

RUNNING HEAD: INJURY TYPE, SETTING, TREATMENT, AND COSTS

A longitudinal cohort study of injury type, settings, treatment and costs in British Columbia
youth, 2003–2013

Bonnie Leadbeater and Alejandra Contreras

University of Victoria, Victoria, BC, Canada

Fahra Rajabali, Alex Zheng, Emilie Beaulieu, Ian Pike

British Columbia Injury Research and Prevention Unit, Vancouver BC, Canada

Contact Information:

Bonnie Leadbeater, PhD
Cornett A241
Department of Psychology
University of Victoria
PO Box 1700 STN CSC
Victoria BC, V8W 2Y2
bleadbea@uvic.ca

Key words: Injuries, sports injuries, falls, adolescence, young adulthood

Conflict of Interests: The authors have no conflicts of interest related to this research.

Acknowledgements: The Victoria Healthy Youth Survey study and this research were supported by grants from the Canadian Institute for Health Research (#88476; #79917; #192583; #130500; SHI-155410). We appreciate the contributions of all youth who participated in this research for over a decade.

Author contribution statement: B.L. conceived of the presented idea. A.C. performed the computations associated with types and mechanisms of injuries. F.R., E.B., I.P., and A.Z. performed all analyses associated with costs of injuries. B.L. took the lead in writing the manuscript. All authors discussed the results, provided critical feedback and contributed to the final manuscript.

The research study received approval from the University of Victoria's Human Research Ethics Board (PROTOCOL NUMBER: 09-292)

ABSTRACT

In 2010 in British Columbia, Canada, total injury costs per capita were higher among youth aged 15-24 years than in any other age group. Injury prevention efforts have targeted injuries with high mortality (transportation injuries) or morbidity (concussions). However, the profile and health costs of common youth injuries (types, locations, treatment choices, and prevention strategies) and how these change from adolescence to young adulthood is not known. Participants (n=662) were a randomly recruited cohort of BC youth, ages 12 to 18 in 2003. They were followed biennially across a decade (6 assessments). Serious injuries (defined as serious enough to limit normal daily activities) in the last year were reported by 27% to 41% of participants at each assessment. Most common injuries were sprains or strains, broken bones, cuts punctures or animal bites, and severe bruises. Most occurred when playing a sport or from falling. Estimated total direct cost of treatment per injury was approximately \$2,500.

What is already known on this subject?

Injuries are the leading cause of death in adolescents and young adults. Thus, it is not surprising that research and prevention effort have focused considerable attention on injuries incurred in transport-related incidents and concussions.

What this study adds.

This study contributes to an understanding of the profiles of more frequently occurring non fatal injuries and their related health costs. We describe the types, locations, treatment choices, prevention strategies and how these profiles injuries change as youth transition to young adulthood. Findings show most injuries are incurred during sports activities and falls, most are seen in hospital emergence care services and they contribute to high health costs in this age group.

A LONGITUDINAL COHORT STUDY OF INJURY TYPE, SETTINGS, TREATMENT AND COSTS IN BRITISH COLUMBIA YOUTH, 2003–2013

Injuries remain the number one cause of death among young Canadians (ages 1 to 34), and they account for substantial health system costs that have been increasing over time[1]. In 2010 in British Columbia (BC) total injury costs per capita were highest among youth aged 15-24 years at \$1,185, followed by older adults aged 65 or more years at \$965[2]. The total health care costs among youth aged 15-24 years in BC in 2010 was \$335 million, with highest costs incurred for transport-related incidents and falls[2]. Research focused on youth has advanced preventive efforts targeting motor vehicle crashes[3,4] and concussions[5]. However, the types, causes, and health costs of injuries in this age group are not limited to these concerns. To advance injury prevention, a better understanding is needed of the profile of injuries in adolescents and young adults; including information about the types, locations, treatment choices, and prevention strategies. There is also little Canadian research about how these aspects of unintentional injuries change as youth transition to young adulthood.

This is a particularly salient stage of life that is marked by decreased parent supervision and increased engagement in new experiences such as driving, cooking, legal substance use, employment, engagement in competitive sports and in recreational or fitness activities. Injuries at this stage can disrupt developmental tasks (high school completion, sports participation, work experiences, post secondary education) and affect health behaviors across the life span.

In this report, we build on previous research[6] with a large randomly recruited, community-based, cohort of youth (n=662, ages 12 to 18) from BC, Canada, recruited in 2003. In 2003, 2005 and 2007, respectively, 273 (41%), 228 (39%) and 176 (33%) youth, reported having experienced at least one serious injury in the last 12 months. The leading injuries were

sprains/strains, broken bones and bruises. Most occurred playing sports, falling or tripping, biking or rollerblading, and occurred mainly at recreation centres (12-15%), schools (27-29%), and workplaces (2-14.5%). Most injuries were treated at emergency departments, walk-in clinics and health professionals' offices (68-84%). Prevention choices included mainly doing nothing; being more careful; and giving up the activity. The total direct cost of treatment in 2007 was \$471,498 (Canadian) with an estimated mean cost of \$775 per injury. The current research extends these analyses by examining additional longitudinal data for the same cohort of youth. New data were collected in 2009, 2011, and 2013. As a longitudinal cohort study, our analyses address many gaps in our knowledge of youth injuries across a decade - from adolescence to young adulthood. The cohort was aged 12 to 18 years old in 2003 and aged 22 to 29 years old in 2013. We report on the types, source, setting, treatments sought, and prevention strategies adopted across a decade in a single cohort and examine whether individuals report injuries at multiple assessment points.

METHOD

A randomly selected community-based sample of youth ($N = 662$; 48.3% males) from the greater Victoria area in BC were surveyed biennially from 2003 (T1) to 2013 (T6). From a random sample of 9,500 telephone listings, 1,036 households with an eligible youth (ages 12 to 18) were identified. Of these, 185 parents or guardians refused the participation of the youth in their care, and 187 youth refused participation. Retention rates were good at each Wave 2, $N = 578$ (87%); Wave 3, $N = 539$ (81%); Wave 4, $N = 459$ (69%); Wave 5, $N = 463$ (70%); and Wave 6, $N = 477$ (72%). Youth lost to follow-up by T6 were more likely to be male than female (T1: 48% male versus T6: 45% male; $\chi^2(1, 662) = 8.77, p = 0.003$), and more likely to be from lower socioeconomic status (SES) families (T1 SES: $M = 5.97, SD = 1.96$) compared to youth

who continued in the study (T1 SES: $M = 6.69$, $SD = 1.71$; $F(1, 659) = 21.72$, $p < 0.001$), suggesting our findings may be conservative. At each assessment, individual interviews were conducted in the youth's home or other private place. The "Victoria Healthy Youth Survey" (V-HYS) questionnaire consists of two parts: A trained interviewer-administered section, which recorded the youth's answers regarding demographics, relationships with parents and peers, and injuries. A second section focused on more personal concerns that are not included in this report [7]. Youth received gift certificates for a music or food store as thanks for their participation at each interview. The research study received approval from the University of Victoria's Human Research Ethics Board (PROTOCOL NUMBER: 09-292). Informed and written consent was obtained from both parents or guardians (for youth under 18) and youth at each assessment.

Measures

To assess the frequency of and circumstances surrounding serious injuries, at each assessment point youth were asked: "In the past 12 months, did you have any injuries (such as broken bones, bad cuts or sprains) that were serious enough to limit your normal daily activities?" A time chart was used to ensure accuracy of for this retrospective reporting, and the dates of injuries and a brief description of the injury were recorded. The "seriousness" of the injuries were ranked, as agreed on by the youth and interviewer. Follow-up questions were asked for the "most serious" injury only. These included "What type of injury was it? Did you seek medical attention as a result of the injury and from where? Where did the injury happen? Which of the following best describes how you were injured (falling or tripping; driving a car or other vehicle; riding a bicycle, rollerblading or using a skateboard; sports injury during training or playing; etc.)? Are you doing anything to prevent this injury from happening again (gave up the activity, rehabilitation or physiotherapy, being more careful, taking safety training, using

protective gear or safety equipment or other)?” Item choices are displayed in the results Tables (1 to 6). In 2003 and 2005, youth were asked to check all that apply” so multiple responses were encouraged. To simplify coding of the data, after 2007, youth were similarly asked to respond “yes” or “no” to each of the choices, allowing for multiple responses.

Incidence counts for injuries among youth treated by a physician (at a doctor’s appointment or walk-in clinic) or in a hospital emergency room, displayed in Table 4, were used to estimate the direct costs of injuries treated in these settings. Direct costs are defined as the value of goods and services for which payment was made and resources used in treatment, care and rehabilitation related to illness or injury. Supplementary Table 2 indicates the sources, references, and direct costs of treatments for injuries in BC that are used in the current study[2,8–12]. All dollar values were calculated as constant 2013 dollars using a government of Canada Consumer Price Index calculation (<https://www.bankofcanada.ca/rates/related/inflation-calculator/>). Costs related to care provided by alternative treatment, a nurse, and other direct costs borne by patients, families or other payers were not included. Indirect cost pertaining to loss of wages and productivity were also not included due to insufficient data from the surveys. To the extent that these other costs exist, the current study represents a conservative estimate of the total costs of serious injuries in this cohort of youth in BC. Total costs are also underestimated given our data focus on the “most serious injury” reported for the last 12 months every two years, attrition and the slightly disproportionate males lost to follow up. The total costs are thus illustrative rather than exhaustive and are used to compute average costs.

RESULTS

Frequencies of injuries

The percentage of youth who reported at least one serious injury in the last 12 months steadily declined from 41% in 2003 when youth were between the ages of 12 and 19 years, to 27% of youth in 2013. Twenty-five percent of the participants (n= 165) reported a serious injury at 3 or more waves, and 22% (n= 142) reported serious injuries at two assessments. Given greater attrition of males from the sample, these figures may underestimate of the recurrence of injuries. More males than females reported being injured at each assessment: 2003 (56% of males compared to 44% females), 2005 (53% compared to 47%), 2007 (54% compared to 46%), 2009 (53% compared to 47%), and 2011 (51% compared to 49%); except for 2013 (45% compared to 55%).

Types of injuries

The four most frequent types of serious injuries in the last year reported at each assessment point were sprains or strains, bruises, broken bones or cuts or punctures (see Table 1). The rank ordering of serious injury frequency was similar across assessments. Sprains or strains accounted for 47% to 66% of injures (averaging 55% across the decade). Severe bruises accounted for 11 % to 44% of the injuries (averaging 28%). There was a decline in the proportion of injured youth reporting broken bones; from 25% in 2003 to 14% in 2013 (with an overall average of 17%).

Table 1. Types of Injuries for the Most Serious Injury in the last year reported

	2003		2005		2007		2009		2011		2013	
	%	N	%	N	%	N	%	N	%	N	%	N
Sprain or strain	47	129	56	128	58	103	66	91	53	70	49	62
Broken bone	25	68	13	30	19	33	15	21	18	24	14	18
Cut, puncture, animal bite	11	31	16	37	15	27	22	30	25	33	14	18
Bruise	11	29	24	56	45	80	33	45	44	59	12	15
Dislocation	7	18	7	17	17	30	8	11	8	10	9	12
Concussion or other TBI ^a	6	17	6	14	9	16	7	9	6	8	6	8
Injury to internal organs	2	6	1	3	4	7	1	1	1	1	1	1
Burn or scald	1	3	3	6	5	9	4	6	2	3	2	2
Poisoning	0.37	1	1	3	1	2	1	1	2	2		0
Nerve damage		0	2	5	3	5	2	3	2	2		0
Other ^b	1	3	3	6	5	8	5	7	6	8	9	12
Total injured	41	273	40	230	33	177	30	137	29	133	27	127

Note. ^a TBI = Traumatic Brain Injury. ^b Responses in the “Other” category include dental injury, eye injury, torn eardrum, etc. Multiple responses were possible; therefore, totals do not add to the number of individuals with injuries and percentages do not add to one hundred percent.

How did injuries occur?

Data in Table 2 show that at each assessment point, injuries were most likely to happen when playing a sport, although frequencies of injuries in this category declined steadily from 51% in 2003 to 25% in 2013. Falls accounted for the next most frequent cause of injuries, accounting for 11% to 25% of injuries (overall average of 18%). Biking, roller blading or skateboarding accounted for 13% of injuries in 2003 and declined steadily at each assessment to

3% in 2013. Injuries that happened when driving or riding in a car were rare and peaked at 7% in the 2009 assessment. Uncategorized or “other” injuries were also among the most frequent responses (25%) for how injuries occurred in 2013.

Table 2. How The Most Serious Injury Happened

	2003		2005		2007		2009		2011		2013	
	%	N	%	N	%	N	%	N	%	N	%	N
Sports injury	51	141	49	111	35	61	36	49	29	38	25	31
Falling or tripping	20	54	11	25	21	36	14	19	24	32	19	23
Bike, roller blading, or skateboard	13	35	7	15	10	17	5	7	5	7	3	4
Beaten or attacked	2	5	1	2	1	1	3	4	1	1	4	5
Hit in a fight	1	2	1	3	1	1	3	4	2	2		0
Rough playing	2	5	2	4	3	6	1	2	2	2		0
Riding in a vehicle as a passenger	1	2	0.44	1	3	5	3	4	1	1		0
Driving a car or other vehicle	0.36	1	4	9	5	9	7	9	3	4	5	6
Hit by a car or vehicle	2	5	2	5	3	5	3	4	1	1	2	2
Lifting	1	2	1	2	3	5	1	2	4	5	6	7
Accidental poisoning/overdose	0.36	1	1	3		0	1	1		0		0
Hurt myself on purpose	0.36	1	0.44	1	2	3		0		0		0
Other *	7	20	20	45	15	26	23	32	30	40	36	44
Total responses		256		189		155		119		105		93

- Note: “Other” injuries were described idiosyncratically as occurring while assembling equipment, catching a falling person/object, dropping a knife, banging on an edge sticking out, stung by an insect or bitten by an animal, and jumping from a roof.

Where did injuries occur?

As shown in Table 3, most injuries were sustained at an outside or inside recreation area reflecting the high rates of sports- and recreation-related injuries. On average, 29% of injuries occurred in one of these locations. Injuries occurring in the workplace increased steadily from 3% in 2003 to 25% in 2013. Injuries occurring at home also increased from 9% in 2003 to 17% in 2013.

Table 3. Where the Most Serious Injury Occurred

	2003		2005		2007		2009		2011		2013	
	%	N	%	N	%	N	%	N	%	N	%	N
School	27	75	16	35	10	17	1	2	0	0	2	3
Outside park or rec center	27	73	28	63	25	44	23	32	27	36	19	24
Inside rec center/arena	15	41	13	29	17	29	18	24	9	12	10	13
Street or road	11	29	9	21	13	22	20	27	14	19	15	18
My home or yard	9	25	11	24	11	20	9	12	17	22	17	21
Someone's home or yard	5	13	7	16	4	7	7	10	8	11	3	4
Workplace	3	8	9	20	14	25	16	22	20	26	25	31
Shopping mall	0.37	1	0.44	1	0		1	1	0		1	1
Bar		0		0	2	3	2	3	2	3	2	3
Other ^a	3	8	7	16	5	8	3	4	3	4	5	6
Total responses		273		225		175		137		133		124

Note. ^a Responses in the “Other” category include at a vacation destination, at an office or clinic, and unsure.

How were injuries treated?

As shown in Table 4, the majority of the youth at each assessment reported having sought health care for their injury. Frequency increased from 75% in 2003 to 87% in 2013. Most youth went to an emergency department - averaging 36% across the 10 years (range 32% to 42%). An

average of 29% across the decade went to a neighbourhood walk-in clinic where a physician can be seen for urgent care (range 27% to 35%), and an average of 18% were seen at a physician's office (range 13% to 24%).

Table 4. Type of Treatment Sought for the Most Serious Injury

	2003		2005		2007		2009		2011		2013	
	%	N	%	N	%	N	%	N	%	N	%	N
Emergency or Hospital	42	86	32	53	36	48	32	33	35	39	39	42
Walk-in clinic	27	55	27	45	35	47	28	29	35	39	27	29
Doctor's appointment	15	30	24	40	19	26	21	22	13	14	18	19
Alternative treatment	9	18	10	16	6	8	9	9	10	11	11	12
Nurse	4	9	1	1	1	2	3	3	2	2	2	2
Other ^a	3	7	5	9	3	4	8	8	5	5	4	4
Total treated of youth injured	75	205	72	164	77	135	75	104	83	110	87	108

Note. ^a Responses in the "Other" category include informal medical advice by family and friends who work in the health sector, coaches, and trainers.

What are youth doing to prevent injuries?

As displayed in Table 5, most youth said they did nothing (an average of 32% across the decade) or were being more careful (an average of 47% across the decade) to prevent future injuries. The number of youth who gave up the activity that resulted in the injury increased as the cohort aged (doubling from 6% in 2003 to 12% in 2007). The use of personal protective gear ranged from 9% to 15% (with an average of 12% across assessments). The use of rehabilitation or physiotherapy increased steadily from 11% to 29% across the decade

Table 5. Preventive Strategies Measures Reported for Most Serious Injury

	2003		2005		2007		2009		2011		2013	
	%	N	%	N	%	N	%	N	%	N	%	N
Did nothing	40	108	36	83	41	72	31	42	27	36	19	24
Being careful	37	101	35	80	43	76	54	74	56	75	56	71
Using protective gear	12	33	9	21	14	25	15	20	12	16	9	11
Re-habilitation/ physiotherapy	11	31	16	37	21	38	25	34	29	38	29	37
Gave up activity	6	17	10	23	11	20	15	21	18	24	9	11
Safety training	0.37	1	1	2	1	2	2	3	1	1		0
Other ^a	1	2	9	20	6	11	7	9	5	7	5	6
Total injured		273		230		177		137		133		127

Note. ^a Responses in the “Other” category include changing diet, drinking less alcohol, warming up before exercise, and asking for assistance. Multiple responses were possible; therefore, totals do not sum to the number of individuals with injuries.

Were alcohol or drugs involved?

Legal access to alcohol is at age 19 in British Columbia. Reports of alcohol use at the time of the injury increased from 5% (n=14) in 2003; 9% (n= 20) in 2005; 11% (19) in 2007 and in 17% (23) in 2009 to a high of 22% (n=29) in 2011 and a declined 18% (n=22) in 2013.

Cannabis was not legal in Canada in 2013 but was widely available and used. Injuries that occurred while youth were using drugs (typically cannabis) were rare, but similarly increased from 3% in 2003 to a high of 7% in 2011 with a decline to 5% in 2013.

What do serious injuries in BC youth cost?

Table 6 presents the total estimated healthcare costs for injuries in each of the six waves. Data were restricted to costs associated with injuries treated at a health professional's office, walk-in clinic, emergency department, or admission to hospital. For the purposes of calculation and based on our previous research [6], we assume that: (I) 8% of injuries treated at an emergency department were serious enough to be admitted to hospital for at least one night, and (II) 20% of injuries treated at an emergency department or a hospital include additional one-way ambulance transportation costs. Transportation costs were not included for injuries treated at a health professional's office. The total cost of injury in 2003 was \$433,253 and decreased 44% to \$241,927 in 2013 (Table 6). This may be, in part, due to the decline in survey participants from 662 to 477, overtime, as only actual reported injuries were included in the cost estimate. The cost per injury however, remained fairly stable over time at approximately \$2,500 (Table 6).

Table 6. Direct costs (in constant 2013 Canadian dollars) of injuries to youth for current sample in 2003, 2005, 2007, 2009, 2011 and 2013 waves.

	Walk in clinic	Hospital emergency	Hospital admission	Rehabilitation	Additional direct health spending (capital, public health, health research)	Total	Cost per Injury
2003	\$46,595	\$68,215	\$41,438	\$25,265	\$251,740	\$433,253	\$2,534
2005	\$43,115	\$42,040	\$25,538	\$30,155	\$201,392	\$342,239	\$2,480
2007	\$39,935	\$38,074	\$23,128	\$30,970	\$165,780	\$297,887	\$2,462
2009	\$26,565	\$26,176	\$15,901	\$27,710	\$127,712	\$224,063	\$2,667
2011	\$30,691	\$30,935	\$18,792	\$30,970	\$135,080	\$246,468	\$2,679
2013	\$25,596	\$33,314	\$20,237	\$30,155	\$132,624	\$241,927	\$2,688

Note: Costs related to care provided by alternative treatment, a nurse, and other direct costs borne by patients, families or other payers were not included.

Figure 1 presents the proportion and cost of injuries by the location where the youth were injured. In the earlier waves, when the youth were younger, higher costs were observed for injuries that occurred at home (\$99,200 in 2005), schools (\$190,023 in 2003) and parks and recreation centres. As the youth got older and joined the workforce, costs for injuries that occurred in workplaces (\$83,330 in 2013) and on the road increased. However, the cost for injuries that occurred in parks and recreation centres were highest throughout the study, ranging from \$288,836 in 2003 to \$99,459 in 2013 (Figure 1).

DISCUSSION

In 2016, there were 849,540 youth between the ages of 15 and 29 in British Columbia – 18% of the BC population^[13]. The proportion of youth treated for an injury is not known. According to BC wide data, in 2013, over 24,524 youth age 22 to 29 (2.9%) were seen in an emergency department for an injury (National Ambulatory Care Reporting System (NACRS))^[14].

The generalizability of our findings for the sample in this paper is limited to population parameters represented by this small urban, Caucasian, sample of youth. However, 27% to 41% reported a “serious injury occurred in the last year” at each assessment. The majority of youth in the current study sought treatment for their serious injuries and this increased with age. Most went to an emergency department (36%), a walk-in clinic (29%), or physician’s office (18%). Youth who reported repeated injuries in the last year, at any given assessment, ranged from 9% at baseline to 5% among older youth in 2013. We also found that 25% of youth reported having a

serious injury at three or more assessment points. These youth were more likely to be male but did not differ on other demographic variables.

Most common injuries were sprains or strains, broken bones, cuts, punctures, and severe bruises and most occurred when playing a sport or by falling. The number of youth injured at school declined and the number of workplace injuries increased as more youth moved from school into the labour market.

Costs associated with injuries among youth averaged approximately \$2,500 per injury (averaged range \$2,462 to \$2,668). In the current study, the overall totals for cost of injuries in this sample decreased over time, in part as a result of the attrition of survey participants i.e., as the number of respondents decreased due to lost to follow up (who were more likely to be males), so did the number of injuries and hence the associated costs. However, the percentage of youth injured at each wave also declined, suggesting other factors may be important, including declines in overall activity, or preventing injuries by dropping out of the activity and/or being more careful. Youth may also gain more experience as drivers, athletes etc. which reduces the likelihood of injuries. Further research is needed to clarify these explanations.

Despite the decline in the number of injuries, the average cost per injury remained similar regardless of the year or location and type of injury. This indicates that when “serious” injuries do occur, the costs of medical care (ED/hospitalization) are similar, regardless of when, where, and how they occur. As the youth got older, the cost of injuries differed by the location where the youth was injured. Costs for workplace and road-related injuries were higher in the later waves than in the earlier waves, where costs were higher for injuries occurring in the home, parks and recreation centres. Youth’s inexperience and lack of on-the-job training may contribute to workplace injuries.

Sports and recreational injuries are often preventable, particularly with adequate safety-related rules and equipment, and sport-specific training. The BCIPRU's searchable website "Active and Safe Central" (<https://www.injuryresearch.bc.ca/active-and-safe-central/>) summarizes detailed, evidence-based strategies to advance sport-specific training. The website is open to the public, but it is not known whether youth in this study knew about, found or accessed this site. Elite and competitive sports have long emphasized warm up, strength and balance training as prevention strategies to reduce health costs and consequences and long-term effects of injuries on professional athletes. For example, the Concussion Awareness Training Tool (CATT) (<https://cattonline.com>), provides online education modules and resources to coaches to assist in the recognition, diagnosis, treatment and management of concussion among athletes (<https://cattonline.com/coach/>). Greater emphasis for young viewers on how sports stars work to maintain fitness could help increase attitudes towards valuing injury-prevention strategies. Regular accessible fitness training for youth that emphasizes good health over competitive sports may also engage a wider group of youth who are vulnerable to injuries.

Falls were the second highest mechanism of serious injuries at each assessment, with an average 18% of the injuries. Prevention of falls has typically targeted the elderly, but not youth. Prevention strategies among the elderly target the promotion of general fitness and balance, attention while carrying objects that may obscure view, advice for lifting heavy objects or people, caution in using stairs, not walking in the dark^[15]. A brief assessment of the responses of youth in the current sample to a question about the circumstances of the fall in 2011 and 2013 are shown in Supplemental Table 1. Falls were attributed by the youth in this study to tripping over small inclines, inattention, wet or icy surfaces, traversing stairs, carrying something heavy, activities, heights, and drinking alcohol. Outreach to youth about establishing personal behaviors

and safer contexts to prevent falls (automatic lights and railings on stairs, clear wet floors, do not obscure view when carrying heaving objects, balance practices, peer support when drinking alcohol, etc.) could reduce serious injuries in this age group.

It is possible that compounding risk factors such as inattention, sleep problems, distraction, and previous injuries contribute to the high rates of injuries in this cohort. Previous research with the current sample also showed dramatic declines in physical activities^[16] and in sleep^[17] in this cohort of youth. This may be the result of declines in organized sports involvement as costs and competitiveness increases, leading to fewer sports injuries. Declines in sleep may contribute to inattention, and sedentary jobs and a lack of activity and training may also contribute to a lack of the fitness, balance, and leg strength that are needed for quicker responses to unexpected events like tripping. Chronic marijuana use is also associated with injuries in the current sample^[18].

Limitations. The youth participating were from one middle sized city only and do not represent youth in highly urban or highly rural settings. Youth were asked about injuries that occurred “in the last 12 months” every two years, more males than females were lost to follow up, and only injuries reported at each assessment are included in the overall cost analyses. Hence, while the average cost of \$2,500 per injury is replicated across time, the overall costs, although high, may be substantially underestimated. Further analyses of BC wide data of injuries to involving youth is needed.

Conclusion and Implications

Consistent with studies conducted in the United States (see review by Miller 2012), this study demonstrates the high occurrence and costs of serious injuries to both youth and the health care system. Considerable savings may be gained from increased age-appropriate, prevention

efforts from non fatal injuries^[19]. Injuries were defined as serious enough to interfere with normal daily activities; implying that time was lost from school or work as result of the injury. Transportation-related injuries (including motor vehicles, bicycles, skateboards etc.) that are major targets of active regulation and prevention strategies were rare in this sample. Research and preventive action have also begun to focus on sports and recreational injuries. However, our findings suggest there is a need for directing prevention efforts at sports injuries, as well as the second highest mechanism of injuries in this cohort; namely falls or tripping.

REFERENCES

1. Belton K, Pike I, Heatley J, Cloutier E. *The Cost of Injury in Canada.*; 2015. Accessed January 12, 2021. https://parachute.ca/wp-content/uploads/2019/06/Cost_of_Injury-2015.pdf
2. Rajabali F, Ibrahimova A, Barnett B, Pike I. *Economic Burden of Injury in British Columbia.*; 2015. Accessed January 12, 2021. <https://www.injuryresearch.bc.ca/wp-content/uploads/2015/08/BCIRPU-EB-2015.pdf>
3. Banz BC, Fell JC, Vaca FE. Complexities of young driver injury and fatal motor vehicle crashes. *Yale J Biol Med.* 2019;92(4):725-731. Accessed January 12, 2021. </pmc/articles/PMC6913817/?report=abstract>
4. Brubacher JR, Chan H, Erdelyi S, et al. Cannabis use as a risk factor for causing motor vehicle crashes: a prospective study. *Addiction.* 2019;114(9):1616-1626. doi:10.1111/add.14663
5. Schneider DK, Grandhi RK, Bansal P, et al. Current state of concussion prevention strategies: A systematic review and meta-analysis of prospective, controlled studies. *Br J Sports Med.* 2017;51(20):1473-1482. doi:10.1136/bjsports-2015-095645
6. Leadbeater B, Babul S, Jansson M, Scime G, Pike I. Youth injuries in British Columbia: Type, settings, treatment and costs, 2003-2007. *Int J Inj Contr Saf Promot.* 2010;17(2):119-127. doi:10.1080/17457300903564561
7. Leadbeater B, Thompson K, Gruppuso V. Co-occurring trajectories of symptoms of anxiety, depression, and oppositional defiance from adolescence to young adulthood. *J Clin Child Adolesc Psychol.* 2012;41(6):719-730. doi:10.1080/15374416.2012.694608
8. BC Emergency Health Services. *Annual Report 2012-2013.*; 2012. <http://www.bcehs.ca/about-site/Documents/annual-report-12-13.pdf>.
9. CIHI. *Cost of a Standard Hospital Stay.*; 2013. [https://yourhealthsystem.cihi.ca/hsp/inbrief?lang=en#!/indicators/015/cost-of-a-standard-hospital-stay/;mapC1;mapLevel2;trend\(C1\)/](https://yourhealthsystem.cihi.ca/hsp/inbrief?lang=en#!/indicators/015/cost-of-a-standard-hospital-stay/;mapC1;mapLevel2;trend(C1)/)
10. CIHI. *National Physician Database, Utilization Table.*; 2013. https://www.cihi.ca/en/quick-stats?xQSType=Pre-formatted%252520Table&%253bxTopic=Hospital%252520Care&%253bpageNumber=2&%253bresultCount=10&%253bfilterTypeBy=1&%253bfilterTopicBy=5&%253bautorefresh=1&field_acronyms_databases_target_id=All&title=&order=fiel
11. Physiotherapy | District of Saanich. Accessed January 18, 2021. <https://www.saanich.ca/EN/main/parks-recreation-community/fitness-health-services/health-rehabilitation-services/physiotherapy.html>

12. Canada TPHA of. *The Economic Burden of Illness in Canada, 2010.*; 2017. <https://www.canada.ca/en/public-health/services/publications/science-research-data/economic-burden-illness-canada-2010.html>
13. Statistic Canada. British Columbia and Canada. Census Profile, 2016 Census. Published 2017. Accessed January 13, 2021. <https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/details/page.cfm?Lang=E&Geo1=PR&Code1=59&Geo2=PR&Code2=01&SearchText=Canada&SearchType=Begins&SearchPR=01&B1=All&type=0>
14. Health M of. *National Ambulatory Care Reporting System (NACRS).*; 2013.
15. Karlsson MK, Vonschewelov T, Karlsson C, CÅster M, Rosengen BE. Prevention of falls in the elderly: A review. *Scand J Public Health.* 2013;41(5):442-454. doi:10.1177/1403494813483215
16. Ames ME, Leadbeater BJ, MacDonald SWS. Health behavior changes in adolescence and young adulthood: Implications for cardiometabolic risk. *Heal Psychol.* 2018;37(2):103-113. doi:10.1037/hea0000560
17. Ames ME, Holfeld B, Leadbeater BJ. Sex and age group differences in the associations between sleep duration and BMI from adolescence to young adulthood. *Psychol Heal.* 2016;31(8):976-992. doi:10.1080/08870446.2016.1163360
18. Ames ME, Leadbeater BJ, Merrin GJ, Thompson K. Patterns of marijuana use and physical health indicators among Canadian youth. *Int J Psychol.* 2018;55(1):1-12. doi:10.1002/ijop.12549
19. Miller T, Finkelstein AE, Zaloshnja E, Hendrie D. The Cost of Child and Adolescent Injuries and the Savings From Prevention. In: Liller K, ed. *Injury Prevention for Children and Adolescents: Research, Practice, and Advocacy.* second. Injury Prevention for Children and Adolescents: Research, Practice, and Advocacy; 2012:21-81.