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Comparing pedestrian and cyclist injuries from falls and collisions in British Columbia, Canada: Frequencies and population characteristics

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A B S T R A C T

Introduction: Walking and cycling offer health benefits but carry injury risks. Traditional road safety datasets often exclude pedestrian and cyclist falls, despite emerging evidence that injuries from falls occur more frequently than collisions with motor vehicles.
Methods: This research compared the frequency of pedestrian and cyclist injuries from falls versus collisions using hospital admissions data from a linked database of road traffic injuries in British Columbia, Canada, which combined hospital admissions, and sociodemographic information from 2015 to 2019. Additionally, we examined differences in injury severity and population characteristics between those injured in falls versus collisions.
Results: Of 6807 pedestrian hospital admissions, 68.8 % were from falls—2.3 times higher than motor vehicle collisions (29.2 %). Among 2409 cyclist admissions, falls accounted for 48.6 %–1.8 times higher than motor vehicle collisions (27.6 %). More severe injuries (MAIS3+) occurred less frequently in falls (25.0 % pedestrians, 17.9 % cyclists) than in collisions with motor vehicles (39.7 %, 27.4 %). We also found that falls disproportionately happen to older adults, females, higher-income individuals, and rural residents with more pronounced differences in pedestrians.
Conclusions: Our analysis revealed that pedestrian and cyclist falls are major contributors to the burden of road traffic injury and emphasizes the need for their inclusion in road safety surveillance and research. Reliance on datasets that exclude falls, or failing to consider falls as a road safety issue, can potentially hinder the development of infrastructure and built environment design solutions aimed at reducing the frequency and severity of fall injuries to pedestrians and cyclists.

1. Background

Active transportation provides population health benefits through increased physical activity (Götschi et al., 2016; Mueller et al.,

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2015) and reduces noise, air pollution and carbon emissions when replacing motor vehicle trips (Lindsay et al., 2011; Woodcock et al., 2007, 2009). Active transportation also presents a risk of injury from collisions with other road users, collisions with objects on or alongside the road or falls. Public health surveillance and research tend to focus on tracking and understanding mainly one type of pedestrian and cyclist road traffic injury: collisions with motor vehicles (Office of the Provincial Health Officer of British Columbia, 2016; Transport Canada, 2023). This focus is often due to data limitations, where the main sources of road safety data such as police reports or insurance claims either highly underreport injuries not involving motor vehicles (Veisten et al., 2007; Winters and Branion-Calles, 2017) or explicitly exclude them (Branion-Calles et al., 2021, 2025; Harris et al., 2024).

As a result, medical records such as emergency department visit data or hospital admissions, are often the only data source that captures fall-related injuries (Harris et al., 2024). However, even where medical records are used, pedestrian falls are often not included in road traffic injury surveillance (Bhalla and Harrison, 2016; Methorst et al., 2017). While pedestrian falls can be identified in country-specific modified versions of the International Classification of Disease (ICD-10) system, widely used to classify medical records for injury surveillance, by combining place of occurrence codes with fall codes, this additional analytic requirement reinforces the idea of falls as an injury prevention issue separate from road safety. This separation means public health surveillance and injury prevention often do not distinguish between falls that occur on the roadway and those in other locations. Consequently, the burden of injury on our public road networks is often underestimated.

Despite these definitional challenges and data limitations, a small but growing number of studies have measured falls on public roadways to understand the magnitude of the issue. Using either country-specific ICD-10 modifications that combine place of occurrence with fall codes, or alternative data like chart reviews or ambulance records, these studies have consistently found fall injuries on roadways occur far more frequently than injuries resulting from collisions with motor vehicles (Amin et al., 2022; Brubacher et al., 2017a, 2017b; Methorst et al., 2017; Rundle et al., 2024; Teschke et al., 2014; Utriainen et al., 2022).

In British Columbia (BC), the third most populous province of Canada, the total contribution of pedestrian and cyclist falls to the road traffic injury burden and characteristics of these populations are not known. Traditional provincial data sources of road traffic injury, including police reports and insurance claims, are designed to only capture injuries resulting from collisions with motor vehicles, not falls (Branion-Calles et al., 2025). Provincial medical data, including records from emergency departments (ED) and hospital admissions, record information on injuries that required treatment, however their use in identifying fall-related injuries is either not possible or not straightforward. In BC, ED data does not include information on mechanism of injury, preventing its use in injury prevention research. Hospital admissions data uses the Canadian version of ICD-10 codes. This system enables indirect measurement of pedestrian fall injuries by combining mechanism of injury codes for falls with Canada-specific place-of-occurrence codes (Harris et al., 2024). As such, hospital admissions data are the only administrative dataset that can identify falls on public roads for the entire province. The exclusion of injuries resulting from falls from traditional road safety datasets not only results in potentially overlooking a major public health concern, but also hampers development of effective injury prevention strategies. To develop and prioritize effective road safety measures, an understanding of the magnitude of the problem is required.

We analyzed a unique linked dataset to compare the frequency and distribution of population characteristics between pedestrian and cyclist injuries resulting from falls, compared to those from collisions with motor vehicles within the province of BC. For each injury mechanism we (i) estimated the number of injuries and (ii) compared sociodemographic characteristics including age, sex, socioeconomic status, and urban versus rural residency.

2. Materials and methods

This analysis was developed as part of the Pedestrian and Cyclist Safety Study, commissioned by the BC Ministry of Health and the BC Ministry of Transportation and Infrastructure, using injury and sociodemographic datasets for the province of British Columbia made available by the BC Data Innovation Program (DIP) (Government of British Columbia, 2022). All inferences, opinions, and conclusions in these materials are those of the authors. They do not reflect the opinions or policies of the provider(s) of the data upon which they are based. The specific datasets used from the DIP include *Ministry of Health – Registry and Demographics* (sociodemographic information), *Ministry of Health – Discharge Abstract Database* (hospital admissions), *Ministry of Social Development and Poverty Reduction – BC Employment and Assistance* (income assistance). These datasets are explained in more detail in the following sections, however, visit the BC Data Catalogue for further information: https://www2.gov.bc.ca/gov/content/data/finding-and-sharing/data-innovation-program.

2.1. Data

Within the DIP we created the BC Road Safety Database, a linked database of road traffic injuries based on insurance claims, police reports and hospital admissions linked to and sociodemographic information that covers the province BC from 2015 to 2019 (Branion-Calles et al., 2025). We exclusively used hospital admissions records from this dataset to identify injuries because insurance claims and police report data only include injuries resulting from collisions with motor vehicles. The province's population during this period was 4.65 million, with 2.5 % of the working population regularly commuting by bicycle and 6.8 % by walking (Statistics Canada, 2017b). Records in the dataset are associated with de-identified study IDs corresponding to individual BC residents based on probabilistic linkage (Ark et al., 2020).

Hospital admissions data are available from the Discharge Abstract Database (DAD), a national database of acute inpatient hospitalization data which has complete coverage of hospital admissions in British Columbia. In this context, hospitalization refers to cases where patients were admitted to a department beyond the emergency department for further treatment.

Hospital admissions were linked to sociodemographic information including age, sex, socioeconomic status and urban versus rural residency for individuals who receive health services through the BC's public health insurance program (Medical Services Plan) (Data Innovation Program (DIP), 2023a, b). The *Central Demographics Collection* includes age, sex and postal code of residence. The data categorized individuals by sex assigned at birth and we use the term "males" and "females" throughout the paper. We acknowledge that this construction does not capture gender identity nor is not inclusive of intersex or people with different sex development. Postal code of residence was used to link to Census neighbourhood income information as a proxy for socioeconomic status, as well as an indicator of whether the individual lived in an urban or rural area. We developed another proxy for low-income status through linkage to BC Employment and Assistance program data from the Ministry of Social Development and Poverty Reduction, enabling the identification of individuals who are part of a family unit that received income assistance in each month since January 1989 (Data Innovation Program (DIP) 2023a). The population eligible for income assistance include those temporarily in need of assistance (out of work, awaiting other income, unable to work, in need of immediate assistance due to hardship, medical illness) as well as those with permanent disabilities that render them unable to work (BC Ministry of Social Development and Poverty Reduction, 2014). We categorized an injured individual as low-income if they received income assistance within five-years before the date of hospital admission.

2.2. *Case definition*

We used external cause codes from the Canadian version of ICD-10 to identify cases which included on-road injuries to pedestrians, cyclists, and motor vehicle occupants (Appendix 1). Pedestrian injuries resulting from collisions with road users were identified using select V-Codes (V01-V09), falls were identified using place of occurrence code indicating street or highway (U98.4) combined with W-Codes indicating a fall (W00-W19). Specific V-Codes were used to identify cyclist injuries from collisions and falls (V10-V19), while V-Codes (V40-V79) were used to identify motor vehicle occupant injury.

2.3. *Analysis*

To understand the contribution of falls to the burden of injury in the province, we counted the number of injuries requiring hospital admission in British Columbia for pedestrians, cyclists, and motor vehicle occupants. We include counts of motor vehicle occupant injuries to contextualize the frequencies observed for pedestrians and cyclists, although the primary focus of this analysis is on the latter two groups. Injuries were stratified by crash type: (i) collision with motor vehicle, (ii) collision with other road user, (iii) fall/ single vehicle crash, and (iv) unknown. Motor vehicles included two- or three-wheeled motorized vehicles, cars, pick-ups, vans, heavy transport vehicles, buses, and other unspecified motor vehicles. Collisions with other road users encompassed non-motor vehicles and trains. While trains are motor vehicles, we classify them as "other" due to their unique operational characteristics, including fixed tracks and comparatively infrequent interaction with pedestrians and cyclists. Cyclist falls included non-collision falls and collisions with fixed or stationary objects, pedestrian falls also included striking against post, sign tree or wall on a public roadway.

Using the ICDPIC-R conversion tool in R (Clark et al., 2018), we classified injury severity by converting the first four digits of each hospital admission's ICD-10 codes to Abbreviated Injury Scale (AIS) scores. While all injuries requiring hospital admission are inherently serious, there is variability in injury severity that warrants further classification. However, since the DAD lacks trained

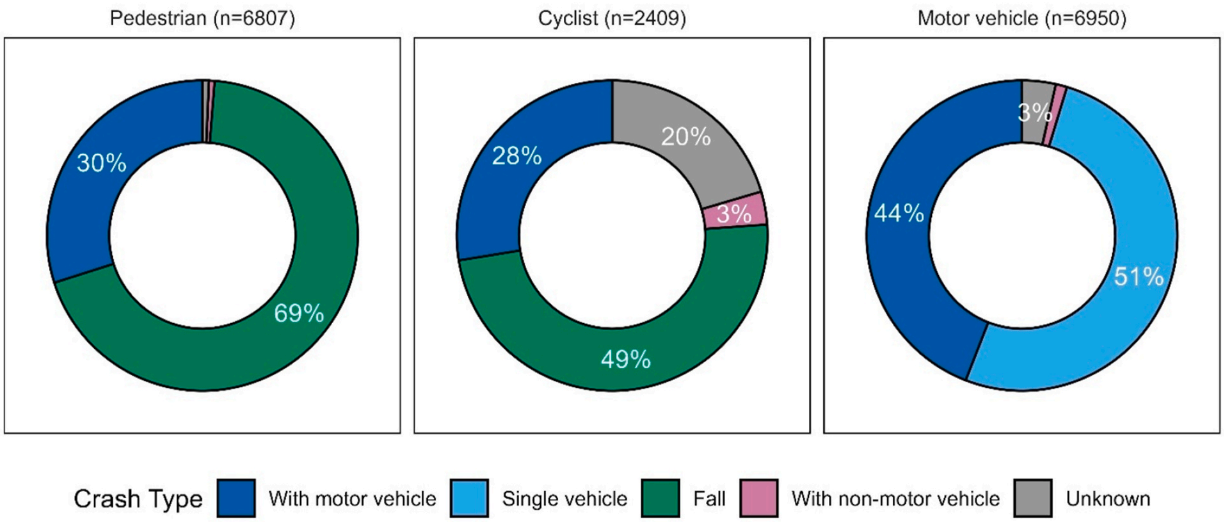

Fig. 1. Relative frequency of injuries requiring hospitalization by crash types for pedestrians, cyclists and motor vehicle occupants. Traditional road safety datasets in the province such as police reports and insurance claims exclude falls by definition, which make up over two thirds of pedestrian injury and nearly half of cyclist injuries.

personnel to conduct standardized injury severity scoring, we must rely on automated algorithms for classification, despite their known limitations (Eskesen et al., 2022). Given these constraints, we dichotomized the maximum AIS score (MAIS) into Less Severe (MAIS <3) or More Severe (MAIS ≥3) categories and compared the injury severity across crash types for pedestrians, cyclists, and motor vehicle occupants.

To investigate potential differences in population characteristics between pedestrian and cyclist falls and other crash types, we compared injury frequencies across age groups, sex, neighbourhood income quintiles, individual low-income status, and urban/rural residency. Pedestrian and cyclist injuries were considered separately. We used Chi-Square tests to assess the statistical significance of observed differences in the frequency distribution of fall-related injuries compared to other mechanisms of injury across socio-demographic groups, excluding missing values. All analyses were conducted in R Version 4.3.1 (R Core Team, 2023).

3. Results

3.1. Distribution of crash types and injury severity amongst pedestrian and cyclist falls

Between 2015 and 2019, 6807 pedestrian injuries required hospital admission, nearly as many as the 6950 sustained by motor vehicle occupants (Fig. 1). Falls accounted for 4685 (68.8 %) of these injuries, 2.3 times more than the 2036 (29.9 %) caused by motor vehicle collisions. The remaining injuries included 40 that involved a collision with other road users (0.6 %) and 46 with unknown mechanisms (0.7 %).

During the same time there were 2409 hospital admissions for injuries to cyclists, just over a third of the number for motor vehicle occupants (Fig. 1). Falls accounted for 1170 (48.6 %) of these injuries, 1.8 times more than the 664 (27.6 %) caused by motor vehicle collisions. The remaining injuries included 492 (20.4 %) with an unknown mechanism, and 83 (3.4 %) involving collisions with other road users.

Collisions with motor vehicles had a higher proportion of more severe injuries than falls for both pedestrians and cyclists. For pedestrians, 25.0 % of falls were classified as more severe (MAIS ≥3) compared to 39.7 % of motor vehicle collisions (Fig. 2). For

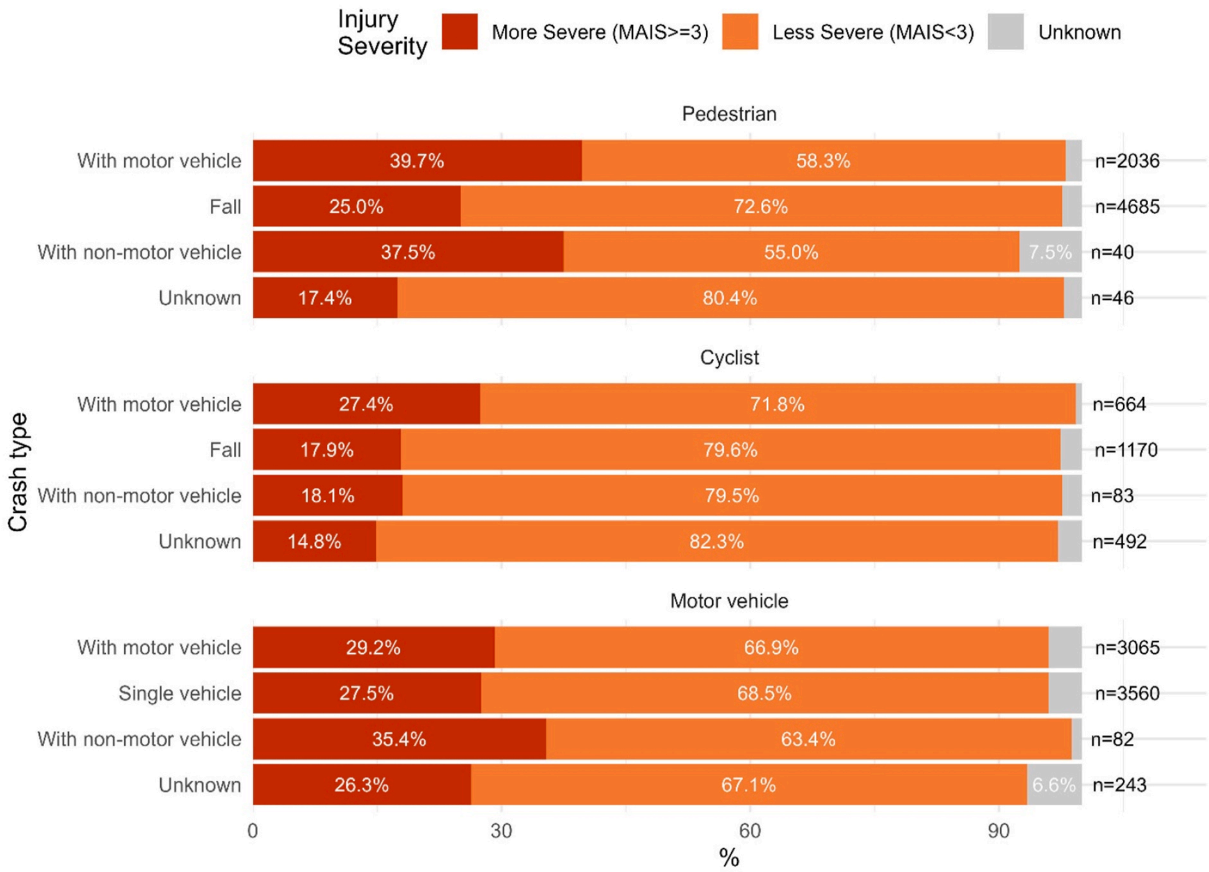

Fig. 2. Distribution of injury severity by crash type among hospitalized pedestrians, cyclists, and motor vehicle occupants, classified by maximum abbreviated injury severity (MAIS ≥3 defined as severe). While motor vehicle collisions resulted in a higher proportion of more severe injuries compared to falls, all injuries required hospital admission and can be considered serious.

cyclists, 17.9 % of falls were classified as more severe compared to 27.4 % of motor vehicle collisions. For comparison, motor vehicle occupants had more severe injuries in 27.5 % of single-vehicle injuries and 29.2 % of multiple-vehicle collisions.

3.2. Sociodemographic differences between injuries from falls and all other crash types

For both cyclists and pedestrians, there were sociodemographic differences between those injured in falls and those injured in motor vehicle collisions (Tables 1 and 2). For pedestrian injuries, falls disproportionately involved older adults (64.4 % of all fall injuries occurred in those over 65 years old compared to 30.6 % of all injuries from collisions), females (54.3 % of all falls compared to 43.6 % of all collisions were female), individuals not receiving income assistance (86.6 % compared to 73.6 %), residents of the highest income quintile neighborhoods (13.7 % compared to 10.1 %), and those living in rural areas (8.2 % compared to 5.7 %) (Table 1). For cyclist injuries, falls disproportionately involved adults over the age of 55 (40.2 % of falls compared to 29.7 % for collisions), females (25.8 % compared to 22.0 %), non income assistance population (82.8 % compared to 79.2 %), and rural areas (10.3 % compared to 7.7 %) (Table 2).

4. Discussion

We used a large, linked database of all hospital admissions between 2015 and 2019 in BC to estimate and compare the frequency of fall-related injuries versus collisions among pedestrians and cyclists. Fall-related injuries are not reported to traditional road safety data sources in the province including insurance claims and police reports (Branion-Calles et al., 2025) and our use of hospital admissions allowed us to measure these unreported road traffic injuries. We found hospital admissions for fall-related injuries to occur more frequently than collisions with motor vehicles. Pedestrian falls were 2.3 times more frequent than pedestrian injuries from collisions with motor vehicles, while cyclist falls were 1.8 times more frequent. Our results are consistent with emerging research which find falls contribute more to pedestrian and cyclist road injuries than collisions with motor vehicles, though the extent varies by study area and data source (e.g. ambulance, emergency department, or hospital admissions). Pedestrian fall injuries were more frequent than motor vehicle collision injuries by factors of 3 in Vancouver, Canada (Brubacher et al., 2017a), 3.5 in the USA (Rundle et al., 2024), 4 in the Netherlands (Methorst et al., 2017), and 9 and 16 in Sweden (Amin et al., 2022). For cyclists, fall injuries were at least twice as common as collisions within Canadian cities (Teschke et al., 2014; Brubacher et al., 2017b), while a review of studies from Europe, Canada and Australia estimated between 52 and 85 % of cyclist injuries requiring treatment in hospital resulted from falls (Utriainen et al., 2022). Although falls are more common, it is important to note that injuries from collisions with motor vehicles tend to more serious, and that, pedestrian and cyclist fatalities overwhelmingly result from collisions with motor vehicles (Gaudet et al.,

Table 1
Comparing frequency of pedestrian falls and collisions/other pedestrian injuries by sociodemographic characteristics of injured individuals in hospital admissions data from 2015 to 2019.

		Fall	Collisions/Other			
Variable	Level	n (%)	n (%)	% Fall - % Collisions/Other (95 % CI)	*P*-Value[a]	S-Value[b]
Total		4685 (100)	2122 (100)			
Age Group	0–15	44 (0.9)	136 (6.4)	−5.5 (−6.6, −4.4)	<0.0001	762.4
	16–24	82 (1.8)	257 (12.1)	−10.4 (−11.8, −8.9)		
	25–34	144 (3.1)	237 (11.2)	−8.1 (−9.6, −6.6)		
	35–44	179 (3.8)	172 (8.1)	−4.3 (−5.6, −3.0)		
	45–54	310 (6.6)	261 (12.3)	−5.7 (−7.3, −4.1)		
	55–64	742 (15.8)	295 (13.9)	1.9 (0.1, 3.8)		
	65+	3018 (64.4)	649 (30.6)	33.8 (31.4, 36.3)		
	Missing[c]	166 (3.5)	115 (5.4)	−1.9 (−3.0, −0.7)		
Sex	Female	2543 (54.3)	926 (43.6)	10.6 (8.1, 13.2)	<0.0001	44.3
	Male	1976 (42.2)	1081 (50.9)	−8.8 (−11.4, −6.2)		
	Missing[c]	166 (3.5)	115 (5.4)	−1.9 (−3.0, −0.7)		
Income Assistance Participation	No	4055 (86.6)	1562 (73.6)	12.9 (10.8, 15.1)	<0.0001	125.7
	Yes	630 (13.4)	560 (26.4)	−12.9 (−15.1, −10.8)		
Neighbourhood Income Quintile	1-Lowest	1532 (32.7)	690 (32.5)	0.2 (−2.3, 2.6)	0.0006	10.6
	2-Medium low	908 (19.4)	464 (21.9)	−2.5 (−4.6, −0.4)		
	3-Medium	771 (16.5)	342 (16.1)	0.3 (−1.6, 2.3)		
	4-Medium high	630 (13.4)	274 (12.9)	0.5 (−1.2, 2.3)		
	5-Highest	644 (13.7)	215 (10.1)	3.6 (2.0, 5.3)		
	Missing[c]	200 (4.3)	137 (6.5)	−2.2 (−3.4, −1.0)		
Urban/Rural	Urban	4113 (87.8)	1877 (88.5)	−0.7 (−2.3, 1.0)	0.0005	11
	Rural	385 (8.2)	120 (5.7)	2.6 (1.3, 3.9)		
	Missing[c]	187 (4.0)	125 (5.9)	−1.9 (−3.1, −0.7)		

CI = Confidence Interval.
[a] *P*-value from chi-square test.
[b] An S-value measures how unlikely a result is due to chance, equivalent to getting heads multiple times in a row when flipping a fair coin. For instance, an S-value of 10 is like flipping heads 10 times consecutively, showing that the result is very unlikely to happen just by chance.
[c] Missing values are excluded from chi-square tests.

Table 2
Comparing frequency of cyclist falls and collisions/other cyclist injuries requiring hospital admission by sociodemographic characteristics of injured individuals in hospital admissions data from 2015 to 2019.

		Fall	Collisions/Other			
Variable	Level	n (%)	n (%)	% Fall - % Collisions/Other (95 % CI)	*P*-Value[a]	S-Value[b]
Total		1170 (100)	1239 (100)			
Age Group	0–15	59 (5.0)	62 (5.0)	0.0 (−1.7, 1.8)	<0.0001	16.3
	16–24	69 (5.9)	103 (8.3)	−2.4 (−4.5, −0.3)		
	25–34	134 (11.5)	173 (14.0)	−2.5 (−5.2, 0.2)		
	35–44	127 (10.9)	162 (13.1)	−2.2 (−4.9, 0.5)		
	45–54	205 (17.5)	254 (20.5)	−3.0 (−6.2, 0.2)		
	55–64	247 (21.1)	205 (16.5)	4.6 (1.4, 7.8)		
	65+	223 (19.1)	164 (13.2)	5.8 (2.8, 8.8)		
	Missing[c]	106 (9.1)	116 (9.4)	−0.3 (−2.7, 2.1)		
Sex	Female	302 (25.8)	272 (22.0)	3.9 (0.4, 7.3)	0.0306	5.0
	Male	762 (65.1)	851 (68.7)	−3.6 (−7.4, 0.3)		
	Missing[c]	106 (9.1)	116 (9.4)	−0.3 (−2.7, 2.1)		
Income Assistance Participation	No	969 (82.8)	981 (79.2)	3.6 (0.4, 6.9)	0.0261	5.3
	Yes	201 (17.2)	258 (20.8)	−3.6 (−6.9, −0.4)		
Neighbourhood Income Quintile	1-Lowest	260 (22.2)	289 (23.3)	−1.1 (−4.5, 2.3)	0.8703	0.2
	2-Medium low	190 (16.2)	209 (16.9)	−0.6 (−3.7, 2.4)		
	3-Medium	207 (17.7)	206 (16.6)	1.1 (−2.0, 4.2)		
	4-Medium high	193 (16.5)	193 (15.6)	0.9 (−2.1, 3.9)		
	5-Highest	202 (17.3)	207 (16.7)	0.6 (−2.5, 3.6)		
	Missing[c]	118 (10.1)	135 (10.9)	−0.8 (−3.3, 1.7)		
Urban/Rural	Urban	936 (80.0)	1022 (82.5)	−2.5 (−5.7, 0.7)	0.0309	5.0
	Rural	120 (10.3)	95 (7.7)	2.6 (0.2, 5.0)		
	Missing[c]	114 (9.7)	122 (9.8)	−0.1 (−2.6, 2.4)		

CI = Confidence Interval.
[a] *P*-value from chi-square test.
[b] An S-value measures how unlikely a result is due to chance, equivalent to getting heads multiple times in a row when flipping a fair coin. For instance, an S-value of 10 is like flipping heads 10 times consecutively, showing that the result is very unlikely to happen just by chance.
[c] Missing values are excluded from chi-square tests.

2015; Harris et al., 2024; Ontario Ministry of Community Safety & Correctional Services and Office of the Chief Coroner, 2012).

Our analysis also compared the distribution of sociodemographic characteristics between injuries from falls and collisions for pedestrians and cyclists. The analysis is descriptive and reflects burden of injury not injury risk, which would require include measurements of exposure (Branion-Calles et al., 2021). As such, the observed differences in the distribution of sociodemographic characteristics between falls and collision-related injuries can be driven by several different processes including differences in: (i) exposure to risk; (ii) risk of an injury and; (ii) susceptibility to more severe injury. For example, we found fall injuries had a much higher proportion of older adults compared to collision injuries. Previous research has observed same level falls (e.g., not from heights) have more severe injury outcomes for older adults compared to younger adults (Elvik and Bjørnskau, 2019; Mitchell et al., 2010; Oxley et al., 2018; Sterling et al., 2001). This may be because fall injuries are more likely to occur in older adult populations than younger adults due to age related changes such as balance, reaction time and decreased strength (Jeon et al., 2023). Older adult falls are more likely to result in severe injury due to greater musculoskeletal frailty (Clegg et al., 2013). However, for cyclist injuries the prevalence of falls in the oldest age group in particular is much smaller than for pedestrian injuries, likely because cycling is not as common in older age groups (Firth et al., 2021). While fall-related injuries are much more prominent in older age groups, particularly for pedestrian falls, they are still a substantial contributor to the burden of injury across all ages.

In addition to age-related differences, we found a significant association between sex and injury type. Females experienced fall-related injuries even more frequently than collision injuries, with this disparity being particularly pronounced in pedestrian falls. Previous research has found disproportionate representation of females in pedestrian fall injury from emergency department visit and hospital admissions data in Australia (Oxley et al., 2018), Norway (Elvik and Bjørnskau, 2019) and Sweden (Amin et al., 2022). Male pedestrians also have a higher risk of injury from being struck by motor-vehicles compared to females which could be partially driving this difference (Branion-Calles et al., 2024). Females may also walk more than males (Branion-Calles et al., 2021), which could impact their risk differentially if high usage is associated more strongly with one type of injury than another. Females may also be more prone to pedestrian fall-related injuries due to differences in gait and footwear (Timsina et al., 2017) or the difference in their age distribution (females live longer) (Statistics Canada, 2017a).

Our analysis provides a novel comparison of sociodemographic characteristics of pedestrian and cyclist falls that goes beyond age and sex. We found that the population that had received income assistance in the previous five years had a lower proportion of pedestrian and cyclist fall-related injury compared to the non-income assistance population, especially for pedestrian injury. Lower-income populations in Canada often live in areas with higher traffic volumes and motor vehicle speeds (Morency et al., 2012) and are at higher risk of pedestrian-motor vehicle injury relative to higher-income populations (Branion-Calles et al., 2024; Burrows et al., 2012). Lower prevalence of fall-related injuries within the low-income population may reflect a higher risk of collision with motor vehicles rather than a lower risk of falls. We also found small but significant differences in the prevalence of fall-related injuries in urban versus rural areas; fall-related injuries were more prevalent in rural areas compared to collisions for both pedestrians and cyclists. People living in urban areas have a higher exposure to motor vehicles compared to rural areas (Zwerling et al., 2005).

Since motor vehicle collisions generally result in more severe injuries than falls, our results likely underestimate the prevalence of fall-related injuries compared to motor vehicle collision injuries as our estimates are based on hospital admissions data and exclude minor injuries such as those treated and released from the emergency department without admission to hospital. Previous research comparing the prevalence of pedestrian falls to pedestrians injured in motor vehicle collisions found that falls were less common when the injury was severe, particularly in fatal injuries (Amin et al., 2022; Harris et al., 2024). For instance, a Swedish national study that included emergency department visit data found pedestrian falls caused 94 % of all pedestrian injuries (Injury Severity Score$\geq$1) but only 27 % of fatal pedestrian injuries (Amin et al., 2022). Moreover, of the more than 117,000 emergency visits recorded in this study only 3.8 % had an MAIS above 3, proportionately far fewer than the 25.0 % we estimated in our hospital admissions data (Amin et al., 2022). In Ontario, Canada, falls accounted for 60.1 % of pedestrian injuries treated at an emergency department, 54.8 % of hospital admissions, and 14 % of fatalities (Harris et al., 2024). In a coroners review of cycling fatalities in Ontario 12 % did not involve a collision, while 78 % involved a collision with a motor vehicle (Ontario Ministry of Community Safety & Correctional Services and Office of the Chief Coroner, 2012); similarly, a review in Alberta revealed that 15 % of fatal injuries to cyclists did not involve a collision and that 82 % of cycling injuries on-road involved a collision with a motor vehicle (Gaudet et al., 2015).

Our research has important strengths. We used a large, province-wide dataset with linkages to sociodemographic data beyond age and sex, enabling unique insight into differences between the populations injured in falls versus collisions. The use of hospital data enabled measurement of fall-related injuries on public roads that otherwise are not captured in routinely used road safety datasets such as police data or insurance claims (Branion-Calles et al., 2025). Our analysis also has limitations. Our categorization of injury severity is based on publicly available algorithms used to convert ICD-10 codes to AIS scores; these algorithms have only moderate agreement with trained professionals when using a binary categorization based on AIS (Eskesen et al., 2022). We were unable to explore more granular differences in circumstances of injury because hospital data has limited details associated with each record. For example, our data has no information on spatial location, details on the events leading to injury or the contribution of modifiable factors to injury. Previous research in Vancouver and Toronto found that 1 in 5 cyclists fall injuries were the result of a maneuver to avoid a collision with a motor vehicle (Teschke et al., 2014). It may be the case that many injuries categorized as a fall in this analysis involved a motor vehicle indirectly. Another source of uncertainty in our analysis is that nearly 20 % of cyclist injuries have an unknown mechanism of injury (ICD-Code V19.9). Fall-related injuries would, however, remain the most common mechanism of injury for cyclists even if all unknown cases were motor vehicle collisions.

The traditional focus of road traffic injury surveillance and injury prevention efforts on collision injuries overlooks a substantial contributor to the burden of road traffic injury and may prevent the development of injury prevention solutions. The definition of road traffic injury for surveillance purposes should be expanded to include pedestrian falls on roadways. Demonstrating the magnitude of the issue can help prioritize interventions. Smooth and level surfaces, removal of snow and ice in winters months, good sight lines along sidewalks and bike routes, adequate light at night and crossings of driveways and minor roads that do not involve dips in road surfaces are measures that can prevent falls (Amin et al., 2022; Teschke et al., 2014). More novel interventions should also be considered and studied. For instance, using more rubber in sidewalk and bike path surfaces can absorb more impact, possibly reducing injury severity from falls while walking or cycling (Wallqvist et al., 2017), while in colder climates ground heated pedestrian paths have been shown to substantially reduce pedestrian injuries from slips on ice or snow (Amin et al., 2024).

5. Conclusions

Traffic injury prevention and surveillance efforts focusing solely on motor vehicle collisions overlook a major public health concern and may hinder the development of strategies to improve road safety for pedestrians and cyclists. Our study found that pedestrian and cyclist falls are not only a substantial contributor to the injury burden in the province but occur more frequently than injuries from collisions with motor vehicles. Though pedestrian falls were much more prevalent within the older adult population, they contribute to injuries across all age groups. We recommend modifying the definition of road traffic injury to include fall-related injuries to help prioritize and develop interventions for injury prevention.

CRediT authorship contribution statement

Michael Branion-Calles: Conceptualization, Methodology, Writing – original draft, Visualization, Formal analysis. **Andrea Godfreyson:** Project Administration, Funding acquisition. **Neil Arason:** Funding acquisition. **Shannon Erdelyi:** Methodology, Writing – review & editing. **Meghan Winters:** Writing – review & editing. **Kay Teschke:** Conceptualization, Writing – review & editing. **Fahra Rajabali:** Writing – review & editing. **M. Anne Harris:** Writing – review & editing. **Jeffrey R. Brubacher:** Conceptualization, Methodology, Resources, Supervision, Project administration, Funding acquisition, Writing – review & editing.

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Declaration of competing interest

The authors declare no conflict of interest.

Appendix 1. Case Definitions

External cause codes from the Canadian version of the International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10-CA) identifying road traffic injuries to pedestrians, cyclists, and motor vehicle occupants on public roads, stratified by collision type: motor vehicle collisions, collisions with other road users, fall and unknown causes.

Mode of Injured Person	Crash Type	ICD-10 V-Code	W-Code	U-Code
Pedestrian	Collision with motor vehicle	V021; V031; V041; V092		
	Collision with other road user	V011; V051; V061		
	Fall		W00; W01; W0208; W03; W04; W0500; W0501; W502; W503; W504; W508; W509; W10; W17; W18; W19; W2208; W2209	U984
	Unknown	V093		
Cyclist	Collision with motor vehicle	V124; V125; V129; V134; V135; V139; V144; V145; V149; V194; V195; V196		
	Collision with other road user	V104; V105; V109; V114; V115; V119; V154; V155; V159; V164; V165; V169		
	Fall	V174; V175; V179; V184; V185; V189		
	Unknown	V199		
Motor vehicle Occupant	Collision with motor vehicle	V425; V426; V427; V429; V435; V436; V437; V439; V445; V446; V447; V449; V494; V495; V496; V525; V526; V527; V529; V535; V536; V537; V539; V545; V546; V547; V549; V594; V595; V596; V625; V626; V627; V629; V635; V636; V637; V639; V645; V646; V647; V649; V694; V695; V696; V725; V726; V727; V729; V735; V736; V737; V739; V745; V746; V747; V749; V794; V795; V796		
	Collision with other road user	V405; V406; V407; V409; V415; V416; V417; V419; V455; V456; V457; V459; V465; V466; V467; V469; V505; V506; V507; V509; V515; V516; V517; V519; V555; V556; V557; V559; V565; V566; V567; V569; V605; V606; V607; V609; V615; V616; V617; V619; V655; V656; V657; V659; V665; V666; V667; V669; V705; V706; V707; V709; V715; V716; V717; V719; V755; V756; V757; V759; V765; V766; V767; V769		
	Single vehicle	V475; V476; V477; V479; V485; V486; V487; V489; V575; V576; V577; V579; V585; V586; V587; V589; V675; V676; V677; V679; V685; V686; V687; V689; V775; V776; V777; V779; V785; V786; V787; V789		
	Unknown	V499; V599; V699; V799		

Data availability

The authors do not have permission to share data.

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