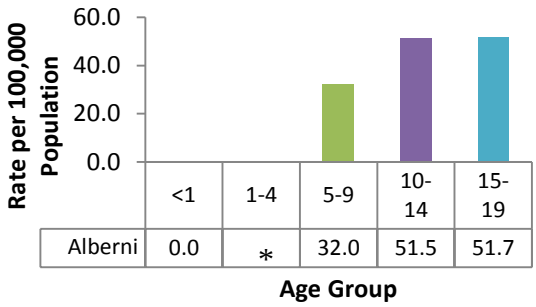
Cowichan reported high concussion hospitalization rates among the older age-groups (Figure 21).

Concussion hospitalization rates in Nanaimo were noticeably low among children aged 5 to 9 years (11.1/100,000) (Figure 23).

All LHAs within Central Vancouver Island reported no or fewer than five cases of concussion hospitalizations among infants less than one year of age. Concussion hospitalization rates were higher among males than females within all Central Vancouver Island LHAs.

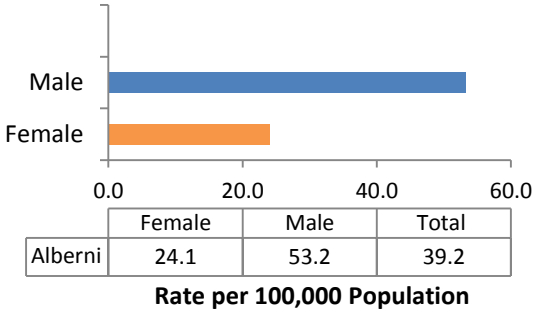
Alberni

Figure 19: Concussion hospitalization rates by age group, ages 0-19 years, Island Health: Central Vancouver Island: Alberni, 2001/02-2013/14.



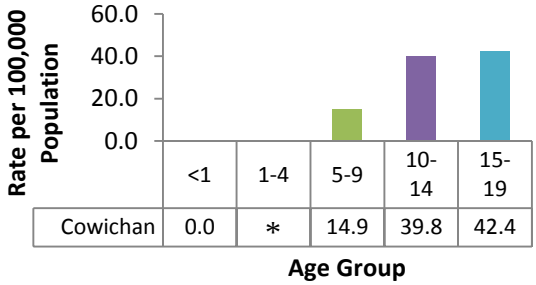
*Note: * Represents fewer than 5 cases*

Figure 20: Concussion hospitalization rates by sex, ages 0-19 years Island Health: Central Vancouver Island: Alberni, 2001/02-2013/14.



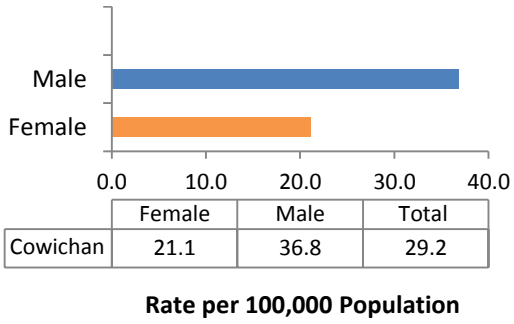
Cowichan

Figure 21: Concussion hospitalization rates by age group, ages 0-19 years, Island Health: Central Vancouver Island: Cowichan, 2001/02-2013/14.



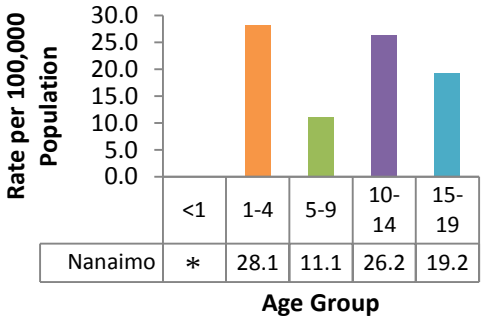
*Note: * Represents fewer than 5 cases*

Figure 22: Concussion hospitalization rates by sex, ages 0-19 years Island Health: Central Vancouver Island: Cowichan, 2001/02-2013/14.



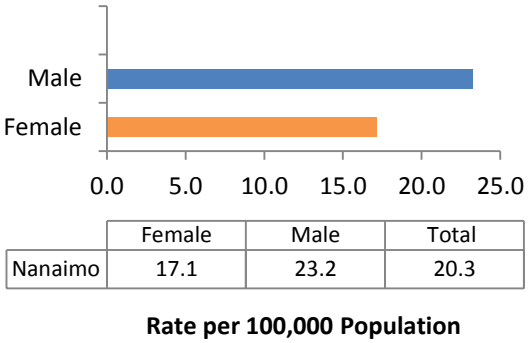
Nanaimo

Figure 23: Concussion hospitalization rates by age group, ages 0-19 years, Island Health: Central Vancouver Island: Nanaimo, 2001/02-2013/14.



*Note: * Represents fewer than 5 cases*

Figure 24: Concussion hospitalization rates by sex, ages 0-19 years Island Health: Central Vancouver Island: Nanaimo, 2001/02-2013/14.



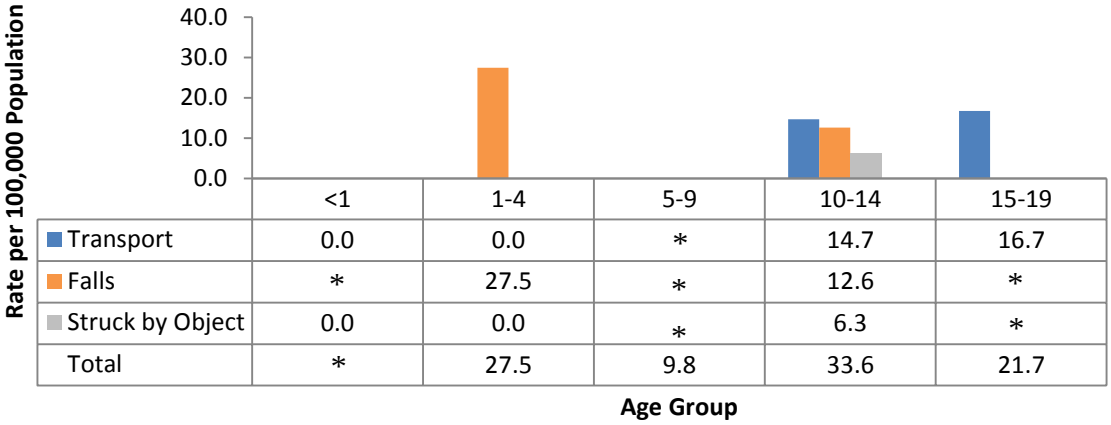
Concussion Hospitalization by Health Service Delivery Area: North Vancouver Island

A total of 82 concussion hospitalizations were reported for North Vancouver Island 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. Transport-related concussion hospitalization rates were highest among youth aged 15 to 19 years (16.7/100,000) (Figure 25).

Rates of child and youth fall-related concussion hospitalizations in North Vancouver Island were highest among children aged 1 to 4 years (27.5/100,000) (Figure 25).

North Vancouver Island is split into four LHAs: Campbell River, Courtenay, Vancouver Island North and Vancouver Island West. The concussion hospitalization rate was highest in Vancouver Island North (29.8/100,000) and lowest in Campbell River (21.7/100,000). The total numbers of hospitalization cases within North Vancouver Island were lowest in Vancouver Island West with fewer than five cases (Figure 26).

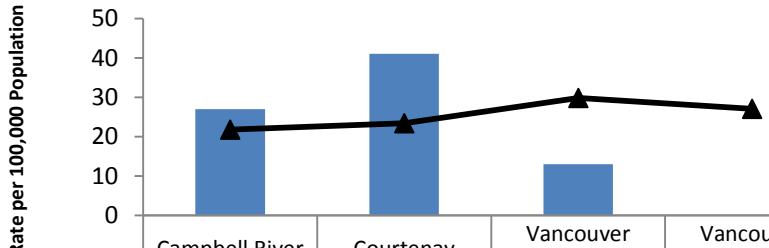
Figure 25: Concussion hospitalization rates by cause and age group, ages 0-19 years, Island Health: North Vancouver Island, 2001/02-2013/14.



	<1	1-4	5-9	10-14	15-19
Transport	0.0	0.0	*	14.7	16.7
Falls	*	27.5	*	12.6	*
Struck by Object	0.0	0.0	*	6.3	*
Total	*	27.5	9.8	33.6	21.7

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

Figure 26: Concussion hospitalization counts and rates by local health area, ages 0-19 years, Island Health: North Vancouver Island, 2001/02-2013/14.



	Campbell River	Courtenay	Vancouver Island North	Vancouver Island West
Number of Hospitalizations	27	41	13	*
Rate per 100,000 Population	21.7	23.4	29.8	27.0

*Note: * Represents fewer than 5 cases*

Campbell River and Courtenay exhibited total numbers of cases high enough to further investigate sex and age differences. Further breakdown of these areas can be seen within Figures 27-30.

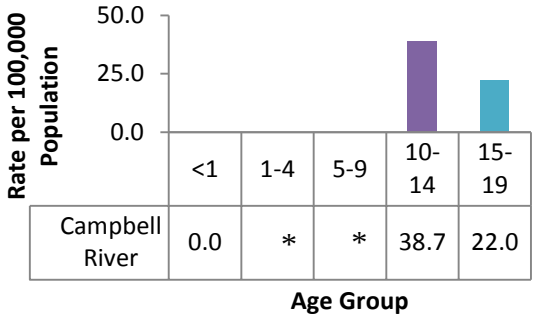
Campbell River had high rates of concussion hospitalizations among children aged 10 to 14 years (38.7/100,000) (Figure 27). High rates were observed in Campbell River among males (33.0/100,000) (Figure 28).

Courtenay had high rates of concussion hospitalizations among males (38.0/100,000) and among children aged 10 to 14 years (31.1/100,000) (Figure 29 and Figure 30).

Concussion hospitalization rates were higher among males than females within all North Vancouver Island LHAs.

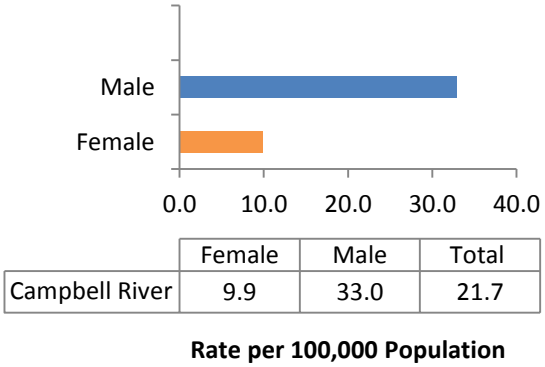
Campbell River

Figure 27: Concussion hospitalization rates by age group, ages 0-19 years, Island Health: North Vancouver Island: Campbell River, 2001/02-2013/14.



*Note: * Represents fewer than 5 cases*

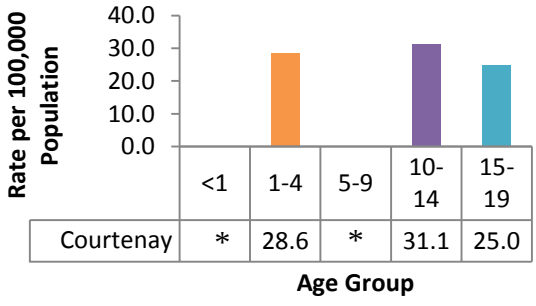
Figure 28: Concussion hospitalization rates by sex, ages 0-19 years Island Health: North Vancouver Island: Campbell River, 2001/02-2013/14.



	Female	Male	Total
Campbell River	9.9	33.0	21.7

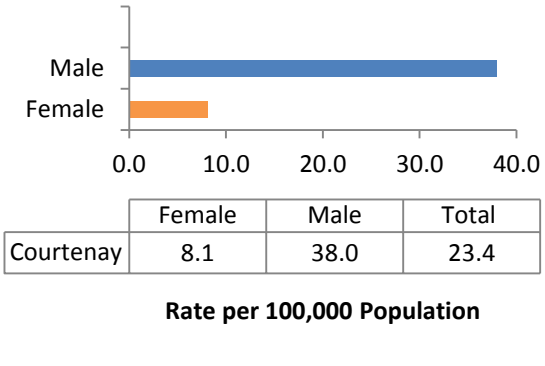
Courtenay

Figure 29: Concussion hospitalization rates by age group, ages 0-19 years, Island Health: North Vancouver Island: Courtenay, 2001/02-2013/14.



*Note: * Represents fewer than 5 cases*

Figure 30: Concussion hospitalization rates by sex, ages 0-19 years Island Health: North Vancouver Island: Courtenay, 2001/02-2013/14.



	Female	Male	Total
Courtenay	8.1	38.0	23.4

Concussion Hospitalization by Health Service Delivery Area: South Vancouver Island

A total of 193 concussion hospitalizations were reported for South Vancouver Island 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. Transport-related concussion hospitalization rates were highest among youth aged 15 to 19 years (11.9/ 100,000) (Figure 31).

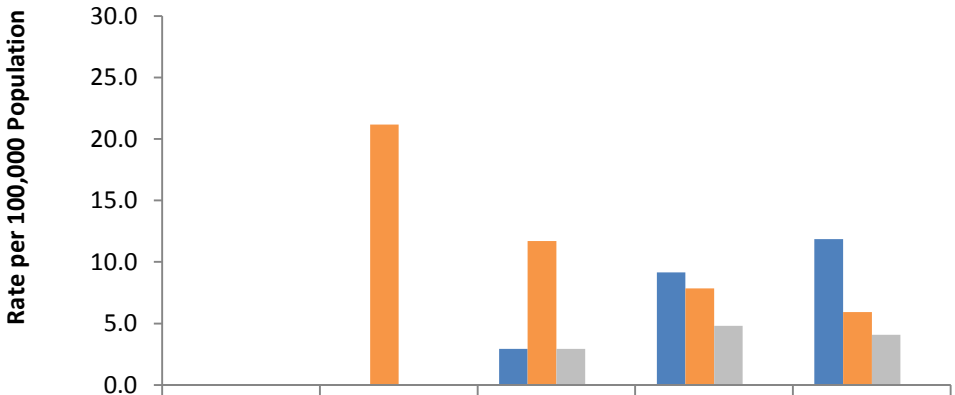
Child and youth fall-related concussion hospitalizations rates in South Vancouver Island were highest among children aged 1 to 4 years (21.2/100,000) (Figure 31).

South Vancouver Island is split into four LHAs: Greater Victoria, Gulf Islands, Saanich and Sooke. Concussion hospitalizations rates were highest in Gulf Islands (67.3/100,000) and lowest in Greater Victoria (17.2/100,000) (Figure 32). Greater Victoria, however, had the highest number of concussion hospitalizations in South Vancouver Island.

Concussion hospitalization rates were higher among males than females for all LHAs of South Vancouver Island. The highest rates among both males and females were found in Gulf Islands (94.7/ 100,000 and 39.1/100,000, respectively) (Figure 33).

Concussion hospitalization rates were lowest in South Vancouver Island, across all LHAs, among infants less than one year of age, with no or fewer than five cases. Gulf Islands had the highest rates of concussion hospitalizations among children and youth aged 10 to 19 years (Figure 34).

Figure 31: Concussion hospitalization rates by cause and age group, ages 0-19 years, Island Health: South Vancouver Island, 2001/02-2013/14.

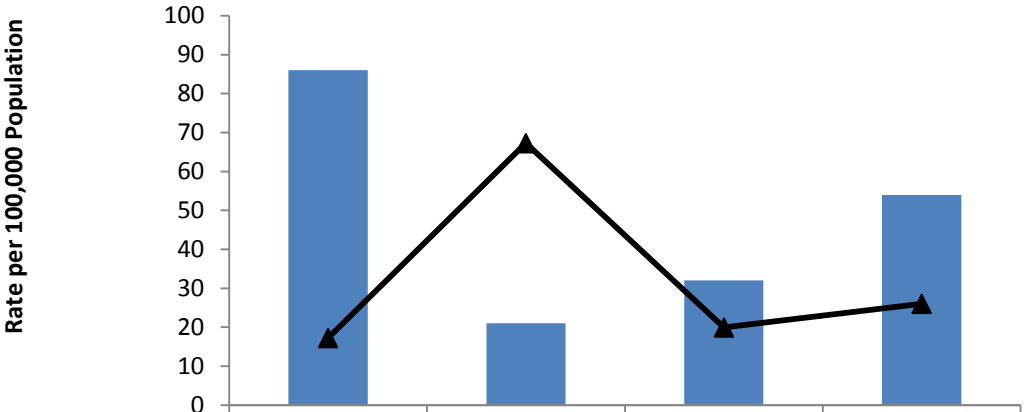


	<1	1-4	5-9	10-14	15-19
Transport	0.0	*	2.9	9.2	11.9
Falls	*	21.2	11.7	7.8	5.9
Struck by Object	0.0	*	2.9	4.8	4.1
Total	*	25.7	17.6	22.7	22.6

Age Group

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

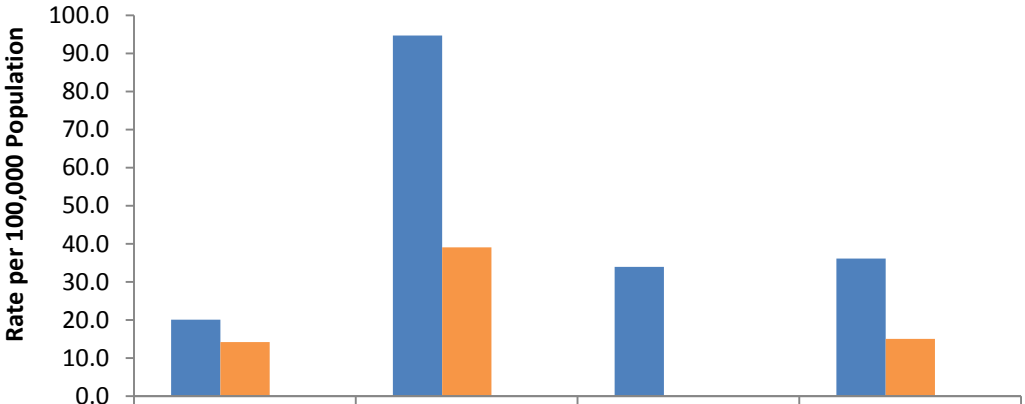
Figure 32: Concussion hospitalization counts and rates by local health area, ages 0-19 years, Island Health: South Vancouver Island, 2001/02-2013/14.



	Greater Victoria	Gulf Islands	Saanich	Sooke
Number of Hospitalizations	86	21	32	54
Rate per 100,000 Population	17.2	67.3	19.9	26.0

Local Health Area

Figure 33: Concussion hospitalization rates by local health area and sex, ages 0-19 years, Island Health: South Vancouver Island, 2001/02-2013/14.

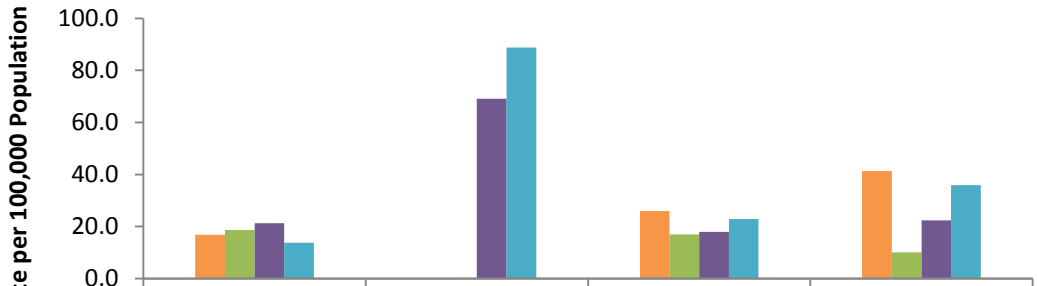


	Greater Victoria	Gulf Islands	Saanich	Sooke
Male	20.1	94.7	34.0	36.2
Female	14.2	39.1	*	15.0
Total	17.2	67.3	19.9	26.0

Local Health Area

*Note: * Represents fewer than 5 cases*

Figure 34: Concussion hospitalization rates by local health area and age group, ages 0-19 years, Island Health: South Vancouver Island, 2001/02-2013/14.



	Greater Victoria	Gulf Islands	Saanich	Sooke
<1	*	0.0	0.0	*
1-4	16.9	*	26.0	41.3
5-9	18.7	*	17.0	10.0
10-14	21.2	69.1	18.0	22.3
15-19	13.8	88.7	22.8	35.9
0-19	17.2	67.3	19.9	26.0

Age Group

*Note: * Represents fewer than 5 cases*

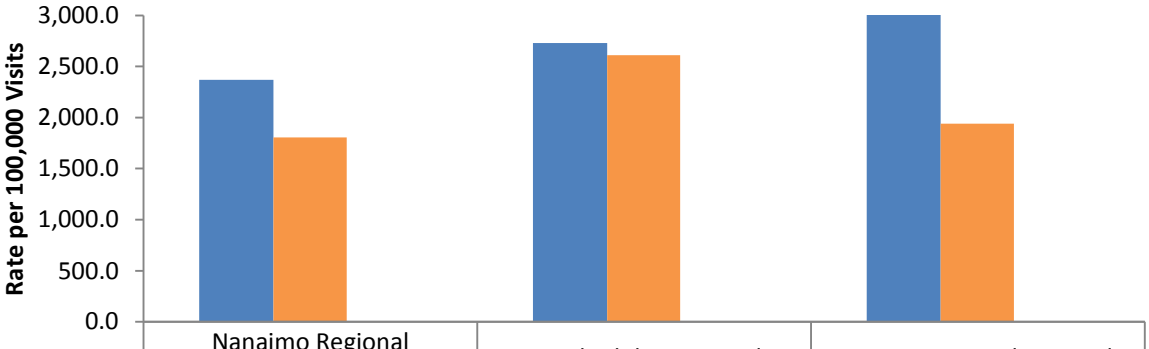
CONCUSSION EMERGENCY DEPARTMENT VISIT RATES

Island Health has three principal hospitals with recorded concussion-related emergency department visits: Nanaimo Regional General Hospital, Royal Jubilee Hospital, and Victoria General Hospital. Emergency department rates for each hospital were calculated per 100,000 emergency department visits for all diagnoses.

There were a total of 1,060 child and youth concussion emergency department visits to these hospitals between July 1, 2013 and March 31, 2015. During this period, Royal Jubilee Hospital saw the highest rate of concussion-related emergency department visits per 100,000 visits, among all hospitals in Island Health (2,669.4/100,000). Lowest rates of emergency department visits due to concussion within the Island Health region were seen at Nanaimo Regional General Hospital (2,091.2/100,000). Victoria General Hospital reported the highest rates of concussion-related emergency department visits for males (3,218.5/100,000) and Royal Jubilee Hospital recorded the highest rates among females (2,611.3/100,000). Males exhibited higher rates than females among all Island Health hospitals. Lowest rates for both males and females were reported at Nanaimo Regional General Hospital (2,368.8/100,000 and 1,804.3/100,000 respectively) (Figure 35).

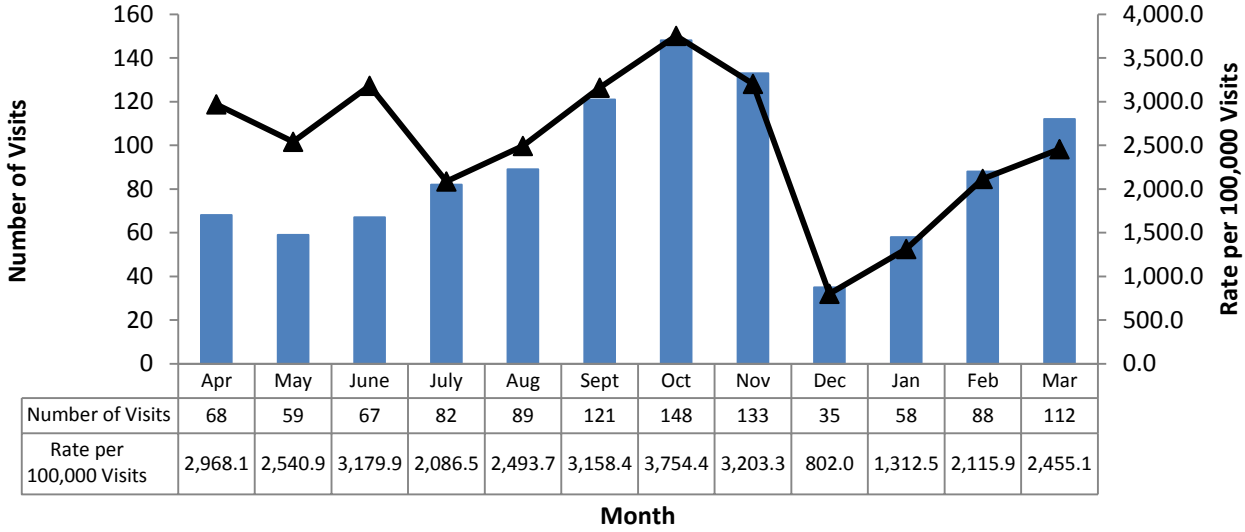
When looking at emergency department visits from concussions by month between July 1, 2013 and March 31, 2015, the number of cases presented were highest during the months of October (148 visits), November (133 visits) and September (121 visits). Rates of concussion emergency department visits per 100,000 visits peaked during October and November (3,754.4/ 100,000 and 3,203.3/ 100,000, respectively). The number of concussion emergency department visits were lowest during December (35 visits) and January (58 visits). Lowest rates were reported during December and January (802.0/ 100,000 and 1,312.5/100,000, respectively) (Figure 36).

Figure 35: Concussion emergency department visit rates by hospital and sex, ages 0-19 years, Island Health, NACRS, July 1, 2013 - March 31, 2015



	Nanaimo Regional General Hospital	Royal Jubilee Hospital	Victoria General Hospital
Male	2,368.8	2,728.5	3,218.5
Female	1,804.3	2,611.3	1,941.2
Total	2,091.2	2,669.4	2,598.4

Figure 36: Concussion emergency department visit rates and number of cases by month, ages 0-19 years, Island Health, NACRS, July 1, 2013 – March 31, 2015



	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Number of Visits	68	59	67	82	89	121	148	133	35	58	88	112
Rate per 100,000 Visits	2,968.1	2,540.9	3,179.9	2,086.5	2,493.7	3,158.4	3,754.4	3,203.3	802.0	1,312.5	2,115.9	2,455.1

Month

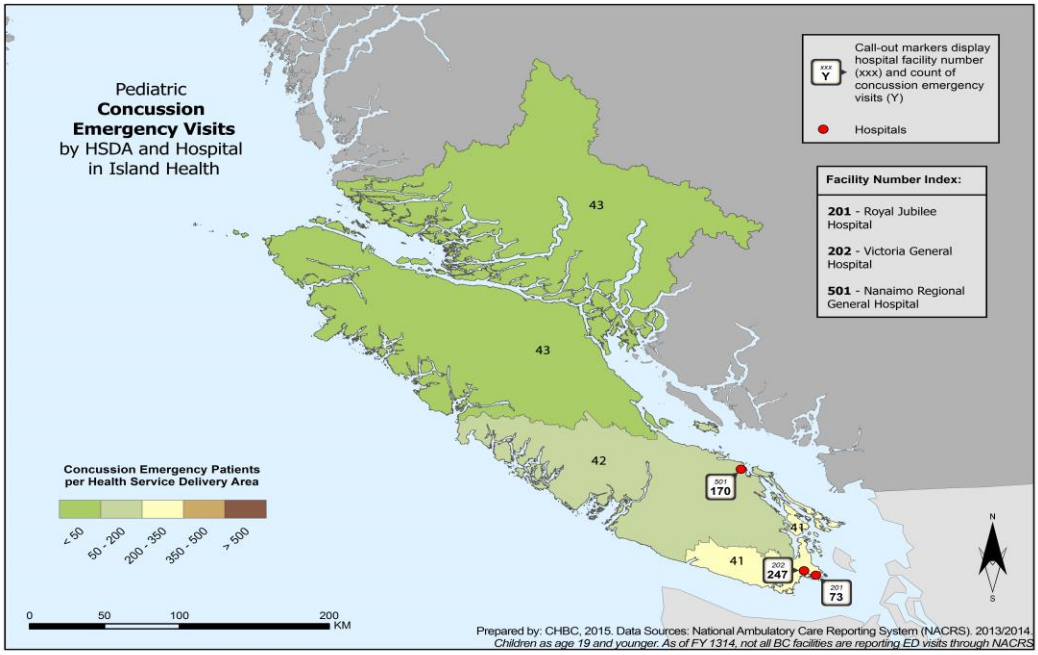
The total numbers of child and youth emergency department visits for concussion at Island Health treating hospital facilities were highest for Victoria General Hospital between July 1, 2013 and March 31, 2015 (579 visits) (Table 2). The highest proportions of emergency department visits attributed to child and youth concussion were seen at Royal Jubilee Hospital (2.67%). Low numbers of visits were seen at Royal Jubilee Hospital (158 visits) and the lowest proportion of concussion emergency department visits was seen at Nanaimo Regional General Hospital (2.09%). Across all treating hospitals, Island Health saw an average 2.43 percent of all child and youth emergency departments visits attributed to concussion-related injury (Table 2).

During the 2013/14 year alone, emergency department visits occurring at hospital locations within Island Health were highest at Victoria General Hospital, which saw 247 concussion emergency department visits. Emergency department visits were also high at Nanaimo Regional Hospital, recording 170 concussion visits. The lowest numbers of child and youth emergency department visits recorded in 2013/14 were seen at Royal Jubilee Hospital (73 visits) (Figure 37).

Table 2: Concussion emergency department visit rates by hospital, ages 0-19 years, Island Health, NACRS, July 1 2013 – March 30 2015

	Number of ER concussion visits	Total ER visits	% of concussion ER visits
Nanaimo Regional General Hospital	323	15,446	2.09
Victoria General Hospital	579	22,283	2.60
Royal Jubilee Hospital	158	5,919	2.67
Grand Total	1060	43,648	2.43

Figure 37: Pediatric concussion emergency visits by local health area and hospital, Island Health, NACRS, 2013/14



Note: 41: South Vancouver Island, 42: Central Vancouver Island, 43: North Vancouver Island

CONCLUSION

The highest rates of concussion hospitalizations were seen among the 10 to 14 year old age group, largely due to transport-related causes. The majority of these hospitalizations were due to the involvement of pedal cyclists and motor vehicle occupants. Among children under five years of age, falls remained the leading cause of concussion hospitalization. The leading cause of falls within this age group was falls from furniture. Males within the Island Health region exhibited higher rates of concussion hospitalizations than females across all ages from 0 to 19 years.

Sport and recreation-related concussion hospitalizations were mostly observed among males between the ages of 10 and 19 years.

Transport-related concussion hospitalizations maintained similar patterns and trends across all HSDAs within Island Health, with rates increasing as age increases. Central Vancouver Island and North Vancouver Island 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 1 to 4 years displayed the highest rates of fall-related concussion hospitalization within all three HSDAs. North Vancouver Island had the highest rate of fall-related concussion hospitalization for the 1 to 4 year old age category. Low rates or no cases of fall-related concussion hospitalization among infants less than one year of age were experienced by all three HSDAs.

There was a large discrepancy in concussion hospitalizations rates among LHAs within Island Health. Gulf Islands, Alberni, Vancouver Island North and Cowichan exhibited much higher rates than most regions in Island Health, while Lady Smith and Greater Victoria reported low rates of child and youth concussion hospitalizations.

Between July 1, 2013 and March 31, 2015, Royal Jubilee Hospital had the highest rate of child and youth concussion emergency department visits per 100,000 visits among all hospitals within Island Health, while Nanaimo Regional General Hospital had the lowest rate.

The months of June, September and October saw the highest rates of concussion emergency department visits per 100,000 visits, while the months of October and November 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 Island Health, both at a regional and hospital level. With this information, Island Health can work towards reducing the occurrence and burden of concussions among children and youth in BC.

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