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Original quantitative research

Area-based socioeconomic disparities in mortality due to unintentional injury and youth suicide in British Columbia, 2009–2013

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Abstract

Introduction: The association between health outcomes and socioeconomic status (SES) has been widely documented, and mortality due to unintentional injuries continues to rank among the leading causes of death among British Columbians. This paper quantified the SES-related disparities in the mortality burden of three British Columbia's provincial injury prevention priority areas: falls among seniors, transport injury, and youth suicide.

Methods: Mortality data (2009 to 2013) from Vital Statistics and dissemination area or local health area level socioeconomic data from CensusPlus 2011 were linked to examine five-year age-standardized mortality rates (ASMRs) and disparities in ASMRs of unintentional injuries and subtypes including falls among seniors (aged 65+) and transport-related injuries as well as the intentional injury type of youth suicide (aged 15 to 24). Disparities by sex and geography were examined, and relative and absolute disparities were calculated between the least and most privileged areas based on income, education, employment, material deprivation, and social deprivation quintiles.

Results: Our study highlighted significant sex differences in the mortality burden of falls among seniors, transport injury, and youth suicide with males experiencing significantly higher mortality rates. Notable geographic variations in overall unintentional injury ASMR were also observed across the province. In general, people living in areas with lower income and higher levels of material deprivation had increasingly higher mortality rates compared to their counterparts living in more privileged areas.

Conclusion: The significant differences in unintentional and intentional injury-related mortality outcomes between the sexes and by SES present opportunities for targeted prevention strategies that address the disparities.

Keywords: *socioeconomic status, health outcome disparities, unintentional injuries, youth suicide and self-harm, mortality*

Highlights

- Mortality due to unintentional injuries and youth suicide continue to rank among the leading causes of death among British Columbians.
- In BC, males and those living in areas with lower income experience significantly higher mortality burden due to youth suicide, unintentional injuries from falls among seniors and transport incidents.
- Disparities in unintentional and intentional injury-related mortality outcomes between the sexes and by socioeconomic status could provide evidence for targeted injury prevention strategies to narrow the gap and increase overall population-level health outcome.

Introduction

The association of health outcomes with socioeconomic status (SES) has been widely documented.[1-3] In particular, international as well as Canadian literature is accumulating a growing body of evidence that both all-cause mortality and mortality for specific causes of death are higher among people of lower SES, using individual-level socioeconomic data[4-10] and small area-based socioeconomic data with or without controlling for individual SES.[4,7,10-18] This evidence suggests that in addition to individual level factors, contextual factors that operate at the aggregate level may contribute independently to population-level disparities in mortality through socioeconomic mechanisms linked to the availability and accessibility of health services and healthy choices, as well as levels of stress and social support.[19-21] Understanding the impact of these factors on population-level health

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outcomes, such as all-cause and cause-specific mortality, could provide important evidence supporting the development and implementation of public health promotion and disease prevention programs.

In Canada, unintentional injuries and intentional self-harm ranked the 5th and 9th leading causes of death in 2015, respectively.[22] British Columbia (BC) is the third most populous province in the country with a population of more than 4.6 million. In BC, unintentional injuries and intentional self-harm claimed a combined total of 1718 lives in 2015, among which one in three were under 44 years of age at the time of death.[23]

In 2017, the BC Injury Prevention Committee identified three provincial injury prevention priorities: seniors falls, transport-related injuries (young drivers, pedestrians, cyclists, and motor vehicle occupants), as well as youth suicide and self-harm.[24] This paper aims to support provincial evidence-informed planning and programming efforts by focusing on these priority injury causes and conduct descriptive analyses to quantify the demographic, geographic, and socioeconomic disparities of injury mortalities.

Methods

Ethics

Ethics approval for this project was granted by the University of British Columbia and Children's and Women's Research Ethics Board, Vancouver, BC. Ethics certificate number: H16-01758.

Data sources

BC Mortality data for the period January 1, 2009 to December 31, 2013 were extracted from Vital Statistics (VS) for this analysis. Everyone's 6-digit residential postal code was translated into a unique Census dissemination area (DA) and local health area (LHA). Postal codes were translated into DAs through the Postal Code Conversion File (PCCF, 2016), a digital file that provides correspondence between the Canada Post Corporation (CPC) 6-digit postal codes and Statistics Canada's standard geographic areas for which census data are created.[25] A DA is a small and standard Canadian census geographic unit with a population of 400 to 700 people, and Canada is divided into an estimated 54 000 DAs[26] including over 7000 in BC. Postal codes not matched through the PCCF were matched through Geocoding Self Services provided by the BC Ministry of Health, which was also used to assign each death record to one of 89 LHAs in BC. Population sizes based on 2011 Census data were extracted from BC Stats at LHA and DA levels[27] and used as average denominator populations for calculating rates.

Outcome classification

Following the ICD-10 (International Version) code book,[28] mortality due to unintentional injury data were extracted based on underlying cause of death with the ICD-10 codes V01-V99, W00-W99, X00-X99, Y00-Y36, Y85-Y87, or Y89. Analyses of fall-related mortality among seniors were restricted to those aged 65 years and older, and analyses of young driver mortality were restricted to those between 16 and 24 years of age. Mortality due to suicide among youth data were extracted based on underlying cause of death with the ICD-10 codes X60-X84 or Y870. Analyses of suicide were restricted to those between 15 and 24 years of age, based on VS reported age. These age groups reflect the provincial injury prevention priorities defined by BC Injury Prevention Committee. Table 1 contains a listing of ICD-10 codes with applicable age restrictions as used in the analyses.

Socioeconomic stratification

Using measured variables from the 2011 CensusPlus dataset, a model-based approach was used to develop the social deprivation (SD) and material deprivation (MD) indices; details on the indices can be found elsewhere.[29] In brief, at the macro-level, deprivation was represented via two overarching variables each built on three subconstructs: SD (lone parenting, living alone, and stability) and MD (employment, income and education). SD and MD indices for all DAs in BC were divided into 5 categories from most deprived (quintile 1) to least deprived (quintile 5). In addition, LHA-level scores for selected socioeconomic sub-constructs, namely income, education, and employment, were linked to VS data to examine disparities for these specific stratifications.

Rate calculations

Numerator data consisted of counts for injury-related mortality between 2009 and 2013 by 5-year age groups and aggregated at the LHA or DA level, depending on the socioeconomic stratification and as the data allowed. When calculating five-year age-standardized mortality rates (ASMRs) for each socioeconomic stratification (e.g., income), denominator data consisted of age-specific Census population within the various categories for each socioeconomic stratification, down to the DA or LHA levels. Due to the lack of actual annual population counts, the 2011 Census population was used as the denominator population for years 2009 to 2013 combined. To account for differences in the age distribution of the population across various geographic areas, crude mortality rates were directly standardized to the 2011 Canadian population, and were expressed as five-year total rates per 100 000 population. In

TABLE 1
International classification of disease (ICD-10 International Version) codes for causes of deaths from unintentional injury and intentional self-harm

Underlying cause of death (age restrictions as applicable)	ICD-10 codes
Unintentional injury overall	V01-V99, W00-W99, X00-X99, Y00-Y36, Y85-Y87, or Y89
Falls (65+)	W00-W99
Transport	V01-V99, Y850, Y859
Motor vehicle occupants	V30-V799, V870-V878, V880-V888, V890, V892, V89
Pedestrians	V01-V099
Motorcyclists	V20-V299
Cyclists	V10-V199
Young drivers (16–24)	V30-V80
Youth suicide (15–24)	X60-X84, Y870

Abbreviation: ICD, International Classification of Diseases.

addition, 95% confidence intervals (CIs) were calculated using gamma distribution function algorithm. Absolute disparities in unintentional injury and intentional self-harm related mortality were assessed by the disparity rate difference (DRD), calculated by subtracting ASMRs for the least deprived Quintile 5 from ASMRs for the most deprived Quintile 1 ($ASMR_{Q1} - ASMR_{Q5}$). Furthermore, relative disparities in unintentional injury and intentional self-harm related mortality were assessed by the disparity rate ratio (DRR), calculated by dividing ASMRs for Quintile 1 by ASMRs for Quintile 5 ($ASMR_{Q1}/ASMR_{Q5}$). Corresponding 95% CIs were calculated. Further information on DRD and DRR including CI calculations have been detailed previously.[30] DRR CIs that did not overlap with 1 and DRD CIs that did not overlap with 0 were considered significant. Mortality rates based on death counts below 16 were not shown in tables and figures due to poor statistical reliability.[31,32] All statistical analyses were conducted using SAS 9.4.[33]

Results

Unintentional injuries

Between 2009 and 2013, there were a total of 10 444 unintentional injury deaths in BC, of which 64.7% were among males (Table 2). The ASMR for unintentional injuries among the BC population during this period was 230.2 (95% CI: 225.8–234.6) per 100 000 population. For females, death due to falls among seniors (age 65+) was one of the major specific causes of unintentional injury-related mortality, accounting for 1544 (41.9%) of the total 3684 deaths. Of the 6760 unintentional injuries among males, falls among seniors (65+) and transport incidents were the major causes, leading to 1136 (16.8%) and 1226 (18.1%) deaths, respectively (Table 2). When comparing sexes, ASMR was significantly higher among males for overall unintentional injury at 321.9 (95% CI: 314.3–329.6) per 100 000 population, compared to 145.5 (95% CI: 140.8–150.2) per 100 000 population among females. Males also had significantly higher ASMR compared to females for all the specific types of unintentional injuries examined, namely falls among seniors (age 65+) and transport incidents including those involving motor vehicle occupants, pedestrians, motorcyclists, cyclists, and young drivers aged 16 to 24.

Figure 1 illustrates age-specific mortality rates for all unintentional injuries for the overall population of BC during 2009 to 2013. Mortality rate was low before 15 years of age and peaked for those aged 85 years and over for both males and females. Unintentional injury-related crude mortality was relatively stable between age groups 20 to 74. At age 75 and over, as age increased, there was a corresponding increase in trend for the overall unintentional injury-related mortality rate. While males had a consistently higher mortality rate due to all unintentional injury causes at every age category, the ratio gap in mortality rates between males and females was most pronounced for age groups 25 to 29, 35 to 39 and 45 to 49.

Overall unintentional injury-related mortality is not evenly distributed among LHAs in BC, ranging from 117.0 (95% CI: 101.4–132.6) per 100 000 population in Richmond LHA in the Lower Mainland to 649.1 (95% CI: 389.4–908.9) per 100 000 population Upper Skeena LHA in Northwest BC (Figure 2). In general, ASMR for overall unintentional injuries in both sexes was lowest in the Lower Mainland area surrounding Metro Vancouver and in southern Vancouver Island area surrounding Victoria, and higher in other parts of the province including several LHAs in southern Fraser Valley (Figure 2).

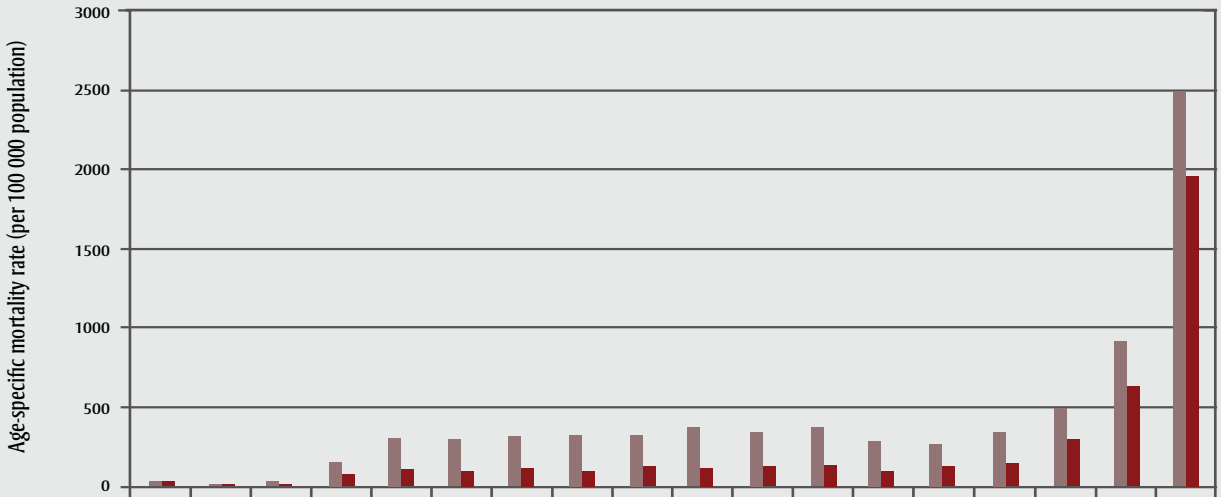
Overall unintentional injury-related mortality showed a clear stepped gradient by income, education, material and social deprivation, with higher mortality rates for people living in areas of lower income, lower education, and higher MD and SD. The DRR between the rate among British Columbians living in areas with the lowest quintiles and that among those living in areas with the highest quintiles of income, education, MD and SD were 4.9 (95% CI: 4.6–5.2), 3.2 (95% CI: 2.9–3.5), 1.8 (95% CI: 1.7–1.9), and 2.0 (95% CI: 1.9–2.1), respectively (Table 3). Percentage excess showed that if the whole population had experienced the ASMR of those living in areas with the highest quintiles of income, education, MD or SD, the ASMR for deaths due to unintentional injuries would have been 20.0%, 21.5%, 16.5%, or 28.0% lower, respectively, representing 46, 50, 38, or 64 fewer deaths per 100 000 population (Table 3). Overall unintentional injury-related mortality did

TABLE 2
Five-year age-standardized mortality rates per 100 000 population for deaths from overall and selected causes of unintentional injury and youth suicide in BC, total and by sex, 2009 to 2013

Cause of death	Total			Males			Females		
	Deaths[a] (n)	ASMR	(95% CI)	Deaths (n)	ASMR	(95% CI)	Deaths (n)	ASMR	(95% CI)
Unintentional injury overall	10 445	230.2	(225.8–234.6)	6 760	321.9	(314.3–329.6)	3 684	145.5	(140.8–150.2)
Falls (65+)	2 680	56.5	(54.4–58.7)	1 136	61.6	(58.0–65.2)	1 544	53.1	(50.4–55.7)
Transport	1 731	38.8	(36.9–40.6)	1 226	57.0	(53.8–60.2)	505	21.8	(19.9–23.7)
Motor vehicle occupants	912	20.5	(19.2–21.8)	592	27.6	(25.4–29.8)	320	13.8	(12.3–15.4)
Pedestrians	298	6.6	(5.9–7.4)	174	8.3	(7.0–9.5)	124	5.2	(4.3–6.2)
Motorcyclists	153	3.4	(2.9–3.9)	S			S		
Cyclists	68	1.5	(1.2–1.9)	S			S		
Young drivers (16–24)	103	2.4	(2.0–2.9)	72	3.3	(2.5–4.1)	31	1.5	(1.0–2.0)
Youth suicide (15–24)	257	6.0	(5.3–6.8)	180	8.3	(7.1–9.5)	77	3.7	(2.9–4.5)

Abbreviations: ASMR, five-year age-standardized mortality rate; BC, British Columbia; CI, confidence interval; S, suppressed to avoid reporting or deduction of small death counts.
[a] Excludes unintentional injury-related deaths not categorized under falls among seniors, transport, or youth suicide. However, total death counts include deaths with a missing or unknown gender.

FIGURE 1
Five-year age-specific mortality rate per 100 000 population for deaths from overall unintentional injury in British Columbia, by sex, 2009 to 2013



	0–4	5–9	10–14	15–19	20–24	25–29	30–34	35–39	40–44	45–49	50–54	55–59	60–64	65–69	70–74	75–79	80–84	85+
Males	28.6	11.6	26.1	152.5	308.5	299.7	309.9	327.0	322.3	367.6	346.4	367.7	286.0	265.0	345.2	495.7	917.1	2494.6
Females	25.1	5.6	12.9	71.9	101.1	91.5	110.8	99.0	122.0	111.1	127.6	129.6	99.1	122.3	146.4	290.6	629.2	1961.3
Male to female ratio	1.1	2.1	2.0	2.1	3.1	3.3	2.8	3.3	2.6	3.3	2.7	2.8	2.9	2.2	2.4	1.7	1.5	1.3

Age groups (years)

not follow a clear stepped pattern with respect to area-based employment measure, although for all stratifications examined, DRD and DRR were significant when comparing the least to the most privileged quintiles (Table 3).

Similar patterns were observed for unintentional injury-related mortality due to falls among seniors, with the exception of absence of a clear pattern for SD. Our analyses showed a stepped gradient by levels of income, education, and MD with higher mortality rates for people living in areas with lower income, lower education, and higher MD. The DRR between the rate among British Columbians living in areas with the lowest quintiles and that among those living in areas with the highest quintiles of income, education, and MD were 1.8 (95% CI: 1.5–2.2), 1.9 (95% CI: 1.6–2.3), and 1.2 (95% CI: 1.1–1.4), respectively (Table 3). Percentage excess showed that if the whole population had experienced the ASMR of those living in areas with the highest quintiles of income, education, or MD in BC, the ASMR for deaths due to falls among seniors would have been 10.4%, 10.6%, or 5.5% lower, respectively (Table 3). Similar to overall unintentional injury, deaths due to falls among seniors did not follow a clear stepped pattern with respect to area-based employment or social deprivation measure. DRDs and DRRs were significant comparing the least to most privileged quintiles for all stratifications examined (Table 3).

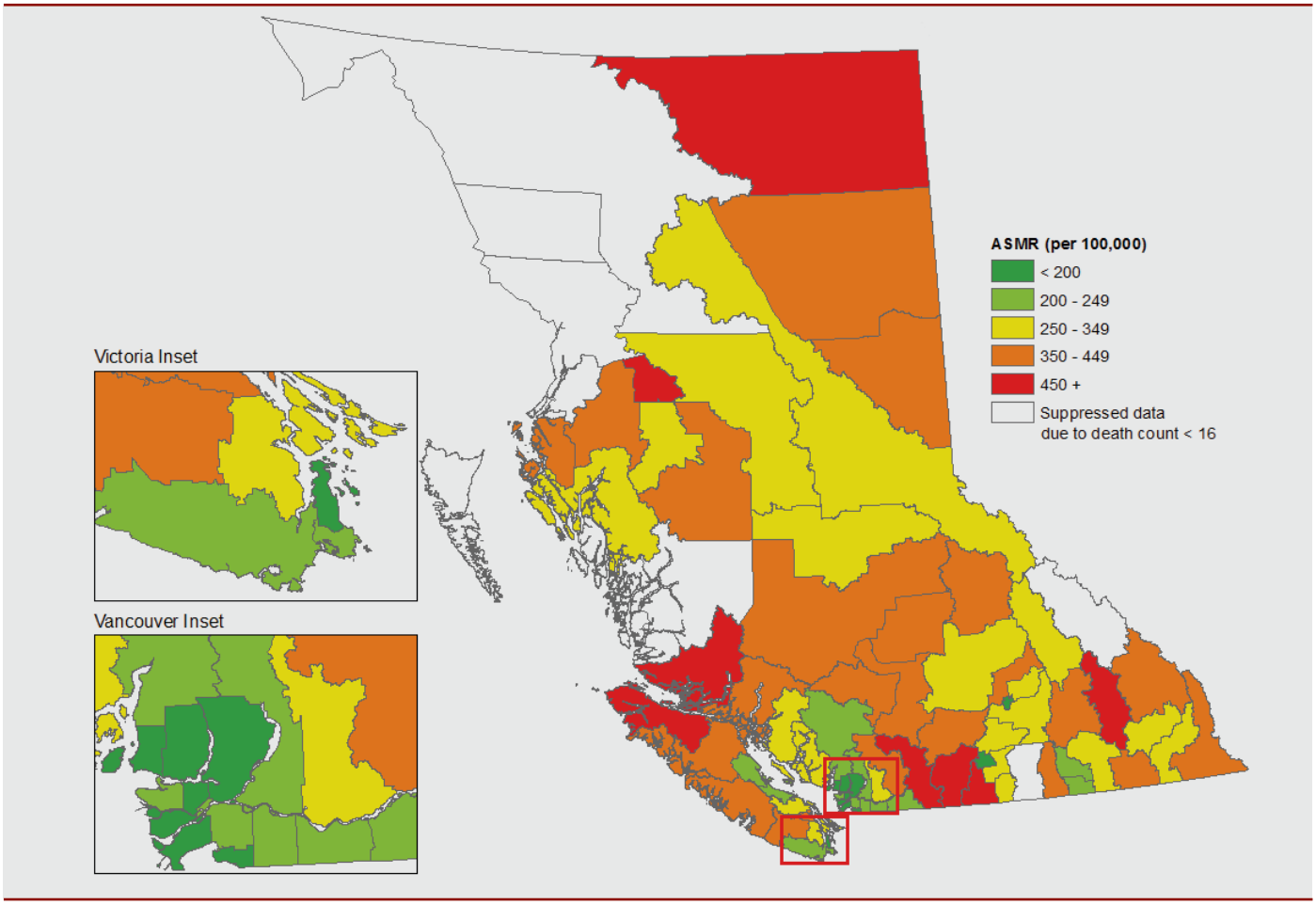
For unintentional injuries due to causes related to transport, a stepped gradient was observed for levels of income and MD with higher mortality rates for people living in areas with lower income and increased deprivation in terms of MD. The DRR between the rate among British Columbians living in areas with the lowest quintiles and that among those living in areas with the highest quintiles of income and MD were 3.4 (95% CI: 2.8–4.1) and 2.4 (95% CI: 2.0–2.8), respectively (Table 3). Percentage excess showed that if the whole population had experienced the ASMR of those living in areas with the highest quintiles of income or MD in BC, the ASMR for deaths due to transport would have been 28.9% or 34.8% lower, respectively (Table 3). While ASMR for deaths due to causes related to transport did not follow a clear stepped pattern with respect to area-based education, employment, or social deprivation measures, DRDs and DRRs were significant comparing the most to least privileged quintiles for all stratifications examined (Table 3).

Youth suicide

Between 2009 and 2013, suicide claimed 257 lives among BC youth 15 to 24 years of age (Table 2). The ASMR for youth suicide in BC during this period was 6.0 (95% CI: 5.3–6.8) per 100 000 population for both sexes combined and significantly higher for males at 8.3 (95% CI: 7.1–9.5) per 100 000 population compared to 3.7 (95% CI: 2.9–4.5) per 100 000 population for females (Table 2).

Between 2009 and 2013 in BC, both females and males between 20 to 24 years of age experienced higher suicide rates when compared to 15- to 19-year-olds, although the difference in age-specific mortality rate was more pronounced for males between 20 and 24 years of age at 79.4 per 100 000 population, compared with 47.3 per 100 000 population for age groups 15 to 19 years. Males had twice the

FIGURE 2
Five-year age-standardized mortality rate per 100 000 population for deaths from overall unintentional injury based on residential local health areas in BC, both sexes, 2009 to 2013



Data source: Statistics Canada. Vital statistics. Map prepared by BC Centre for Disease Control, Provincial Health Services Authority.
Abbreviations: ASMR, five-year age-standardized mortality rate; BC, British Columbia.

age-specific mortality rate from suicide as compared to females, in both age groups (Figure 3).

ASMR for youth suicide also showed a stepped gradient by the measured SES stratifications. The DRR between the rate among British Columbians living in areas with the lowest quintiles and that among those living in areas with the highest quintiles of income, education, and employment were 3.0 (95% CI: 1.7–5.2), 3.6 (95% CI: 2.2–6.0), and 5.3 (95% CI: 3.0–9.4), respectively (Table 4). Percentage excess showed that if the whole population had experienced the ASMR of those living in areas with the highest quintiles of income, education, or employment in BC, the ASMR for deaths due to youth suicide would have been 18.3%, 26.7%, or 20.0% lower, respectively. Youth suicide-related mortality did not follow discernible pattern with respect to MD and appeared to show an N-shaped pattern with respect to SD, whereas compared to people who live in areas of either highest or lowest social deprivation quintiles, those living in areas with moderate social deprivation had higher ASMR due to suicide (Table 4). Comparing the least to most privileged quintiles, DRDs and DRRs were significant for income, education, and employment but were not significant for MD and SD (Table 4).

Discussion

An equity lens was applied to a quantitative analysis of the mortality burden of the three BC provincial injury prevention priority areas: falls among seniors, transport injury, and youth suicide. Our study highlights significant sex differences, with males experiencing significantly higher mortality rates for examined causes. In addition, notable geographic variations were observed throughout the province. overall, people living in areas with lower income and higher levels of material deprivation had significantly higher mortality compared to their counterparts living in more privileged areas.

This analysis confirmed findings from other Canadian studies that males experience significant, 2- to 3-fold higher rates of mortality due to overall and specific causes of unintentional injury compared to females.[9,23] This analysis also suggests an important link between mortality and socioeconomic characteristics including income, education, employment, and material deprivation, being broadly consistent with prior research in Canada and internationally based on populations with diverse demographic characteristics.[4,9,11,18]

We observed significantly higher ASMRs due to falls among seniors for those with

TABLE 3
Five-year age-standardized mortality rates per 100 000 population for deaths from overall and selected causes of unintentional injury in BC by area-based socioeconomic characteristics, both sexes, 2009 to 2013

	Unintentional injury overall			Senior Falls (65+)			Transport		
	Deaths (n)	ASMR	(95% CI)	Deaths (n)	ASMR	(95% CI)	Deaths (n)	ASMR	(95% CI)
Total	10 445	230.0	(225.8–234.6)	2 680	56.5	(54.4–58.7)	1731	38.8	(36.9–40.6)
Income									
Quintile 1 – lowest	1 179	903.2	(851.6–954.7)	122	93.2	(76.7–109.7)	124	94.4	(77.8–111.0)
Quintile 2	1 272	373.2	(352.7–393.7)	270	70.8	(62.3–79.2)	248	76.1	(66.6–85.6)
Quintile 3	1 717	282.8	(269.4–296.2)	492	67.4	(61.5–73.4)	285	49.4	(43.6–55.1)
Quintile 4	3 163	252.6	(243.8–261.4)	864	63.5	(59.3–67.7)	541	44.4	(40.7–48.1)
Quintile 5 – highest	3 522	183.9	(177.8–189.9)	932	50.6	(47.7–53.9)	533	27.6	(25.3–29.9)
Disparity rate difference (Q1 − Q5)		719.3	(667.4–771.2)		42.6	(25.7–59.5)		66.8	(50.0–83.6)
Disparity rate ratio (Q1/Q5)		4.9	(4.6–5.2)		1.8	(1.5–2.2)		3.4	(2.8–4.1)
Excess (Total − Q5)		46.1			5.9			11.2	
Excess % (Total − Q5)/Total		20.0			10.4			28.9	
Education									
Quintile 1 – lowest	677	572.1	(529.0–615.2)	104	94.3	(76.1–112.4)	200	167.7	(144.4–190.9)
Quintile 2	1 236	404.7	(382.1–427.3)	278	84.5	(74.6–94.4)	260	86.7	(76.1–97.2)
Quintile 3	1 954	310.3	(296.6–324.1)	483	71.9	(65.5–78.3)	411	66.2	(59.8–72.5)
Quintile 4	2 761	255.9	(246.3–265.4)	685	63.5	(58.7–68.3)	385	35.6	(32.1–39.2)
Quintile 5 – highest	3 817	180.5	(174.8–186.2)	1 130	50.5	(47.6–53.5)	1232	55.5	(52.4–58.6)
Disparity rate difference (Q1 − Q5)		391.6	(348.1–435.1)		43.8	(25.4–62.2)		112.2	(88.8–135.6)
Disparity rate ratio (Q1/Q5)		3.2	(2.9–3.5)		1.9	(1.6–2.3)		3.0	(2.6–3.5)
Excess (Total − Q5)		49.5			6.0			−16.7	
Excess % (Total − Q5)/Total		21.5			10.6			−43.0	
Employment									
Quintile 1 – lowest	570	709.0	(650.8–767.2)	114	117.3	(95.8–138.9)	138	180.6	(150.5–210.8)
Quintile 2	1 094	267.0	(251.2–282.8)	254	58.4	(51.2–65.6)	221	54.3	(47.2–61.5)
Quintile 3	3 135	248.5	(239.8–257.2)	793	62.3	(58.0–66.7)	546	43.3	(39.6–46.9)
Quintile 4	2 338	284.5	(273.0–296.1)	538	63.4	(58.1–68.8)	403	49.6	(44.8–54.5)
Quintile 5 – highest	3 308	196.9	(190.2–203.7)	981	55.2	(51.7–58.7)	423	25.9	(23.5–28.4)
Disparity rate difference (Q1 − Q5)		512.1	(435.5–570.7)		62.1	(40.3–83.9)		154.7	(124.5–184.9)
Disparity rate ratio (Q1/Q5)		3.6	(3.3–3.9)		2.1	(1.7–2.5)		7.0	(5.8–8.5)
Excess (Total-Q5)		33.1			1.3			12.9	
Excess % (Total-Q5)/Total		14.4			2.3			33.2	
Material deprivation									
Quintile 1 – most deprived	2 473	352.7	(338.8–366.6)	633	66.3	(61.1–71.4)	395	59.5	(53.7–65.4)
Quintile 2	2 396	274.1	(263.1–285.1)	684	65.6	(60.7–70.5)	388	46.6	(60.7–70.5)
Quintile 3	2 158	243.0	(232.8–253.3)	559	61.2	(56.1–66.3)	390	44.4	(40.0–48.8)
Quintile 4	1 808	206.5	(197.0–216.1)	458	54.8	(49.8–59.8)	336	38.1	(34.1–42.2)
Quintile 5 – least deprived	1 607	192.1	(182.7–201.4)	346	53.4	(47.8–59.0)	222	25.3	(22.0–28.7)
Disparity rate difference (Q1 − Q5)		160.6	(143.8–177.4)		12.9	(5.3–20.5)		34.2	(27.5–40.9)
Disparity rate ratio (Q1/Q5)		1.8	(1.7–1.9)		1.2	(1.1–1.4)		2.4	(2.0–2.8)
Excess (Total − Q5)		37.9			3.1			13.5	
Excess % (Total − Q5)/Total		16.5			5.5			34.8	

Continued on the following page

TABLE 3 (continued)
Five-year age-standardized mortality rates per 100 000 population for deaths from overall and selected causes of unintentional injury in BC by area-based socioeconomic characteristics, both sexes, 2009 to 2013

	Unintentional injury overall			Senior Falls (65+)			Transport		
	Deaths (n)	ASMR	(95% CI)	Deaths (n)	ASMR	(95% CI)	Deaths (n)	ASMR	(95% CI)
Social deprivation									
Quintile 1 – most deprived	3 147	323.3	(312.0–334.6)	809	64.8	(60.3–69.3)	371	40.9	(36.7–45.0)
Quintile 2	2 539	299.8	(288.2–311.5)	752	71.7	(66.5–76.8)	453	57.2	(51.9–62.5)
Quintile 3	1 937	245.7	(234.7–256.6)	479	58.9	(53.6 –64.1)	363	46.5	(41.8–51.3)
Quintile 4	1 550	202.8	(192.7–212.9)	354	53.4	(47.9 –59.0)	304	38.1	(33.8–42.4)
Quintile 5 – least deprived	1 269	165.6	(156.5–174.7)	286	48.2	(42.6–53.7)	240	29.0	(25.3–32.7)
Disparity rate difference (Q1 − Q5)		157.7	(143.2–172.2)		16.6	(9.4–23.8)		11.9	(6.4–17.4)
Disparity rate ratio (Q1/Q5)		2.0	(1.9–2.1)		1.3	(1.1–1.5)		1.4	(1.2–1.6)
Excess (Total − Q5)		64.4			8.3			9.8	
Excess % (Total − Q5)/Total		28.0			14.7			25.3	

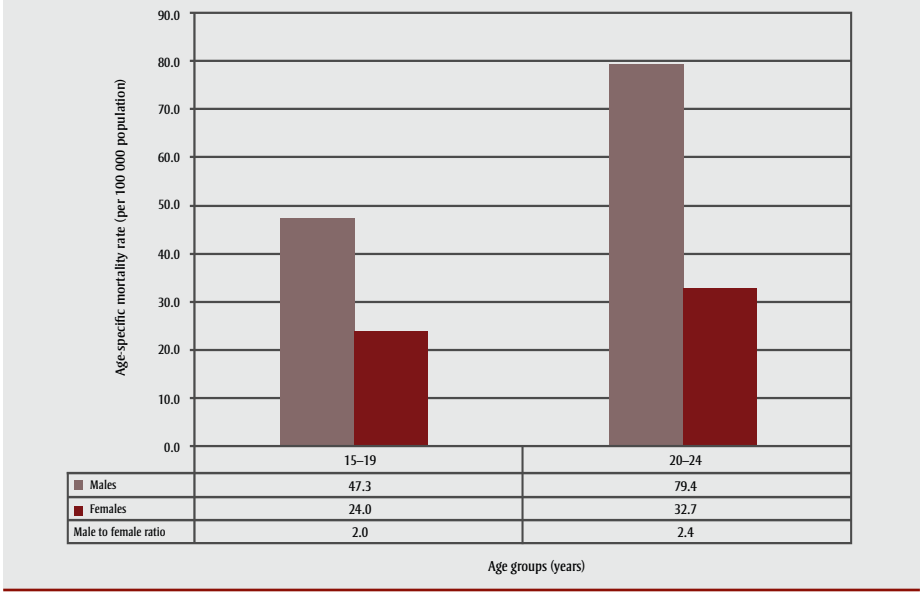
Abbreviations: ASMR, five-year age-standardized mortality rate; BC, British Columbia; CI, confidence interval; DRD, disparity rate difference; DRR, disparity rate ratio.

Notes: DRR CI: significant if CI does not overlap with 1.
DRD CI: significant if CI does not overlap with 0.

lower socioeconomic status as measured by living in areas of lower income and employment rate. Another study using population data for Canadians living in census metropolitan areas and looking at an injury group consisting largely of falls among seniors showed similar results, where mortality rates for those living in the poorest income quintile showed persistent and significant disadvantage, compared to those in the highest income group.[14] Conversely, another Canadian study found significant association between falls and income among male seniors but not females,[4] suggesting a potential sex modifier effect. Even though specific measures of employment varied slightly, other studies reported similar findings regarding the association between employment and mortality due to falls among seniors.[4,8,34]

The finding of significantly higher transport-related mortality rate among British Columbians living in areas of lower income agreed with a few studies conducted in Canada and the United States,[4,35,36] but not others.[4] In another Canadian study, it was reported that deaths specific to motor vehicle occupants showed an inverted association with area-based income.[14] Other analyses were consistent with the current study findings for transport-related injury deaths being significantly higher for those living in areas with lower socioeconomic status as measured by education and employment.[4,8,34] We demonstrated significant and step-wise lower ASMR due to transport-related incidents among British Columbians living in areas from least to most deprived of material resources, consistent with another Canadian study, although their results were only significant for males.[4]

FIGURE 3
Five-year age-specific mortality rate per 100 000 population for deaths from youth suicide in British Columbia (ages 15–24 years), by sex, 2009 to 2013



The wide geographic variations in unintentional injury ASMR as observed across the local health areas in BC was similar to another Canadian study of transport fatalities.[17] A precise public health approach that targets high-risk areas for unintentional injuries throughout the province may be valuable to consider.

The analysis of ASMR for youth suicide revealed similar patterns to those for unintentional injuries, suggesting that intent may not play a big role in observed differences by sex, area, and socioeconomic characteristics in injury-related mortality rates. Our results that demonstrated significant links between youth suicide and income, education, and employment have also been reported by other Canada-based studies.[8-10,14]

TABLE 4
Five-year age-standardized mortality rates per 100 000 population for deaths from youth suicide in BC by area-based socioeconomic characteristics, both sexes, 2009 to 2013

	Intentional self-harm		
	Deaths (n)	ASMR	(95% CI)
Total	257	6.0	(5.3–6.8)
Income			
Quintile 1 – lowest	15	14.8	(7.3–22.4)
Quintile 2	33	12.5	(8.2–16.8)
Quintile 3	50	10.0	(7.2–12.8)
Quintile 4	62	5.2	(3.9–6.5)
Quintile 5 – highest	97	4.9	(3.9–5.8)
Disparity rate difference (Q1 − Q5)		9.9	(2.3–17.5)
Disparity rate ratio (Q1/Q5)		3.0	(1.7–5.2)
Excess (Total − Q5)		1.1	
Excess % (Total − Q5)/Total		18.3	
Education			
Quintile 1 – lowest	18	16.0	(8.6–23.4)
Quintile 2	33	12.2	(8.0–16.4)
Quintile 3	50	8.2	(5.9–10.5)
Quintile 4	67	6.4	(4.9–8.0)
Quintile 5 – highest	89	4.4	(3.5–5.3)
Disparity rate difference (Q1 − Q5)		11.6	(4.2–19.0)
Disparity rate ratio (Q1/Q5)		3.6	(2.2–6.0)
Excess (Total − Q5)		1.6	
Excess % (Total − Q5)/Total		26.7	
Employment			
Quintile 1 – lowest	14	25.4	(12.1–38.8)
Quintile 2	39	10.1	(7.0–13.3)
Quintile 3	81	6.5	(5.1–7.9)
Quintile 4	49	6.3	(4.5–8.0)
Quintile 5 – highest	74	4.8	(3.7–5.9)
Disparity rate difference (Q1 − Q5)		20.6	(7.2–34.0)
Disparity rate ratio (Q1/Q5)		5.3	(3.0–9.4)
Excess (Total − Q5)		1.2	
Excess % (Total − Q5)/Total		20.0	
Material deprivation			
Quintile 1 – most deprived	46	7.2	(5.1–9.3)
Quintile 2	31	3.9	(2.5–5.3)
Quintile 3	59	6.8	(5.1–8.6)
Quintile 4	56	6.5	(4.8–8.3)
Quintile 5 – least deprived	47	5.6	(4.0–7.1)
Disparity rate difference (Q1 − Q5)		1.6	(−1.0–4.2)
Disparity rate ratio (Q1/Q5)		1.3	(0.87–2.0)
Excess (Total − Q5)		0.4	
Excess % (Total − Q5)/Total		6.7	
Social deprivation			
Quintile 1 – most deprived	54	6.6	(4.9–8.4)
Quintile 2	45	6.2	(4.4–7.9)
Quintile 3	59	8.0	(6.0–10.1)
Quintile 4	50	6.0	(4.4–7.7)
Quintile 5 – least deprived	49	5.1	(3.6–6.5)
Disparity rate difference (Q1 − Q5)		1.5	(−0.77–3.8)
Disparity rate ratio (Q1/Q5)		1.3	(0.88–1.9)
Excess (Total − Q5)		0.9	
Excess % (Total − Q5)/Total		15.0	

Abbreviations: ASMR, five-year age-standardized mortality rate; BC, British Columbia; CI, confidence interval; DRD, disparity rate difference; DRR, disparity rate ratio.

Notes: DRR CI: significant if CI does not overlap with 1.
DRD CI: significant if CI does not overlap with 0.

Strengths and limitations

This study was the first to quantify the socioeconomic and geographic disparities in mortality outcomes due to unintentional injury as well as the socioeconomic disparities related to youth suicide among British Columbians in support of program planning and policy development related to provincial injury prevention priorities. However, some data limitations should be recognized in the interpretation of the results. Geographic assignment of death records to census or health boundaries based on residential 6-digit postal codes could not differentiate between those that live at home and those that live in group homes. Our analysis is restricted to area-based socioeconomic status data and thus does not explore or account for the impact of individual-level socioeconomic status factors on injury-related mortality. Since dissemination areas and local health areas vary in geographic and population sizes as well as population characteristics, the overall socioeconomic status measures of income, education, employment as well as MD and SD represent the average socioeconomic characteristics in each dissemination area or local health area. Further, any associations observed at the provincial level might not necessarily hold true at the individual or aggregate levels including dissemination area or local health area. The ecological nature of this descriptive analytical approach and the inability to control for other potential confounders also precluded causal inferences on the association between injury-related mortality rates and social determinants of health. While the use of composite socioeconomic status measures such as the material and social deprivation indices acted to control for factors that may be potential confounders and yet highly correlated, the interplay between multiple factors may be further examined through multivariate analyse as a potential future direction for this work. This study is also limited by the use of all deaths occurring during the period from 2009 to 2013, while the 2011 Census population was used as the average denominator population for 2009 to 2013 combined, due to the lack of annual population data aggregated by age-groups and dissemination areas or local health areas. Furthermore, due to a change in BC Vital Stats Agency coding policy in 2010, there was a potential for over-estimation of falls-related deaths among seniors during the study period, 2009 to 2013. However, the change was

not expected to influence any observed correlation between mortality and socioeconomic status.

Conclusion

In conclusion, not only does mortality due to unintentional injuries—especially falls among seniors and transport incidents—continue to rank among the leading causes of death among British Columbians, there are significant differences in unintentional and intentional injury-related mortality outcomes between males and females, and by socioeconomic status. Having recognized these as provincial injury prevention priority areas,[24] there are opportunities for targeted injury prevention strategies in the province among high-risk geographic areas and segments of the population to address disparities in injury-related mortality outcomes.

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Conflicts of interest

None to declare.

Authors' contributions and statement

IP and DR were involved in design and conceptualisation of the work. MZ, LRZ, DK, FR, KT, and AZ were involved in the acquisition and/or analysis of the data. MZ and LRZ drafted the paper. All authors provided input for the interpretation of the results and revision of the paper.

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