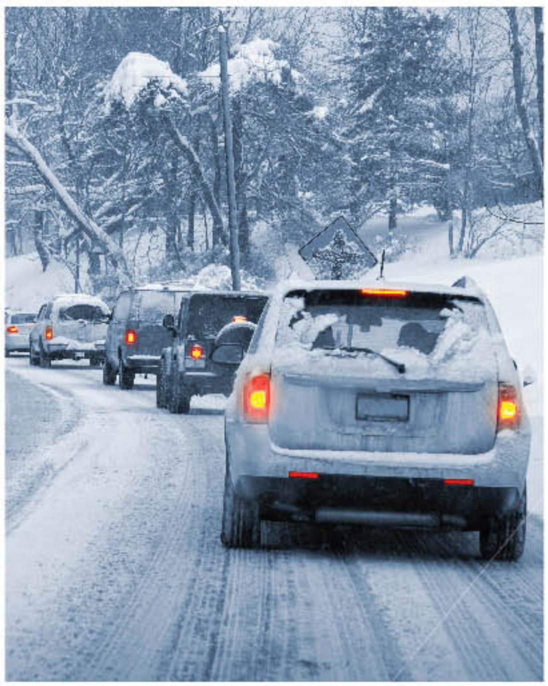
Where the Rubber Meets the Road:

Reducing the Impact of Motor Vehicle Crashes on Health and Well-being in BC



BRITISH COLUMBIA

Provincial Health Officer's Annual Report

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Office of the Provincial Health Officer
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PO Box 9648, STN PROV GOVT
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Victoria, BC
V8W 3C8
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Facsimile: (250) 952-1362

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Ministry of Health
Victoria, BC

March, 2016

The Honourable Terry Lake
Minister of Health

Sir:

I have the honour of submitting the Provincial Health Officer's Annual Report for 2011.

P.R.W. Kendall
OBC, MBBS, MHSc, FRCPC
Provincial Health Officer

Table of Contents

List of Figures and Tables

Chapter 1

Chapter 2

Chapter 3

Chapter 4

Chapter 5

Chapter 6

Chapter 7

Chapter 8

Chapter 9

Acknowledgements

This report represents a large-scale, collaborative effort that has spanned numerous years and iterations. The Provincial Health Officer (PHO) is grateful to the many analysts, researchers, writers, project managers, and experts who have contributed to, or reviewed, drafts of this report over the years. While not all content contributions can be included, the input received was vital in the development of the final report.

This report is dedicated to the work of former Deputy PHO, Dr. Eric Young. His passion and dedication to improving road safety in BC were essential to the development of this report.

2014-2016 Report Contributors and Reviewers (Alphabetical)

Numerous individuals and organizations contributed to the current iteration of this report. The PHO would like to thank Neil Arason, a technical reviewer of this report, as well as the contributions of the BC Injury Research and Prevention Unit, the Insurance Corporation of British Columbia, the BC Coroners Service, regional health authorities, the First Nations Health Authority, and the ministries of Justice, Public Safety and Solicitor General, and Transportation and Infrastructure.

The PHO would like to thank the following individuals for their contributions and assistance to the PHO team during the last two years of report development:

Dr. Sandra Allison
Chief Medical Health Officer
Northern Health Authority

Debbie Andersen
Director, Seniors Health Promotion Directorate
BC Ministry of Health

Neil Arason
Manager
BC Road Safety Strategies
BC Ministry of Public Safety and Solicitor General

Dr. Charl Badenhorst
Medical Health Officer
Northern Health Authority

Denis Boucher
Officer in Charge
E-Division, Traffic Services
Royal Canadian Mounted Police

Dr. Jeff Brubacher
Associate Professor
Department of Emergency Medicine
University of British Columbia

Dr. John Carsley
Medical Health Officer
Vancouver Coastal Health

Dr. Herbert Chan
Researcher
Department of Emergency Medicine
University of British Columbia

Dr. Ronald Chapman
Medical Health Officer
Northern Health Authority

The City of Richmond
Richmond, BC

Dr. Trevor Corneil
Senior Medical Health Officer
Interior Health Authority

Dr. Patricia Daly
Chief Medical Health Officer
Vancouver Coastal Health

Dr. Meenakshi Dawar
Medical Health Officer
Vancouver Coastal Health

Dr. Raina Fumerton
Medical Health Officer
Northern Health Authority

Dr. Kamran Golmohammadi
Medical Health Officer
Interior Health Authority

Dr. Réka Gustafson
Medical Health Officer
Vancouver Coastal Health

James Haggerstone
Manager of Health Information Analysis
Northern Health Authority

Dr. Althea Hayden
Medical Health Officer
Vancouver Coastal Health

Matt Herman
Executive Director
Healthy Living and Health Promotion
Population and Public Health
BC Ministry of Health

Clint Kuzio
(former) Director
Aboriginal Health Directorate
BC Ministry of Health

Lisa Lapointe
Chief Coroner
BC Coroners Service
BC Ministry of Public Safety and Solicitor General

Dr. Andrew Larder
Medical Health Officer
Fraser Health Authority

Dr. Victoria Lee
Chief Medical Health Officer
Fraser Health Authority

Dr. Marcus Lem
Medical Health Officer
Fraser Health Authority

Dr. Gord Lovegrove
Associate Professor
Faculty of Applied Science, School of Engineering
University of British Columbia Okanagan

Dr. James Lu
Medical Health Officer
Vancouver Coastal Health

Dr. Mark Lysyshyn
Medical Health Officer
Vancouver Coastal Health

Sam MacLeod
Superintendent of Motor Vehicles
RoadSafety BC
BC Ministry of Public Safety and Solicitor General

Dr. Paul Martiquet
Medical Health Officer
Vancouver Coastal Health

Richard Mercer
Research Officer
Office of the Provincial Health Officer
BC Ministry of Health

Megan Misovic
(former) Project Director
Aboriginal Health Directorate
BC Ministry of Health

Dr. Lisa Mu
Medical Health Officer
Fraser Health Authority

Dr. Michelle Murti
Medical Health Officer
Fraser Health Authority

Tara Nault
Director, Aboriginal Health
Rural, Remote and Aboriginal Health
BC Ministry of Health

Ken Ohrn
Photographer
Cypress Digital

Dr. Shovita Padhi
Medical Health Officer
Fraser Health Authority

Mike Pennock
Population Health Epidemiologist
Office of the Provincial Health Officer
BC Ministry of Health

Kathleen Perkin
Manager, Harm Reduction Policy
Population and Public Health
BC Ministry of Health

Dr. Ian Pike
Director
BC Injury Research and Prevention Unit
Child and Family Research Institute

Dr. Sue Pollock
Medical Health Officer
Interior Health Authority

Fahra Rajabali
Researcher and Data Analyst
BC Injury Research and Prevention Unit
Child and Family Research Institute

Kim Reimer
Economist
Office of the Provincial Health Officer
BC Ministry of Health

Tej Sidhu
Manager, Policy, Research and Systems
BC Coroners Service
BC Ministry of Public Safety and Solicitor General

Will Speechley
Research Officer
BC Coroners Service
BC Ministry of Public Safety and Solicitor General

Dr. Richard Stanwick
Chief Medical Health Officer
Vancouver Island Health Authority

Jan Staples
Director, Road Safety Unit
Police Services Division
BC Ministry of Public Safety and Solicitor General

Dr. Helena Swinkels
Medical Health Officer
Fraser Health Authority

Dr. Kay Teschke
Professor
School of Population and Public Health
University of British Columbia

Dr. Gerald Thomas
Director, Alcohol and Gambling Policy
Population and Public Health
BC Ministry of Health

Shannon Tucker
Program Manager, Road Safety Unit
Police Services Division
BC Ministry of Public Safety and Solicitor General

Dr. Kenneth Tupper
Director, Problematic Substance Use Prevention
Population and Public Health
BC Ministry of Health

Past Report Contributors (Alphabetical)

Many individuals and organizations contributed to the inception and initial work on this report, and/or to previous drafts and related draft recommendations. While these people have not had a chance to review the report in its current iteration, prior to publication, the PHO acknowledges the work of these dedicated individuals and would like to thank them for their contributions.

Every attempt has been made to provide a comprehensive list of the numerous individuals and organizations* who have contributed to this report over the years, but the PHO wishes to apologize in advance for any who have been missed.

The PHO would like to thank the following individuals for their contributions and assistance to the development of this report:

Marc Alexander
Royal Canadian Mounted Police

Mary Anne Arcand
Central Interior Logging Association RoadHealth, Northern Health Initiatives

Dr. Gillian Arsenault
Fraser Health Authority

Dr. Najib Ayas
Vancouver Coastal Health

Dr. Shelina Babul
BC Injury Research and Prevention Unit

Dr. Peter Barss
Interior Health Authority

Kevin Begg
BC Ministry of Public Safety and Solicitor General

Dr. Nathaniel Bell
Trauma Services BC

Kevin Bennett
WorkSafeBC

Hilary Blackett
Interior Health Authority

Tyann Blewett
RoadSafety BC

Dr. David Bowering
Northern Health Authority

Dr. Elizabeth Brodkin
Fraser Health Authority

Dr. Ross Brown
Provincial Health Service Authority

Dr. Beth Bruce
(contracted by) BC Injury Research and Prevention Unit

Glenyth Caragata
Insurance Corporation of BC

Barbara Carver
BC Ministry of Health

Dr. Ronald Chapman
Northern Health Authority

Charmaine Chin
Preventable.ca

Aline Chouinard
Transport Canada

Mary Chu
BC Ministry of Health

Denise DePape
BC Ministry of Health

Dr. Ediriweera Desapriya
BC Injury Research and Prevention Unit

* This information reflects affiliation at the time of contribution, which may not be the same as an individual's current organization.

Mike Diak
Royal Canadian Mounted Police

Teresa Dobmeier
Interior Health Authority

Dr. Naomi Dove
First Nations and Inuit Health Branch
Health Canada

David Dunne
Insight Driving Solutions

Ted Emanuels
Royal Canadian Mounted Police

Denise Foucher
Northern Health Authority

Dr. Murray Fyfe
Vancouver Island Health Authority

Joe Gallagher
First Nations Health Council

Norm Gaumont
Royal Canadian Mounted Police

Jamie Graham
Victoria Police Department

Jim Gross
Highway Safety Roundtable

Nial Helgason
Interior Health Authority

Karen Horn
Safe Start, BC Children's Hospital

Nicolas Jimenez
Insurance Corporation of BC

Mavis Johnson
Canadian Traffic Safety Institute

Catherine Jones
Provincial Health Service Authority

Magda Kapp
BrainTrust Canada Association

Miranda Kelly
First Nations Health Authority

Debra Kent
Drug and Poison Information Centre

Eric Kowalski
Interior Health Authority

Dr. Cecile Lacombe
RoadSafety BC

Nasira Lakha
Trauma Services BC

Allan Lamb
BCAA Traffic Safety Foundation

Pierre Lemaitre
Royal Canadian Mounted Police

Eve Lenkevitch
BC Ministry of Public Safety and Solicitor General

Nancy Letkeman
RoadSafety BC

Steve Martin
RoadSafety BC

Alyson McKendrick
Safe Start, BC Children's Hospital

Jeff Moffett
Contractor

Pamela Morrison
First Nations Health Authority

Glen Nicholson
Advocate – Electronic Stability Control

Mark Ordeman
WorkSafeBC

Dr. Shaun Peck
Public Health Consultant

Dr. Roy Purssell
BC Medical Association

Doug Rankmore
Brain Trust Canada

Dan Riest
Centre for Addictions Research BC

Melanie Rivers
First Nations Health Authority

Dr. Diane Rothon
BC Coroners Service

Manik Saini
BC Ministry of Health

Jat Sandhu
Vancouver Coastal Health Authority

Amy Schneeberg
(contracted by) BC Injury Research and Prevention Unit

Giulia Scime
BC Injury Research and Prevention Unit

Samantha Scott
RoadSafety BC

Sonny Senghera
Insurance Corporation of BC

Joy Sengupta
BC Ministry of Transportation and Infrastructure

Sukhy Sidhu
BC Ministry of Health

Leonard Sielecki
BC Ministry of Transportation and Infrastructure

Joelle Siemens
RoadSafety BC

Gurjeet Sivia
Fraser Health Authority

Dorry Smith
BC Injury Research and Prevention Unit

Meridith Sones
BC Coroners Service

Shannon Stone
First Nations Health Authority

Dana Tadla
RoadSafety BC

Pierre Thiffault
Canadian Council of Motor Traffic Administrators

Kyle Todoruk
BC Ministry of Health

Kate Turcotte
BC Injury Research and Prevention Unit

Janis Urquhart
Vancouver Island Health Authority

Lori Wagar
BC Ministry of Healthy Living and Sport

Dr. Shannon Waters
First Nations and Inuit Health Branch
Health Canada

Dr. Veerle Willaeys
First Nations and Inuit Health Branch
Health Canada

Dori Williams
Trauma Services BC

Jean Wilson
Insurance Corporation of BC

Frank Wright
Capital Reional District Integrated Road Safety Unit

Louise Yako
BC Trucking Association

PHO Report Team

The Provincial Health Officer would like to thank the following PHO team members (past and present) for their work on this report:

Adrienne Bonfonti – *Project Manager*
Manager, Project Research Reporting Initiatives
Office of the Provincial Health Officer
BC Ministry of Health

Robin Yates
(former) Project Manager, Injury Prevention Analyst
Population and Public Health
BC Ministry of Health

Sophia Baker-French – *Research and editing*
Manager, Projects and Strategic Initiatives
Office of the Provincial Health Officer
BC Ministry of Health

Leanne Davies – *Research and editing*
(former) Manager, Projects and Strategic Initiatives
Office of the Provincial Health Officer
BC Ministry of Health

Adrienne Munro – *Research and editing*
(former) Manager, Projects and Strategic Initiatives
Office of the Provincial Health Officer
BC Ministry of Health

Stacy White – *Research and editing*
Health Promotion Policy Analyst
Healthy Living Branch
BC Ministry of Health

Wendy Vander Kuyl – *Data analysis*
Research Assistant
Office of the Provincial Health Officer
BC Ministry of Health

Barb Callander – *Copy editing and referencing*
Manager, Projects and Strategic Initiatives
Population and Public Health
BC Ministry of Health

Tim Anderson – *Graphic design*
Alphabet Communications Ltd.
Vancouver, BC

Dr. Bonnie Henry
Deputy Provincial Health Officer
Office of the Provincial Health Officer
BC Ministry of Health

Dr. Evan Adams
(former) Deputy Provincial Health Officer for Aboriginal Health
Office of the Provincial Health Officer
BC Ministry of Health

Dr. Eric Young
(former) Deputy Provincial Health Officer
Office of the Provincial Health Officer
BC Ministry of Health

Highlights

This report explores road safety in BC using a comprehensive safe system framework that includes the pillars of a Safe System Approach (SSA)—safe road users, safe speeds, safe roadways, and safe vehicles—in combination with a population health approach and a public health approach. The report explores each of the four pillars of the SSA, including technologies and strategies for improving road safety related to road user behaviours and conditions, speed limits, vehicle technologies, and roadway design and infrastructure. The report aims to support and advance the health of the BC population as a whole, while examining sub-populations that face a greater burden of motor vehicle crash (MVC) serious injuries and fatalities. Analyses explore data according to road user type, age, sex, and health authority area. Analyses presented also examine road safety for Aboriginal peoples and communities. The report concludes with 28 recommendations for reducing the burden of MVCs and improving road safety in BC.

SUMMARY OF KEY FINDINGS

Road Use and MVC Fatalities in BC

- In 2012, Canada ranked 15^{th} for MVC fatalities compared to 36 international jurisdictions.
- The MVC fatality rate in BC has substantially declined over time, from 18.4 deaths per 100,000 population in 1996 to approximately one-third that rate in recent years. This success should be celebrated, as should the work of the many dedicated individuals who brought it about. However, our numbers are still high relative to other Canadian and international jurisdictions, and there are still opportunities to improve road safety in BC, particularly for vulnerable road users.
- In 2012, BC's rate for MVC fatalities (6.2 per 100,000 population) was fourth lowest and just slightly higher than the average among Canadian provinces (6.0 per 100,000). In the same year, BC's rate for MVC serious injuries (444.5 per 100,000 population) was slightly lower than the average among the provinces (475.3 per 100,000).
- Each year about 280 people are killed and another 79,000 are injured on BC's public roads.
- In 2013 there were approximately 3.3 million active driver's licences in BC, including 1,675,000 held by males and 1,619,000 by females.

MVC Trends in BC

- Among BC health authorities, proportionately more MVC fatalities occur in Northern Health and Interior Health than their respective proportions of the BC population. In 2012, Northern Health had 6.3 per cent of the population, but 13.5 per cent of MVC fatalities in BC occurred there; Interior Health had 15.9 per cent of the population but 38.8 per cent of MVC fatalities in BC.
- For 2008-2012, MVC fatality rates were 18.0 per 100,000 population in Northern Health and 16.3 per 100,000 in Interior Health—both much higher than the BC average of 6.9 per 100,000. Vancouver Coastal had the lowest rate for that period at 2.3 per 100,000.
- Analyses based on age group show that for 2002 to 2013 there were decreases in MVC fatality rates across all age groups, but those aged 16-25 and 76 and up continue to have the highest MVC fatality rates per 100,000 population. Similarly, those two age groups had the highest MVC serious injury rates per 100,000 from 2002 to 2011.
- Age-standardized MVC fatality rates for males and females in BC for 1996 to 2013 show that the rate for males was more than double the rate for females for the majority of years, although a greater decline in the rate for males has narrowed the gap somewhat in recent years.
- The top human contributing factors for MVCs with fatalities that were reported by police in BC between 2008 and 2012 were speed, impairment, and distraction. In 2012, speed was the top factor, associated with 35.7 per cent of MVC fatalities, followed by distraction (28.6 per cent of MVC fatalities), and impairment (20.4 per cent of MVC fatalities).

MVC Fatalities and Serious Injuries among Vehicle Drivers and Passengers

- As one would expect, drivers represent the largest number of MVC fatalities and serious injuries. While the MVC fatality rate for passenger vehicle drivers improved from 2009 to 2013—decreasing from 4.0 per 100,000 population to 2.7 per 100,000—this was still the highest fatality rate compared to other road user groups (passenger vehicle passengers, motorcycle occupants, cyclists, and pedestrians).
- Among the driver population of BC, males have higher fatality rates than females across all age groups.
- Drivers age 16-25 and 76 and up have the highest fatality rates for both males and females. Compared to their proportion of the BC population, these two age groups are overrepresented in MVC fatalities.
- Of all MVC fatalities that occurred in BC for 2009-2013, 19.3 per cent involved heavy vehicles (in this case defined as vehicles over 10,900 kg). In 2013, there were almost two crashes per 10 licenced heavy commercial vehicles in BC.
- Measures to reduce vehicle occupant fatality and serious injury include proper restraint use, such as child safety seats and seatbelts; a strong driver's licensing program; and increasing the safety of commercial vehicle drivers.

MVC Fatalities and Serious Injuries among Vulnerable Road Users

- Vulnerable road users (those without the protection of an enclosed vehicle) make up a substantial proportion of MVC fatalities and serious injuries in BC—a proportion that has been increasing in recent years. They accounted for 38.7 per cent of MVC serious injuries in 2007, which increased to 45.7 per cent in 2011, as well as 31.7 per cent of MVC fatalities in 2009, which increased to 34.9 per cent in 2013.
- Motorcycle occupant fatalities are disproportionately high in Interior and Northern Health, and cyclist fatalities are disproportionately high in Island and Interior Health. Pedestrian fatalities are more evenly distributed compared to health authority population.
- The number and rate of MVC serious injuries and deaths among motorcycle occupants have increased over time in BC, but have declined in recent years. The rates were much higher among males than females for all age groups analyzed. In 2011, there were 658 motorcycle-related serious injuries in BC, and in 2013 there were 29 motorcycle-related MVC fatalities.
- For cyclists, both the numbers and rates per 100,000 population of MVC-related serious injuries and deaths have increased over time. MVC fatality and serious injury rates were higher among males than females for almost all age groups. In 2011, there were 237 MVC serious injuries to cyclists, and in 2013 there were 13 MVC-related cyclist deaths in BC.
- Among pedestrians, both the numbers and rates per 100,000 population of MVC-related serious injuries and deaths have decreased over time. In 2011 there were 493 MVC serious injuries to pedestrians, and in 2013 there were 52 pedestrian MVC fatalities in BC.
- Roadway design is one of the top ways to improve the safety of vulnerable road users. Roadways should be designed to improve the clarity of all road users' travel paths and the visibility of vulnerable road users to vehicles. Policy measures can further support vulnerable road users, for example, by shifting laws and policies to favour vulnerable road users as other national and international jurisdictions have done.

Road User Distraction

- The number and rate per 100,000 population of distraction-related fatalities have been decreasing, but the proportion of MVC fatalities that are distraction-related has increased from 17.3 per cent in 2004 to 28.6 per cent in 2013.
- Despite the distracted driving legislation that came into force in January 2010 prohibiting the use of handheld devices, road user distraction is still contributing to a sizeable portion of MVC serious injuries and fatalities in BC. In 2011, distraction surpassed impairment as a contributing factor to MVC fatalities, making it the second highest contributing factor in BC (to speed).

Substance-based Road User Impairment

- The number and rate of substance-based, impairment-related MVC fatalities have fluctuated, but overall have decreased from 1996 to 2013. In fact, the rate in 2013 was just over one-third of the rate it was in 1996.
- From 1996 to 2013, the substance-based, impairment-related MVC fatality rate for males decreased from 5.8 to 2.3 per 100,000 population (a 60.3 per cent reduction), and for females decreased from 2.1 to 0.4 per 100,000 (an 81.0 per cent reduction). Across almost every age group males have at least double the impaired-related MVC fatality rate as females. The highest impaired-related fatality rates identified for both sexes are in the 16-25 age group, at 6.3 fatalities per 100,000 for males and 2.4 per 100,000 for females.
- The strongest approach to preventing and reducing substance-based road user impairment is by employing a combination of strategies, which includes increasing public education and awareness, limiting access to substances such as alcohol and illegal drugs, lowering legal blood alcohol content limits, increasing enforcement checkpoints and testing, increasing related penalties, and introducing additional measures to deter repeat offenders.

Physical- and Cognitive-based Road User Impairment

- Mental and physiological conditions can compromise a road user's ability to safely navigate the roadway, increasing the risk of MVC involvement. Detecting these forms of impairment is difficult and relies heavily upon self-awareness, self-detection, and/or feedback from a person's friends, family, and health care professionals.
- Older adults are a growing proportion of the BC population and are more likely than younger adults to be medically at risk as road users. While many older adults are skilled and experienced drivers, changes related to aging can make driving more challenging, such as slower reaction times, reduced range of motion, sensory impairments, and cognitive declines. Furthermore, age-related frailty makes older adults more susceptible to serious injuries and fatalities if they are involved in an MVC.
- In BC, some drivers are required to complete medical examinations relevant to their driving ability (e.g., those with a possible or known medical condition, commercial drivers, and drivers 80 years and older), and a few of them are then referred for further assessment. A variety of medical professionals are required to report individuals whose driving ability may be impaired by a condition, but this reporting role is currently challenging.
- Driving ability is also impaired by fatigue, and for 2008-2012 fatigue was a contributing factor in 53 MVC fatalities (3.2 per cent of all MVC fatalities during that time).
- Some road infrastructure may be effective in reducing fatigue-related MVCs: those that alert drivers when they cross a highway line (e.g., shoulder and/or centre line rumble strips) and secure highway rest areas (to encourage breaks).

Speed-related MVCs in BC

- There is an established and expanding body of research showing a clear relationship between safe speeds and road safety. This is founded on two main facts: as speed increases, reaction time decreases; and physical force increases with speed, resulting in an exponentially increasing risk of serious injury or death in an MVC.

- The human body has a limited tolerance for experiencing physical force. For example, research shows that pedestrians have a 10 per cent risk of dying when hit at 30 km/h, but an 80 per cent risk of dying when hit at 50 km/h. There are different survivable speeds for different road users. Research suggests that survivable speed limits are 30 km/hr for pedestrians and cyclists, 50 km/hr for vehicle occupants in a side-impact MVC, and 70 km/hr for vehicle occupants in a head-on MVC.
- The number and rate per 100,000 population of speed-related MVC fatalities increased in the early 2000s, but declined from 2005 to 2013. Similarly, the speed-related proportion of MVC fatalities has decreased in recent years and reached its lowest proportion since 1996 in 2013, at 29.0 per cent.
- From 1996 to 2013, among those in BC age 16 to 55, males had a consistently higher speed-related fatality rate than females—often double or triple the female rate. The highest speed-related fatality rates identified for both sexes are in the 16-25 age group, at 6.9 fatalities per 100,000 population for males and 3.5 per 100,000 for females.
- Speed limits are one key strategy to manage roadway speed, and it is important that speed limits are appropriate for road types and conditions; safe for all road users, especially vulnerable road users; and realistic so that drivers are more likely to follow them.
- Despite the concerns of numerous health, enforcement, and road safety professionals in BC, in July 2014, speed limits were increased on 1,300 kilometres of rural highways in BC, including a new maximum speed in BC of 120 km/h. In 2015, legislation was also amended to enable police to enforce the requirement of slower drivers to move into the right lane to allow drivers travelling at higher speeds to pass.
- Options for speed control mechanisms include conventional roadside ticketing; speed cameras; use of technology such as speed reader boards; vehicle features (e.g., intelligent speed adaptation, which alerts drivers when they are above the speed limit); and roadway design (e.g., rumble strips, speed humps).

Safe Roadways

- The number and rate of MVC fatalities at intersections in BC decreased overall from 1996 to 2010, but the rate has increased slightly since that time. Vulnerable road users were the most likely fatal victims at intersections for 2009-2013, making up 53.3 per cent of intersection fatalities.
- In BC for 2008-2012, 32.9 per cent of MVC fatalities occurred on highways with posted speed limits of 90 km/hr or higher.
- MVCs are more commonly fatal in rural areas because of relatively high travel speeds, increased interaction between non-commercial and commercial vehicles, longer emergency response times, and further distances to hospitals.

- In BC in 2008-2012, 23.7 per cent of fatal MVCs had one or more contributing factors that were related to the roadway environment—road condition and weather were the most common. While the number of MVC fatalities with environmental contributing factors did not meaningfully change between 2001 and 2012, their proportion of total MVCs increased, from 21.6 per cent in 2001 to 29.6 per cent in 2012.
- Measures to improve road safety through roadway design include expanding availability and accessibility of public transportation; implementing traffic calming infrastructure; enhancing cycling infrastructure; improving intersection safety (e.g. installing roundabouts, red light cameras); and installing rumble strips and barriers on highways. Other measures to improve road safety focus on wildlife, road and weather conditions, and resource roads. Some of these are currently in place and/or underway in BC.

Safe Vehicles

- From 2000 to 2009, the proportion of light vehicles on the road that were cars decreased from 60.5 per cent to 55.4 per cent; during the same time period, the proportion of sport-utility vehicles nearly doubled from 6.9 per cent to 12.8 per cent.
- Additionally, during this time sub-compact and mini-compact vehicles (both very small vehicle types) were introduced by vehicle manufacturers. As a result of these changes, vehicle crash incompatibility in Canada has become more pronounced, with the different shapes and sizes, and frame-to-frame misalignment resulting in increased risk of injury or death for vehicle occupants (usually for the occupants of the smaller vehicle). After-market modifications (such as raising vehicles or adding bull bars) also create and/or exacerbate vehicle crash incompatibility.
- Imported vehicles can pose additional safety challenges for road safety in BC, including right-hand drive vehicles (which were not designed for the Canadian road system) and vehicles 15 years and older (which can be exempt from current safety standards). Right-hand drive vehicles have been associated with a 39 to 60 per cent increased risk of MVC compared to left-hand drive vehicles in BC. Older vehicles are not likely to have current safety features that protect vehicle occupants and other road users.
- There are a wide variety of crash avoidance technologies available to help prevent MVCs from occurring. Examples include adaptive headlights, lane departure warning systems, adaptive cruise control, intelligent speed adaptation, forward collision warning, electronic stability control for braking, and pedestrian detection systems.
- Crash protection technologies such as passenger restraints and air bags are also available and can reduce fatalities and serious injuries during an MVC.
- Evidence indicates that people with lower socio-economic status are more likely to own a vehicle with lower safety ratings and fewer standard safety features (e.g., side air bags, electronic stability control), putting them at disproportionate risk of serious injury or death in an MVC.
- Vehicle condition and maintenance are important components of vehicle safety. Among fatal MVCs with one or more contributing factors related to vehicle design in BC in 2008-2012, tire failure/inadequacy was by far the most often reported contributing factor, being cited in 56.5 per cent of these MVCs.

Aboriginal Health and Road Safety

- MVCs were responsible for the largest number of deaths due to external causes among Aboriginal people in BC between 1992 and 2002. The age-standardized fatality rate for MVCs during this time period was nearly four times higher for Aboriginal people than for other BC residents (38 per 100,000 for Status Indians, compared to 10 per 100,000 for other residents).
- The age-standardized fatality rate for MVCs for Status Indians decreased from 34.7 per 100,000 population in 1993 to 18.8 per 100,000 in 2006, but was still more than double that of other residents of BC (7.1 per 100,000 in 2006).
- Examination of potential years of life lost (PYLL) shows that MVCs were the third highest cause of PYLL for Status Indians at 842.5 per 100,000 population for 2002-2006—more than twice the rate of other residents at 338.2 per 100,000.
- The age-standardized fatality rate for MVCs for Status Indians was higher than for other BC residents across the regional health authorities. The highest rate for Status Indians was in Interior Health at 35.9 per 100,000 population, while the rate for other residents in Interior Health was less than half of that (15.7 per 100,000).
- For 1992-2006, MVCs were the leading cause of death for Status Indian children age 1-4 years, with a rate of 5.6 per 100,000 population. This rate was nearly four times higher than the rate for other BC children this age at 1.5 per 100,000.
- A survey of Aboriginal youth in BC found that the self-reported proportion of alcohol-impaired driving among those who lived off reserve was fairly stable from 2003 to 2008, at 5 and 6 per cent respectively, while the proportion for youth who lived on reserve increased from 8 per cent in 2003 to 17 per cent in 2008.
- Seat belt use may be improving among Aboriginal youth in BC, with self-reported proportion of seat belt use increasing from 35 per cent in 2003 to 59 per cent in 2013 on reserve and from 49 per cent in 2003 to 73 per cent in 2013 off reserve among youth.
- A variety of best and promising practices for road safety among Aboriginal people have been identified. Some examples include working in close partnership with communities and with organizations that have a clear understanding of Aboriginal culture and values, integrating Aboriginal culture and values in resource materials and their delivery, and involving Elders in safety program development and delivery.

SOLUTIONS

Over the last two decades BC has achieved many gains in advancing road safety and reducing the burden of MVCs. By continuing to improve infrastructure, vehicle designs, speed-related safety measures, and road user behaviours and conditions—particularly with a focus on vulnerable road users, BC can achieve even lower death and injury rates. These improvements would also foster more active and ecologically friendly transportation—improving both human and environmental health. The 28 recommendations offered in this report aim to address challenges to road safety while building upon our current successes. These recommendations highlight opportunities and tools to strengthen the approach to road safety in BC. Key areas of focus for these recommendations are taking a strategic and comprehensive approach to road safety in BC, safe road users (including driver behaviours and conditions), safe speeds, safe roadways, safe vehicles, improving Aboriginal road safety, revising education and enforcement, and expanding research and data collection related to road safety. Overall, this report demonstrates that motor vehicle crash fatalities and serious injuries are systemic failures and that road safety is a critical public health issue that can—and should—be further improved in BC. Any preventable death or serious injury is unacceptable, including those that occur as the result of an MVC.

Chapter 1

Introduction to Road Safety in BC

INTRODUCTION

Transportation is an important part of daily life for British Columbians. People seldom live, work, learn, and play in the same place, and motor vehicles are a popular method of transportation—whether a car, van, truck, bus, or other vehicle.[1] At the same time, these vehicles mix with cyclists and **pedestrians**[a], who are considered **vulnerable road users**. Together, these **road users** are all at risk of motor vehicle crash (MVC) related injuries, disabilities, and death. Every year around the globe, over 1.25 million people are killed in MVCs, and another 50 million are injured.[2] As this report shows, despite important improvements in road safety in BC, hundreds of people are still killed and thousands are still injured in MVCs each year.

There has been a notable decrease in the last decade in the number of MVC-related serious injuries and fatalities occurring in BC. While these successes should be celebrated, the numbers are still high relative to other Canadian and international jurisdictions, and there are still opportunities to improve road safety in BC, particularly for vulnerable road users.[3] In BC in 2010, MVCs were the leading cause of unintentional injury-related fatalities for people age 1 to 24 years, and the third leading cause for those age 25 and up.[4] MVCs were the second leading cause of injury-related hospitalizations for those age 15–34 and those over age 45, in BC in 2010/2011.[5] While there have been many achievements in road safety and related improvements in serious injury and fatalities, almost no meaningful or sustained progress has been made over the last decade to improve serious injuries and fatalities for cyclists and pedestrians.[3]

This Provincial Health Officer's (PHO) report discusses road safety strategies in BC, provides related data and analyses, and offers recommendations to further improve road safety in BC. The report combines a **Safe System Approach** (SSA), and population health and public health perspectives to create a safe system framework for examining road safety in BC. This framework includes four main pillars (safe road users, safe speeds, safe roads, and safe vehicles), impacts of those four areas on the health of the population in BC, and related best and promising practices to improve the safety of the whole road system. This report looks at causes of MVC fatalities that are direct or immediate (e.g., **distracted driving, speeding**), and those that are distal or more indirect (e.g., roadway design, vehicle design). The report also discusses the impact of MVCs on the health and well-being of **Aboriginal peoples** in BC, and how road safety can be enhanced in Aboriginal communities. The report concludes with a discussion of key findings and recommendations for programs and policies that broaden the discussion from basic traffic safety to a multi-stakeholder population health approach to road safety, with the goal of further reducing MVCs and related serious injuries and fatalities in BC.

[a] Bolded text throughout this report indicate glossary terms, which are defined in Appendix A.

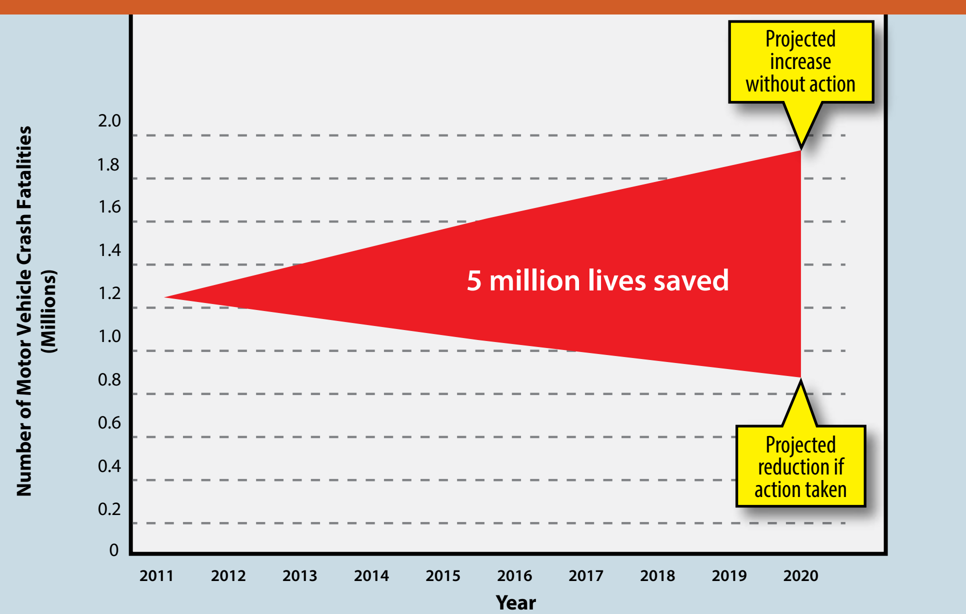
In this report, **road** and **roadway** are used interchangeably, and generally mean the open way for vehicles and persons, and may include only the strip used for travel (usually paved or gravel) or encompass related features on the right-of-way such as the shoulder or sidewalk.

REIMAGINING ROAD SAFETY

Recently there has been a shift in the understanding of road safety. Experts in the field have moved away from the historical view that MVC-related serious injuries and deaths are unfortunate but inevitable, to the current view that MVCs are, in large measure, systemic failures, and that while some crashes are unavoidable, related deaths and serious injuries are preventable through systemic interventions.[6(p.111)] In recent years there has been wide acknowledgement of the impact of MVCs in Canada and beyond, and consequently efforts to improve road safety are underway around the world.

In 2004, the World Health Organization (WHO) identified MVC injury and death as a major public health problem, and recognized that MVC-related serious injuries and deaths are preventable.[7] In response, the United Nations General Assembly proclaimed the "Decade of Action for Road Safety" (2011-2020), as a way to draw public attention to road safety at local, regional, national, and global levels. This initiative emphasizes the need for a holistic, multidisciplinary, and cooperative approach to road safety,[8] and a shift to a "culture of safety" that includes collaborative work between policy-makers, victims and survivors, private companies, international organizations, media, and more.[9] One key goal of the initiative is to stabilize and then reduce by 50 per cent the projected number of global MVC fatalities for 2020. This would result in less than 1 million MVC-related fatalities occurring globally by 2020, or approximately 5 million fatalities prevented (see Figure 1.1).[9]

Figure 1.1 Motor Vehicle Crash Fatalities and the Decade of Action for Road Safety, Worldwide, 2011 to 2020



Source: Adapted from Fia Foundation. *Make Roads Safe. A Decade of Action for Road Safety*[10] and World Health Organization. 2013. *Global Status Report on Road Safety: Time for Action*[11].

> **"The current situation is a system failure. Because safety has not been the starting point for the design of the system, what we now have is an untreated public health problem. In many other areas of public policy, we simply do not tolerate such consistent levels of unmanaged human harm."**
>
> – N. Arason, *No Accident: Eliminating Injury and Death on Canadian Roads*[14(p.3)]

As a United Nations Road Safety Collaboration Partner, Canada is actively participating in this initiative, and named 2011 the National Year of Road Safety to promote and raise public awareness for road safety.[12] In 2015, the Canadian Council of Motor Transport Administrators (CCMTA) released the *Canadian Road Safety Strategy 2015* (CRSS 2015),[b] which brings stakeholders together to work on road safety in an interdisciplinary and inclusive way. It has the long-term vision that Canada will have the "safest roads in the world."[13] A subsequent version of this national road safety strategy is currently being planned.

In BC, a provincial strategy was developed by RoadSafetyBC (formerly the Office of the Superintendent of Motor Vehicles) to address the impact of MVCs in the province. RoadSafetyBC's vision aligns with the CRSS 2015, and aims to have "the safest roads in North America and work toward an ultimate goal of zero traffic fatalities."[15] This provincial strategy, *British Columbia Road Safety Strategy: 2015 and Beyond* (BC RSS 2015), was released in August 2013. Acknowledging the multidisciplinary nature of road safety, BC RSS 2015 is based on a partnership approach involving over 40 different road safety partners across the province, including government and non-government organizations. The strategy is designed to leverage the work of all partners and to ensure that effective mechanisms are in place to support cross-sector activities.

GOVERNANCE OF ROADS AND ROAD SAFETY

Governance of road safety is complex, involving municipal, provincial, and federal government responsibilities, along with numerous acts and regulations. Chapters 3 to 9 provide more detail about the responsibilities for roads and road safety governance.

In Canada, the control, regulation, and administration of **highway** safety and motor vehicle transportation is shared among various levels of government and coordinated by the CCMTA, who developed the CRSS 2015. This organization includes members from federal, provincial, and territorial governments, and works closely with stakeholders to develop motor transport programs and strategies.[13] CRSS 2015 was endorsed by the Council of Ministers Responsible for Transportation and Highway Safety in September 2010.[16] This federal/provincial/territorial council comprises ministers with responsibility for transportation policy and highway safety from each of 10 provinces and three territories, as well as the federal government.[17]

Transport Canada is the federal department responsible for policies and programs related to transportation in Canada.[18] Road safety responsibilities fall under three main areas: safe vehicles (e.g., vehicle design), child safety

[b] CRSS 2015 is Canada's third national road safety strategy and spans five years (2011–2015). Canada's first road safety strategy, *Road Safety Vision 2001*, was released in 1996. It was followed by *Road Safety Vision 2010* in 2000.

(e.g., car seat manufacturing regulations), and **commercial vehicles**.[19] Relevant legislation governing Transport Canada includes the *Motor Vehicle Safety Act* and *the Motor Vehicle Transport Act*.[19] Transport Canada also leads the Canadian Global Road Safety Committee. This committee develops and promotes national road safety initiatives, shares best practices and information, and discusses road safety issues.[20] It includes representatives from the CCMTA, federal/provincial/territorial governments, government insurance agencies, police, academia, non-government organizations, and youth from the Canadian Road Safety Youth Committee. The Canadian Department of Justice is responsible for driver behaviour relating to the *Criminal Code of Canada*, such as impaired driving and dangerous driving causing death.

In BC, responsibility for road safety is shared between the Ministry of Transportation and Infrastructure (MoTI), the Ministry of Justice (including RoadSafetyBC and the Policing and Security Branch), and the Insurance Corporation of British Columbia (ICBC). MoTI plans transportation networks, provides transportation services and infrastructure, develops and implements transportation policies, has responsibilities regarding commercial vehicle safety, administers many related acts and regulations, and administers federal-provincial funding programs.[21] It is also responsible for the province's rural highways, and some roads that run through local or municipal government boundaries. MoTI shares responsibility for the *Motor Vehicle Act* with RoadSafetyBC at the BC Ministry of Justice. In addition to sharing responsibility for this Act and leading the implementation of the province's coordinated road safety strategy (BC RSS 2015), RoadSafetyBC works collaboratively with government ministries, departments, and agencies; road safety interest groups; law enforcement; research organizations; and others. RoadSafetyBC leads on legislation and policies such as those addressing distracted driving, drinking and driving (e.g., **Immediate Roadside Prohibitions**), and vehicle impoundment for excessive and unsafe speed. In addition, RoadSafetyBC is responsible for some aspects of driver licensing, including working to ensure that drivers are medically fit to drive, and that **high-risk drivers** are not on the road. The Policing and Security Branch is responsible for ensuring that there is an adequate and effective level of policing and law enforcement throughout BC; it is specifically responsible for traffic enforcement policy, as well as administration and oversight of road safety enforcement initiatives.[22] ICBC is responsible for providing vehicle insurance, some aspects of driver licensing, and vehicle licensing and registration services, as well as promoting road safety overall.[23]

While the provincial government leads road safety in BC, the *Motor Vehicle Act* gives local governments the power to improve road safety in their communities in numerous ways. For example, municipal councils have the ability to change speed limits, install traffic control devices (such as stop signs), establish school crossings, and more.[24]

METHODOLOGY AND DATA SOURCES

Since the underlying premise of an SSA is that MVC-related fatalities can be eliminated and the severity of injuries can be reduced, this PHO report uses fatality and serious injury (hospitalization) data to help measure, examine, and discuss the impact of MVCs in BC. Some variables are examined only in relation to fatalities, but this does not suggest that serious injuries are not a critical component of understanding the full burden and impact of MVCs on the lives of British Columbians; we recognize that some serious injuries involve months, years, and/or a lifetime of pain and suffering, and rehabilitation, and have profound negative impacts on a person's family, their ability to earn income, and their quality of life.

Data Analysis and Methodology

This report presents descriptive analyses by year, health authority, road user, age group, sex, and MVC circumstances. MVC-related injuries can be minor or serious, but those that require admission to hospital are more likely to be serious, or to result in long-term or permanent disability. Accordingly, hospitalization data in this report are used as an indicator of serious injury. Definitions of serious injuries and fatalities are described in the following section.

Comparisons of MVC fatalities and hospitalizations are made using **age-standardized rates**. Rates are calculated per 100,000 population for year, age, sex, and health authority. The rates of MVC fatalities and hospitalizations are based on the total population and calculated by the total number of MVC deaths or hospitalizations over the sum of the annual population for the same period. If rates are age- and sex-specific, the rates are calculated using the numbers of deaths or hospitalizations for the specific age group and sex, over the population for that age group and sex. Age-standardized rates have been calculated using the 1991 Canada Census for the purpose of rate comparisons between sexes, geographic regions, or populations, or over time periods. Ninety-five per cent confidence intervals are provided where appropriate and reasonable, and are not shown on figures with lower rates.

While some data regarding MVC fatalities are available with details including type of vehicle (e.g., truck, bus, taxi) or type of MVC (e.g., side impact, head-on, run-off-road), an in-depth exploration of these factors is beyond the scope of this report. Off-road vehicles (e.g., snowmobiles, all-terrain vehicles [ATVs]), and private and rural access roads are also beyond the scope of this report.

For more information about MVCs and related policies and programing for regional health authorities, including additional region-specific data, refer to the reports produced by the respective regional health authorities.[c] For more detailed information about data sources and methodology, see Appendix B.

Data Sources

Data for this report were obtained from a variety of primary and secondary sources. Primary data presented in this report were obtained from three main sources: (1) the Police Traffic Accident System (TAS) database from ICBC's Business Information Warehouse; (2) the Discharge Abstract Database (DAD) from the BC Ministry of Health; and (3) the BC Vital Statistics Agency (VSA) statistical database at the Ministry of Health. These three sources are discussed in this section. Some additional data were provided by the BC Trauma Registry, BC Coroners Service, BC Ministry of Transportation and Infrastructure, BC Ministry of Justice (RoadSafetyBC), Statistics Canada, Transport Canada, and WorkSafe BC.

1. Police Traffic Accident System

Fatality data are derived from the TAS for this report. Fatality data included in the TAS database are gathered from police reports and include information from police-attended MVCs, and MVCs self-reported by the public to police. In the TAS, a fatality is defined as a road user who dies from injuries resulting from an MVC within 30 days of the incident. This only includes MVCs that occur on roadways where the *Motor Vehicle Act* applies. Roads where the *Motor Vehicle Act* does not apply, such as forest service roads, industrial roads, and private driveways, are excluded. Additionally, fatal victims of off-road snowmobile accidents, and vehicle-involved homicides or suicides are also excluded. TAS data include both information about the crashes (e.g., annual and monthly

[c] Some of these reports are accessible via the website of the Office of the Provincial Health Officer (www.health.gov.bc.ca/pho/reports).

trends, and crash location) and **contributing factors** to the crashes (contributing factors will be described further in Chapter 2). Fatality data presented by health authority are reported based on crash location.

2. Discharge Abstract Database

In this report, hospitalization data from the DAD are used as a proxy indicator for serious injuries. The DAD includes patient information about diagnoses, causes of injury, and types of injury. The DAD only reflects data for those persons who were admitted to hospital. Serious injury (hospitalization) data include acute, rehabilitation, and surgery cases that required at least one overnight stay in the hospital. To avoid multiple counts of the same injury, when a patient was hospitalized more than once during a fiscal year (e.g., re-admitted, transferred to another hospital), only the first admission was counted. Fatalities that occurred in hospital as a result of a serious injury were excluded from serious injury counts. Typically, DAD data are reported by fiscal year. The hospitalization data in this report are depicted by calendar year based on the admission dates, so as to be consistent with the fatality data sources that report out by calendar year. Hospitalization data presented by health authority are reported based on the health authority region of residence of the victim.

3. BC Vital Statistics Agency

The VSA registers vital events in BC, including deaths. VSA data used in this report provide fatality information about victims of MVCs, and were used to conduct regional analyses by health authority, year, age group, and sex. VSA data were also used in Chapter 9 for analyses showing MVC fatalities of Aboriginal peoples compared to other residents. These analyses do not include contributing factor information but include MVC fatalities on all roads, such as forest service roads and industrial roads, as well as vehicles designed for off-road use, such as ATVs and snowmobiles.

Data Challenges and Limitations

As with any data sources, data presented in this report are subject to challenges. Some limitations of the data include different interpretations from reporting law enforcement staff, unreported crashes, incorrect classifications, missing values, and different methods for identifying Aboriginal identity among data sources (see Chapter 9). Furthermore, data sources for MVCs differ; for example, ICBC data differ from police-reported data, as police do not attend all MVCs, and not all MVCs are reported to police and/or to ICBC.

In addition, since multiple data sources are used in this report, they are each subject to their respective procedures, updates, and challenges. TAS data are subject to the police reports of a crash and so most often focus on establishing human causes of crashes rather than focusing on a multi-dimensional system for preventing injuries (e.g., safe vehicles, safe roads, appropriate speed limits). It is also possible for misinterpretation, such as a heart attack being mistaken for driver inattention. Within DAD data analyses, there may be reasons beyond actual decreases in MVC serious injuries that may reduce the rate of related MVC hospital admissions over time (e.g., improved diagnostic and treatment technologies). Furthermore, while fatality and serious injury data may be presented together in a discussion, there are usually different years and/or levels of detail available for analyses. For example, for most discussions fatality data were available and presented up to 2013, but serious injury data were only available up to 2011, and while fatality data specify MVC contributing factors and whether a vehicle occupant was a driver or passenger, available hospitalization data do not.

"The recognition that any level of serious trauma arising from the road transport system is ultimately unacceptable, and that the system should be designed to expect and accommodate human error, is relatively new in road safety. These views have long been held in other transport and infrastructure systems, such as air transport or the distribution of domestic electricity. In these environments elaborate protection strategies have been developed; the manager of the system responds to crashes and other incidents by making systemic improvements, and the leaders of the system expect a failsafe system and prioritise activity and resources accordingly."

– Organisation for Economic Co-operation and Development, *Towards Zero: Ambitious Road Safety Targets and the Safe System Approach*[6]

THE FRAMEWORK

To best examine the complex topic of road safety and MVCs and to highlight the importance of a comprehensive and multi-sectoral approach to injury prevention, this report integrates three key approaches into its framework: a population health approach, a public health approach, and an SSA.

Population Health Approach

Population health focuses on improving the health of the broader population and reducing health disparities between groups within the larger population. To achieve this, population health seeks to understand and address the causes of underlying inequities. In the case of road safety, a population health approach examines why some populations are more affected by deaths and serious injuries related to MVCs than others, and then seeks to address underlying causes.

The built environment (such as transportation infrastructure and parks or other green spaces) affects population health and is one important part of examining roadway systems.[25] The design of the built environment, starting with planning and investment policies and practices, affects behaviour. Behaviour then influences the health of the people living in the environment. For example, in denser, well-planned neighbourhoods, it is easier for people to walk, cycle, or use public transit. This results not only in fewer vehicles on the road, and subsequently fewer MVCs, but also in reduced emissions, better air quality, and healthier, more physically active residents.[26] For the last 50 years the built environment in BC had been designed primarily around vehicles, but, as will be explored in this report (see Chapter 8), this is beginning to change.

Public Health Approach

Public health refers to efforts that focus on health promotion, disease and injury prevention, and protection of the health of the population as a whole. It recognizes the relationship between individuals and their environment, and how they work together to influence health. Epidemiology is the study of the patterns, causes, and effects of health and disease conditions in defined populations. It is the cornerstone of public health and is used to examine relevant data to help understand the complexities of MVC fatalities and injuries. This report incorporates a public health approach with consideration of multiple public health concepts: the public health triangle, the Haddon Matrix, and an SSA. These concepts will be discussed in the sections that follow.

The Public Health Triangle Model

The public health triangle is an epidemiological model used to identify the major risk factor categories of a disease or injury, and show the relationship between the three elements that impact its occurrence and associated prevention (agent, host, and environment). In this model, the host is the person (or population) with the disease or injury, the agent is the entity that causes the disease or injury, and the environment is the place where the host and agent interact.[27] Using a public health approach to road safety allows for an investigation of these three factors and how they contribute to an MVC. This application of the model is shown in Figure 1.2, in which the roadway is the environment, the road user population is the host, and the vehicle is the agent. These elements can be considered risk factor categories for MVCs and are foci for MVC prevention.

The Haddon Matrix

Early attempts to improve road safety focused almost exclusively on addressing road user behaviour and improving that behaviour through education, information, and enforcement strategies.[6] The evolution to a more systemic approach to road safety is widely credited to Dr. William Haddon, whose development of the "Haddon Matrix" (Table 1.1) broadened the focus of road safety strategies beyond road users to include roadways and vehicles. This approach incorporates a public health triangle model (host/road user population, agent/vehicle, environment/roadway) with the three phases of an MVC in which related fatalities and injuries may be prevented or mitigated: before the crash, during the crash, and after the crash.[6,7(p.13),28] The resulting matrix provides a method for identifying strategies to prevent MVCs or reducing their severity, for each of the three public health factors, at each of the three phases of an MVC.

Figure 1.2 Public Health Triangle

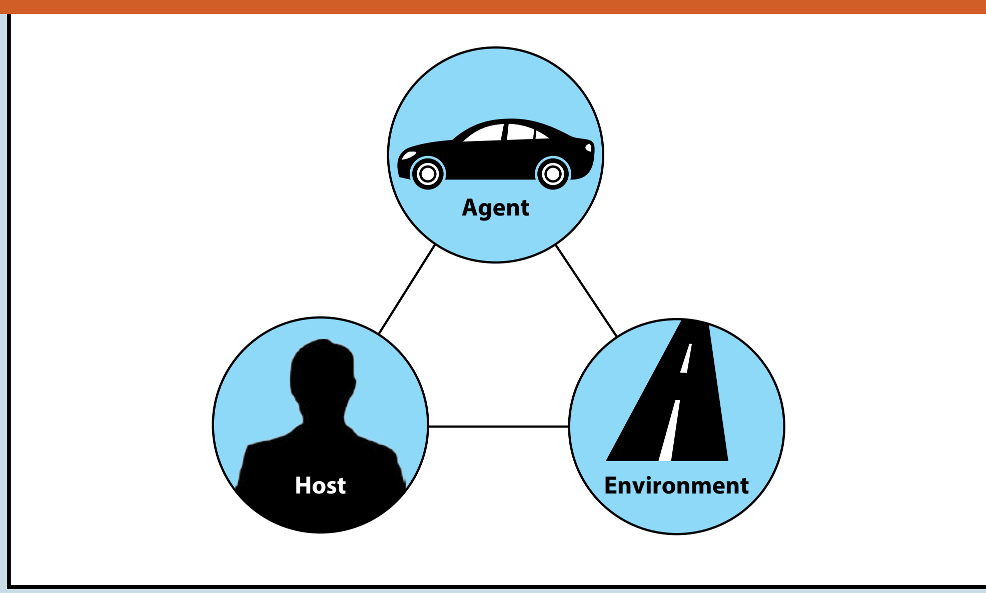


Table 1.1 The Haddon Matrix

OPPORTUNITY FOR PREVENTION	FACTORS		
	Road User	**Vehicle**	**Roadway**
Before Crash *(Crash prevention)*	Attitudes Information Impairment Enforcement	Handling Roadworthiness Lighting Speed management Braking Crash avoidance technologies Electronic stability control	Road design and layout Speed limits Intelligent transport systems Weather Pedestrian facilities
Crash *(Injury prevention during crash)*	Restraint use Speed at impact Impairment	Crash protection from vehicle structure (crashworthiness) Restraints Safety features (e.g., air bags)	Kinetic energy-absorbing roadside objects
After Crash *(Sustaining life)*	Access to medical care General health of road user First aid skill	Automatic crash notification systems Access to crash site Fire risk	Rescue services Time to medical care Congestion

Source: Adapted from Organisation for Economic Co-operation and Development. *Towards Zero: Ambitious Road Safety Targets and the Safe System Approach,*[6(p.71)] and Peden M, Scurfield R, Sleet D, Mohan D, Hyder AA, Jarawan E, et al. 2004. *World Report on Road Traffic Injury Prevention.*[7(p.13)]

A Safe System Approach to Road Safety

The aim of an SSA is to reduce the overall level of risk for human trauma in a multi-sectoral, multi-faceted way. The premise of this approach is that MVCs will undoubtedly occur, but that associated fatalities and serious injuries are preventable.[6] It recognizes that road users will inevitably make mistakes that may lead to crashes and that human beings have a limited tolerance for physical force; thus, it emphasizes the need for a comprehensive system designed to anticipate and accommodate human error, and reduce the risk of death and serious injury to road users when an MVC occurs.[6,29] Within an SSA, responsibility for preventing MVCs and related fatalities and serious injuries is not borne solely by road users, but is shared by those responsible for designing and managing vehicles, as well as those who are responsible for speed limits and roadways.[6] This approach also recognizes that road safety decisions must be made in a larger societal and economic context and that improving safety may be achieved more effectively by investing in innovative technologies, rather than investing more in traditional interventions.[6] An SSA aligns with a public health perspective because both recognize that road safety is multi-faceted and both rely on multi-sectoral partnerships and a comprehensive approach to reducing the negative impact of MVCs on health outcomes.

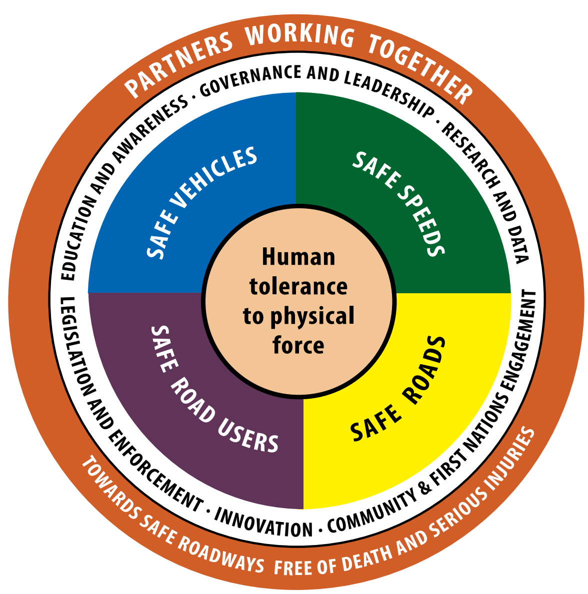
The SSA has been recommended by the WHO[7] and the Organisation for Economic Co-operation and Development,[6] and has been adopted and adapted by several countries such as Australia and New Zealand.[30,31] Though not entirely based on an SSA, the CRSS 2015 uses safe system concepts.[13] The BC RSS 2015 adopted the SSA as part of one of the underlying principles to promote road safety.[3] The safe system framework used in this report is derived from road safety strategies developed in the mid-1990s in Sweden and the Netherlands—both world leaders in road safety.[32,33,34]

Figure 1.3 represents the safe system approach applied in the framework in this report, which includes four pillars:

- **Safe Road Users** – a safe system includes road users who are skilled, alert, focused, and unimpaired. They take steps to increase road safety, such as complying with rules and choosing safe vehicles.[35] This group includes drivers, motorcyclists, cyclists, pedestrians, and other road users.[3]
- **Safe Speeds** – in a safe system, speeds are chosen to match the function and design of the road, and there is alignment between the use of the road and the related **survivable speed** for those road users.[14,35,36,37]
- **Safe Roads** – roadways in a safe system are designed around all road users—they should be predictable, be forgiving of mistakes, and encourage appropriate speed and road user behaviour.[35] This includes infrastructure such as roads, signals, and sidewalks.[3]
- **Safe Vehicles** – a safe system's vehicles are designed to both prevent crashes and to reduce the severity of crashes for road users.[35]

Represented in the outermost circle of Figure 1.3 is the foundational understanding that organizations and partners in road safety must work together to achieve a road system that is free of fatalities and serious injuries. Each has responsibility within their area of influence and control to apply key intervention functions, which include education and awareness, governance and leadership, research and data, legislation and enforcement, innovation, and community and **First Nations** engagement.

Figure 1.3 Safe System Approach to Road Safety



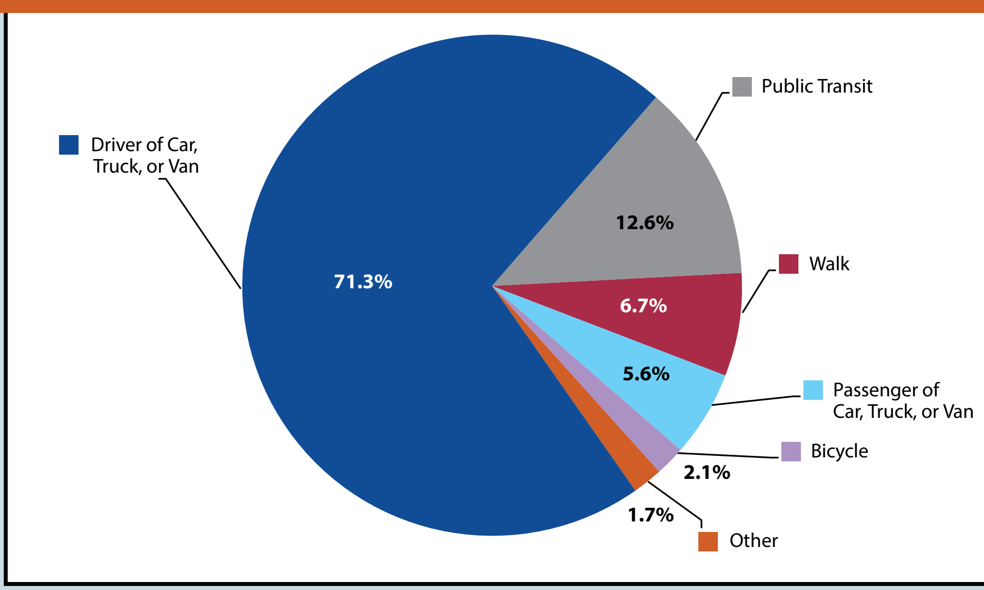
Source: Reproduced with permission from BC Ministry of Justice. 2013. *British Columbia Road Safety Strategy 2015 and Beyond.*[3]

ROAD USE IN CANADA AND BC

In 2009, approximately 4.4 million people lived in BC,[38] which is about 13 per cent of Canadians. Also, almost 2.7 million cars and trucks were registered in BC,[39] representing about 13 per cent of registered vehicles in Canada. According to the federal government's 2009 Canadian Vehicle Survey, there was an estimated average of 1.43 vehicles per household in BC.[40] The ratio of registered vehicles to people in BC has consistently been the highest in Canada, at approximately 0.57 vehicles per person.[41]

In 2006, approximately 1.9 million people in the BC labour force commuted to work.[1] During that year, BC workers travelled a median distance of 6.5 km from their homes to their workplaces, which was less than the national average in that year of 7.6 km.[42] Figure 1.4 shows that 76.9 per cent of commuters traveled to work in a car, truck, or van, either as a driver (71.3 per cent) or as a passenger (5.6 per cent). Another 12.6 per cent used public transit, while

Figure 1.4 **Proportion of Mode of Transportation to Work among Employed Labour Force, Canada, 2011**



Note: See Appendix B for more information about this data source.
Source: Statistics Canada, 2011 Census of Population. Prepared by Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

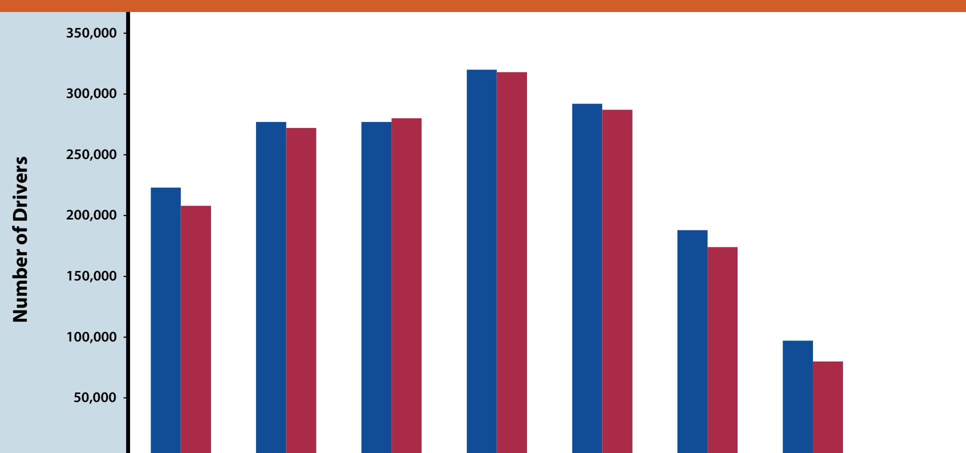
8.8 per cent used **active transportation** (6.7 per cent walked and 2.1 per cent cycled). Road user types will be explored further in Chapters 3 and 4, and more information on the types of vehicles on roads in BC will be provided in Chapter 8.

According to ICBC there were approximately 3.3 million active driver's licences in BC in 2014.[43] As shown in Figure 1.5, this included nearly equal proportions held by males and females. This figure indicates that the largest group of British Columbians holding an active driver's licence in 2014 were males and females between the ages of 46 and 55.

MVC-RELATED FATALITIES AND SERIOUS INJURIES IN CANADA AND BC

In Canada, about 2,500 people are killed in MVCs each year and another 180,000 are injured.[44] In BC, about 280 people are killed, and about 79,000 people are injured[d] on BC's public roads each year.[43] Cross-jurisdictional analyses show that there is still room for improvement in road safety both provincially in BC and nationally.

Figure 1.5 Profile of Drivers, by Sex and Age Group, BC, 2014



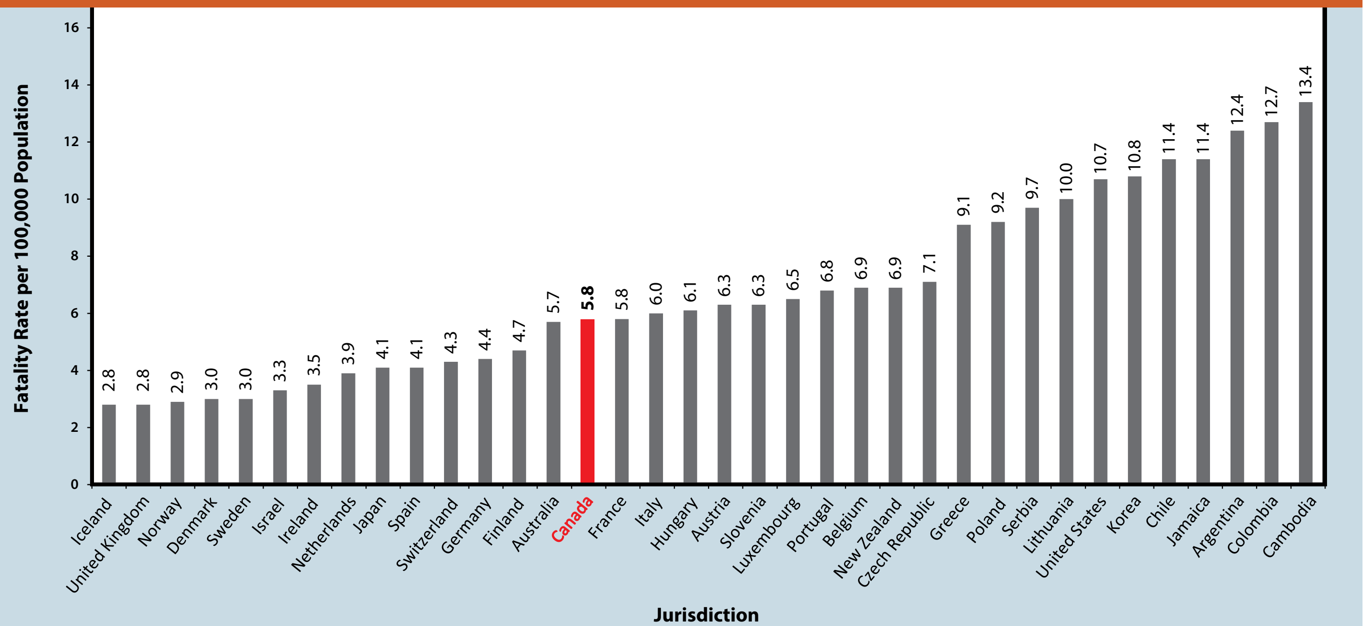
	16-25	26-35	36-45	46-55	56-65	66-75	76+	Total
Male	223,000	277,000	277,000	320,000	292,000	188,000	97,000	1,675,000
Female	208,000	272,000	280,000	318,000	287,000	174,000	80,000	1,619,000
Total	430,000	550,000	557,000	639,000	579,000	362,000	178,000	3,297,000

Age Group

Note: "Drivers" include those who currently hold an active BC driver's licence. Not all individuals who hold a driver's licence own or operate vehicles in BC. Counts have been rounded to the nearest thousand. Totals are rounded, but calculated based on unrounded numbers. There were 3,000 cases where age group and/or sex was missing, and these cases are excluded from this figure. See Appendix B for more information about this data source.
Source: Business Information Warehouse, Insurance Corporation of British Columbia, data as of September 30, 2014. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

[d] Fatality and injury numbers are calculated based on a five-year average for 2009-2013.

Figure 1.6 **Motor Vehicle Crash Fatality Rate per 100,000 Population, by Jurisdiction, 2012**



Note: "Fatality" includes death within 30 days of the crash. Numbers are based on police recorded data (except the Netherlands). See Appendix B for more information about this data source.
Source: International Traffic Safety Data and Analysis Group. 2014. *Road Safety Annual Report: Summary.*[45] Prepared by Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

MVC-related Fatalities and Serious Injuries in Canada

As shown in Figure 1.6, Canada had 5.8 fatalities per 100,000 population in 2012, and ranked 15th for road safety by this measure (along with France), when compared to 36 other international jurisdictions, including some international leaders in road safety.

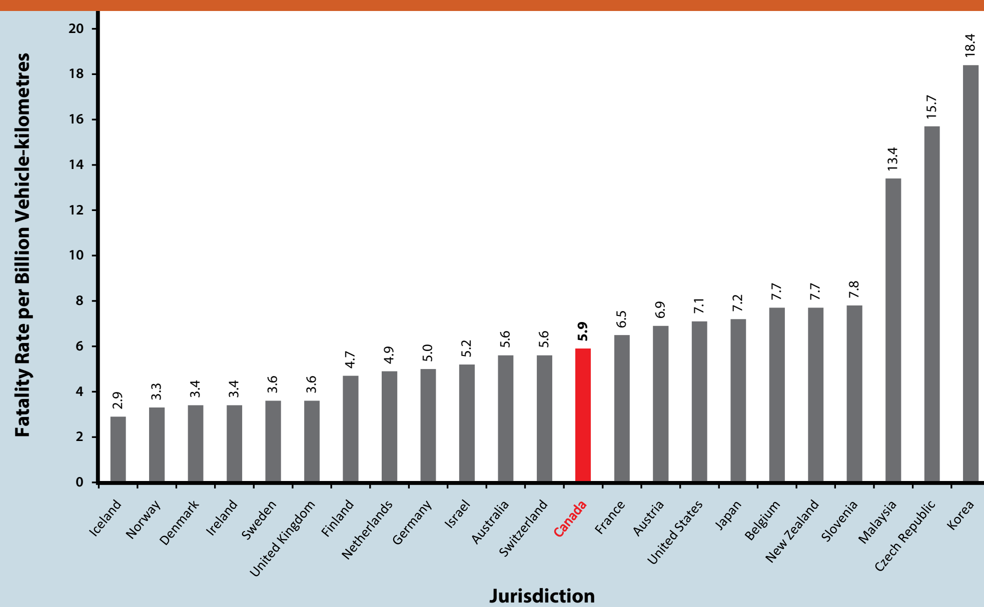
For a more fulsome comparison across international jurisdictions, calculation of the rate of fatalities per billion **vehicle kilometres** can be used, which takes into consideration how much and how far people in a given population drive.[46] Vehicle kilometres measure an estimate of traffic volume and are calculated by multiplying the number of vehicles on the road by the distance travelled. The distance travelled can be via odometer readings, traffic counts, or household surveys and fuel sales.[46]

Figure 1.7 shows that in 2012, Canada had 5.9 MVC fatalities per billion vehicle kilometres. While comparisons should be made with caution since international jurisdictions are likely to measure these data differently, Canada ranks 13th compared to 22 other jurisdictions. Together, analyses presented in Figures 1.6 and 1.7 suggest that approaches used by other jurisdictions for roadways, vehicle requirements, and related policies and programs (e.g., Sweden, Norway, Denmark, and the United Kingdom) may be having positive impacts on road safety that can serve as models for improvement in BC.

MVC-related Serious Injuries and Fatalities in BC

In BC, approximately 260,000 MVCs are reported to ICBC each year.[e,43] There has been an overall decrease in MVC fatalities and serious injuries over time in BC, but there has been considerable variation from year to year.

Figure 1.7 **Motor Vehicle Crash Fatality Rate per Billion Vehicle-kilometres, by Jurisdiction, 2012**



Note: "Fatality" includes death within 30 days of the crash. Numbers are based on police recorded data (except the Netherlands). Comparisons of vehicle-kilometres shown here should be interpreted with caution, as these data may not be consistently measured across international jurisdictions. See Appendix B for more information about this data source.

Source: International Traffic Safety Data and Analysis Group. 2014. *Road Safety Annual Report: Summary.*[45] Prepared by Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

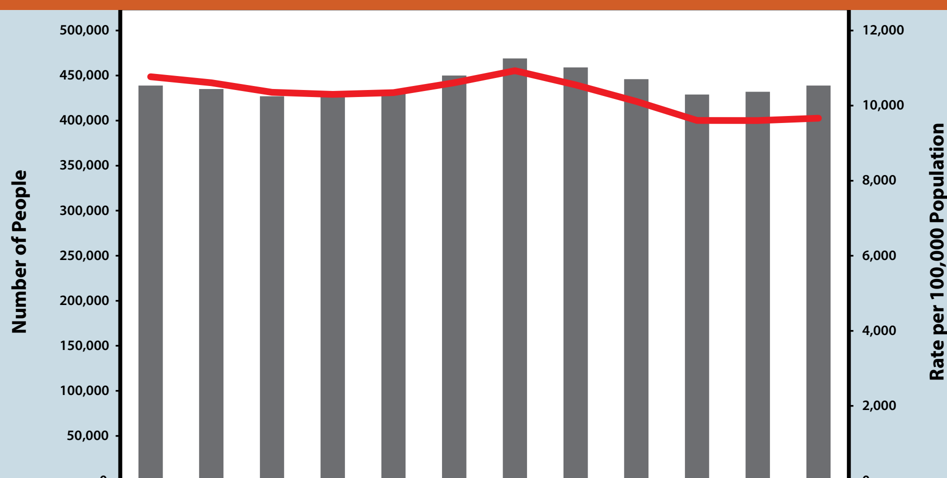
[e] This number is based on a five-year average for 2008-2012.

> "The number and rate of people involved in MVCs in BC was the same in 2012 as it was in 2001. However, even a steady number shows progress since there have been increases in the size of the BC population and in the number of active driver's licences in BC during that time."

As shown in Figure 1.8, a reduction in the total number of individuals involved in MVCs has not been sustained in recent years; in fact, the number of people involved in MVCs was the same in 2012 as in 2001. There were increases in both the number and rate of people involved in MVCs from 2004 up to their peaks in 2007, in which 469,000 people in total and 10,929 people per 100,000 population were involved in MVCs.

However, this figure also shows that since the population of BC is increasing, the rate of people involved in MVCs per 100,000 population has improved somewhat over time. Therefore, while reducing the number of MVCs and their associated serious injuries and fatalities is an important goal for BC, even a steady number during these years of population growth indicates improvement.

Figure 1.8 **People Involved in Motor Vehicle Crashes, Count and Rate per 100,000 Population, BC, 2001 to 2012**



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Number of People	439,000	435,000	427,000	428,000	434,000	450,000	469,000	459,000	446,000	429,000	432,000	439,000
Involvement Rate	10,768.0	10,609.3	10,354.2	10,300.8	10,343.8	10,609.0	10,929.9	10,553.2	10,111.8	9,606.1	9,601.8	9,664.3

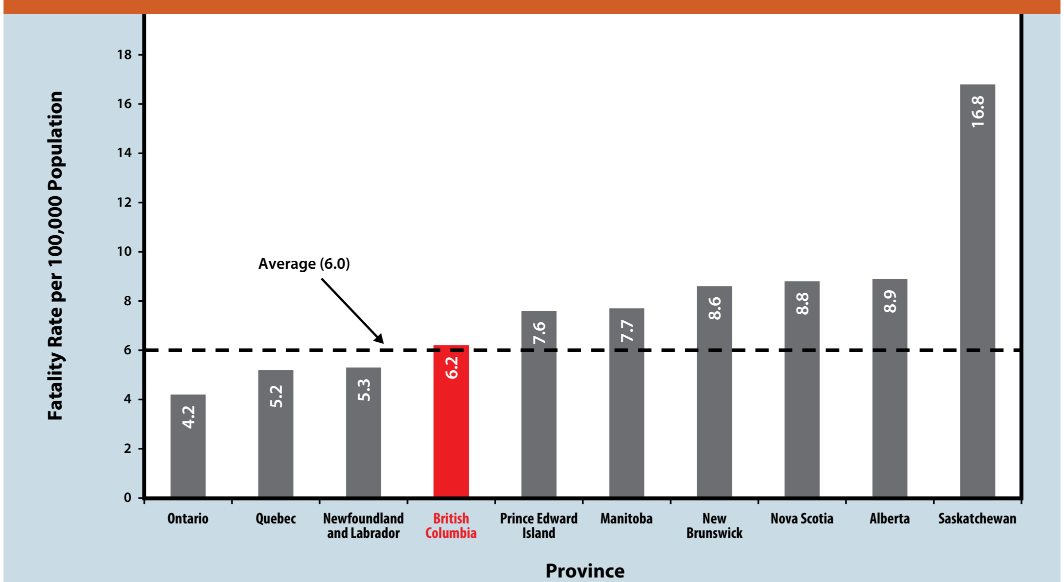
Year

Note: "People" includes drivers, passengers, pedestrians, and cyclists involved in a motor vehicle crash (MVC) regardless of injury or fatality. Counts have been rounded and do not include people involved in an MVC that was not reported to the Insurance Corporation of British Columbia. See Appendix B for more information about these data sources.
Sources: Motor vehicle crash data are from the Business Information Warehouse, Insurance Corporation of British Columbia, 2001-2012; population estimates are from the BC Stats website, April 2015. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

Figure 1.9 depicts the MVC fatality rates for Canadian provinces in 2012. It shows that BC had the fourth lowest MVC fatality rate in Canada in 2012, at 6.2 fatalities per 100,000 population—slightly higher than the national average of 6.0 per 100,000. Ontario had the lowest among provinces that year, at 4.2 per 100,000 population. According to Ontario's *Road Safety Annual Report 2010*,[47(p.9)] the low fatality rate per 100,000 population may be attributable to the province's focus on strong enforcement, education, and legislation, as well as rigorous truck safety laws.

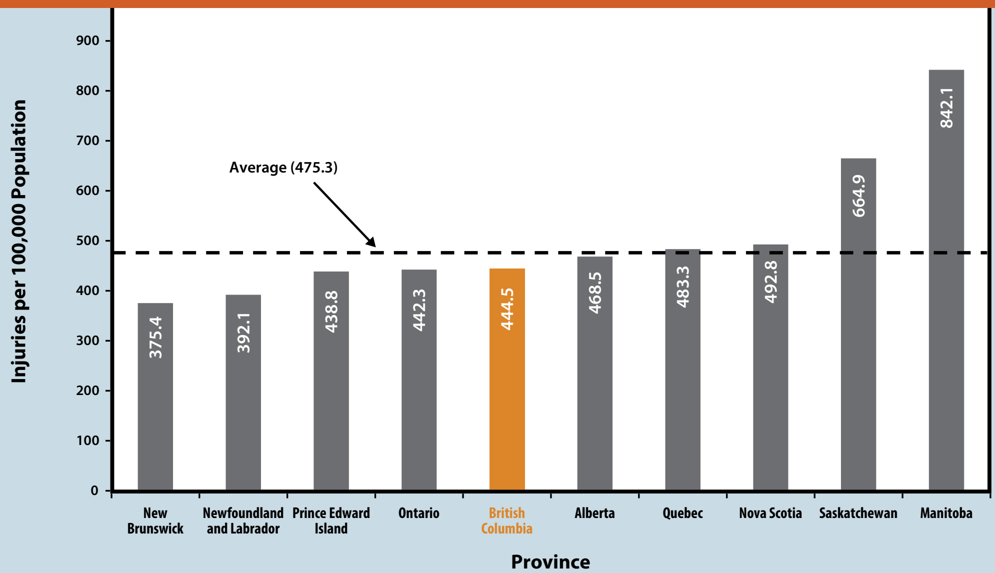
While BC had a fatality rate slightly above the provincial average in Canada in 2012, Figure 1.10 shows that BC had an injury rate slightly below the average across Canadian provinces in the same year. BC had 444.5 serious injuries per 100,000 population, while the national average was 475.3 per 100,000.

Figure 1.9 **Motor Vehicle Crash Fatality Rate per 100,000 Population, by Province, Canada, 2012**



Note: Northwest Territories, Yukon, and Nunavut have been omitted due to unreliable reporting. Data for Ontario were preliminary. Data for Newfoundland and Labrador, and New Brunswick were estimated. See Appendix B for more information about this data source.
Source: Transport Canada, Canadian Motor Vehicle Collision Statistics, 2012. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

Figure 1.10 Motor Vehicle Crash Injury Rate per 100,000 Population, by Province, Canada, 2012

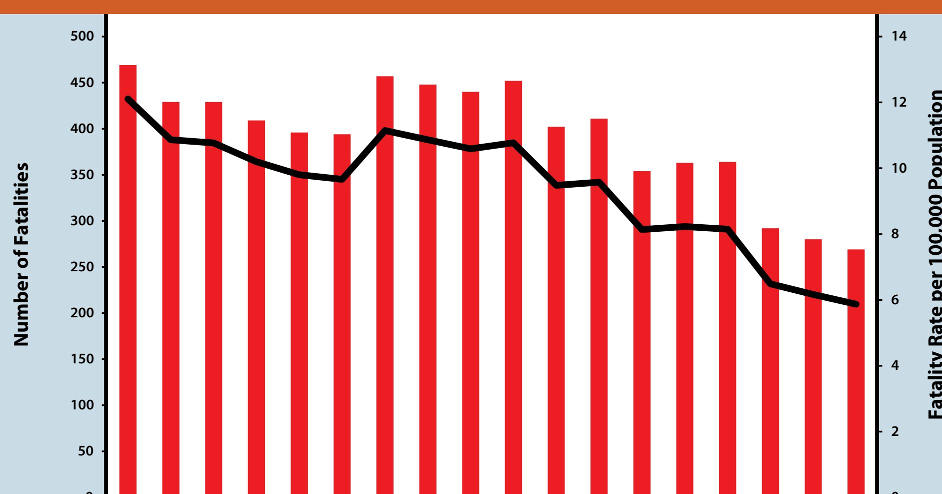


Note: Northwest Territories, Yukon, and Nunavut have been omitted due to unreliable reporting. Data for Ontario were preliminary. Data for Newfoundland and Labrador, and New Brunswick were estimated. Changes in how motor vehicle crash reports are collected in Manitoba resulted in an increased number of minor injuries being captured in these data compared to previous years. See Appendix B for more information about this data source.
Source: Transport Canada, Canadian Motor Vehicle Collision Statistics, 2012. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

In BC, the numbers of MVC fatalities and serious injuries have fluctuated considerably over time, but overall, have shown a downward trend. Figure 1.11 shows MVC fatalities in BC from 1996 to 2013, while Figure 1.12 shows MVC hospitalizations in BC from 2002 to 2011. These figures indicate that fatalities and serious injuries have decreased over the years shown, with a reduction by 42.6 per cent for fatalities and 23.3 per cent for serious injuries.

Declines in MVC-related fatalities and serious injuries in BC are likely due to factors such as improvements to vehicle safety standards and better road engineering, and may also relate to legislative and regulatory changes. However, while these two figures depict overall successes, it is noteworthy that the steady decline in fatalities from 1996 to 2001 was disrupted by a spike in fatalities in 2002, and did not reach a similar level again until 2006. This may be the result of program and policy changes in 2001, particularly the cancellation of the photo radar program. These trends will be examined further in subsequent chapters.

Figure 1.11 **Motor Vehicle Crash Fatality Count and Rate per 100,000 Population, BC, 1996 to 2013**



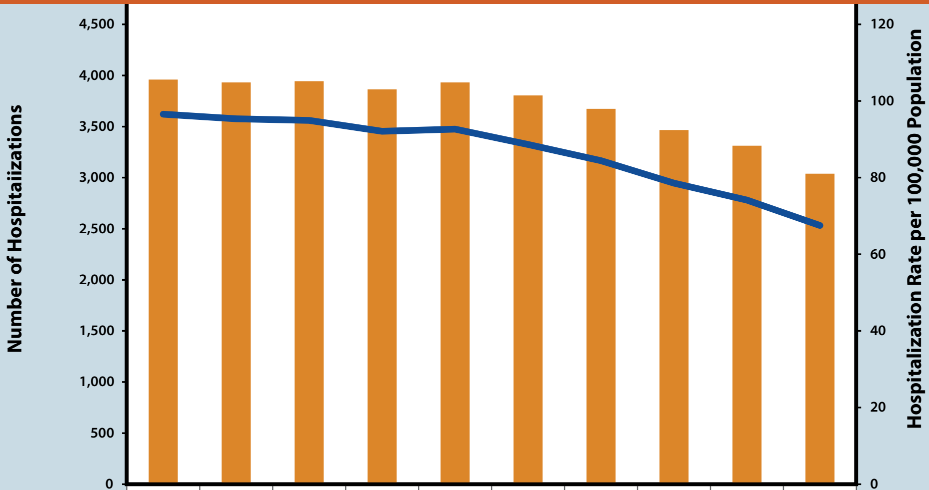
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Number of Fatalities	469	429	429	409	396	394	457	448	440	452	402	411	354	363	364	292	280	269
Fatality Rate	12.1	10.9	10.8	10.2	9.8	9.7	11.1	10.9	10.6	10.8	9.5	9.6	8.1	8.2	8.2	6.5	6.2	5.9

Year

Note: See Appendix B for more information about these data sources.
Sources: Fatality counts are from the Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia, 1996-2013; population estimates are from the BC Stats website, April 2015. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

Figure 1.12

**Motor Vehicle Crash Hospitalization
Count and Rate per 100,000 Population, BC, 2002 to 2011**



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Number of Hospitalizations	3,959	3,932	3,944	3,864	3,931	3,804	3,673	3,466	3,312	3,038
Hospitalization Rate	96.6	95.3	94.9	92.1	92.7	88.7	84.4	78.6	74.2	67.5

Year

Note: See Appendix B for more information about these data sources.
Sources: Hospitalization data are from the Discharge Abstract Database, Ministry of Health, 2002-2011; population estimates are from the BC Stats website, April 2015. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

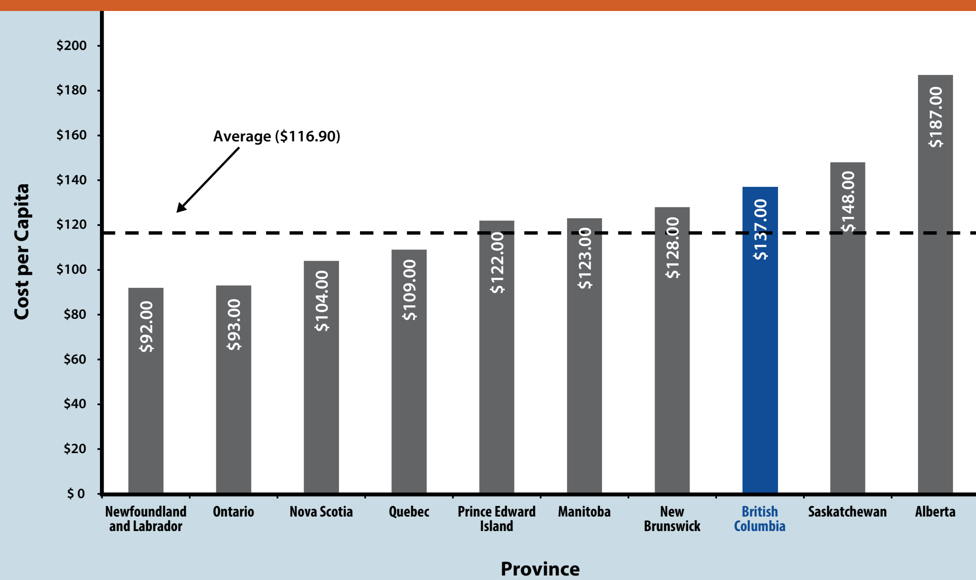
THE COST OF MVCS IN CANADA AND BC

There are three major cost components when estimating the economic impact of MVCs. The first component is direct costs. These include costs for medical treatment of people involved in MVCs, costs to repair or replace damaged vehicles, policing and enforcement, repair of roadways damaged by MVCs, and related administration costs. The second component is indirect costs—losses due to goods and services that were not produced as a result of an MVC fatality or serious injury. This includes the value of time lost from work and homemaking due to morbidity, disability, and premature mortality.[48] The third component is often left out of economic calculations, but is also important to consider. It involves social costs, such as the loss of quality of life due to physical and emotional pain and suffering resulting from an MVC, changes to relationships and family dynamics (e.g., if the primary income earner for a family dies or is seriously injured from an MVC), increased fuel use, increased pollution, and more.[48,49]

In 2009, SMARTRISK[f,50] completed a report on the economic burden of injury in Canada, using calculations that included costs based on 2004 data. Figure 1.13 shows the resulting estimated per capita cost of transport-related injuries in Canadian provinces. It shows that in 2004 BC had the third highest cost per capita of transport-related injuries. The total estimated yearly cost of MVCs in BC was $574 million, 45.3 per cent of which were direct costs.[48] The estimate did not include the direct costs related to vehicle damage, or indirect costs resulting from the MVC. Direct costs for this estimate included all the goods and services used to diagnose and treat MVC patients, as well as rehabilitation and terminal care when needed; as such, the estimate incorporates expenditures for hospitalization, outpatient care, nursing home care, services of physicians and other health professionals, pharmaceuticals, and the administrative costs of third-party payers.

According to BC Ministry of Health data, average annual direct MVC-related hospital costs in BC between 2001 and 2010 were estimated at $51.3 million (or $140,448 per day).[g,51] This is 12.7 per cent of all injury-related hospitalization costs in BC, which total approximately $404.9 million,[h] and about 13.8 per cent of the hospitalization costs associated with unintentional injury (approximately $373.0 million) in BC in 2010/2011.[52] In addition to economic costs for health care, the provincial workers' compensation system (WorkSafe BC) incurs costs for workers who are injured or killed on the job. In BC for 2009-2013, MVCs cost the workers' compensation system an average of $56.6 million per year (totalling $283 million over these five years).[53]

Figure 1.13 **Total Cost per Capita for Transport-related Injuries, by Province, Canada, 2004**



Note: Total cost per capita includes direct costs (the value of resources used to treat the persons in motor vehicle crashes) and indirect costs (the value lost to society as a result of the motor vehicle crash). "Transport-related injuries" include incidents with pedestrians, pedal cycles, motor vehicles, all-terrain vehicles, snowmobiles, and other non-specified transport.
Source: SMARTRISK. 2009. *The Economic Burden of Injury in Canada.*[48] Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

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[f] SMARTRISK was a national charity that focused on injury and fatality prevention. In 2012, SMARTRISK joined with Safe Communities Canada, Safe Kids Canada, and ThinkFirst Canada to become Parachute, a national charity that acts as a leader in injury prevention.

[g] Based on a cost per weighted case value of $5,390. Calculation of per-day cost is based on annual related costs of $51,263,379.04.

[h] These costs include intentional, unintentional, other causes, and undetermined causes of injury-related hospitalizations.

ORGANIZATION OF THIS REPORT

This report provides an overview of the impact of MVCs on the health of British Columbians and identifies current successes, challenges, and opportunities to improve road safety in BC. Chapter 2 provides an overview of the burden of MVCs in BC, including related fatalities and hospitalizations. Chapters 3 to 8 look at data and trends related to the four main pillars of the SSA (safe road users, safe speeds, safe roadways, and safe vehicles), examining serious injuries and fatalities and presenting evidence-based practices from leading jurisdictions when possible. Chapter 9 was developed in collaboration with the First Nations Health Authority. It explores MVCs involving Aboriginal peoples in BC, and discusses current initiatives and promising practices to improve road safety in Aboriginal communities. The final chapter discusses the main findings presented in this report, and offers a comprehensive set of recommendations that aim to prevent fatalities and serious injuries due to MVCs in BC. Bolded text throughout this report indicate glossary terms, which are defined in Appendix A.

SUMMARY

This chapter has provided an overview of the data sources and methodologies used in this report, and outlined key responsibilities of the various partners and bodies that together provide governance of road safety in BC. This report combines population health and public health perspectives, and a Safe System Approach (SSA) in its analyses. It does this by focusing on the impact of motor vehicle crashes (MVCs) on the population, and exploring each pillar of the SSA while examining related fatalities and serious injuries. Principles of public health and population health are incorporated into the analyses, discussions, and related recommendations in this report. This chapter showed that Canada ranked somewhat higher in MVC fatality rates than some other international jurisdictions and leaders in road safety. Within Canada, BC ranked fourth lowest, but slightly higher than the average for MVC fatality rates, and slightly below the average for related serious injury rates. Over time, BC has seen reductions in the number of MVC-related hospitalizations and fatalities, as well as in related rates per 100,000 population.

The next chapter will examine the burden of MVCs in BC in more detail.

Chapter 2

Motor Vehicle Crashes in BC

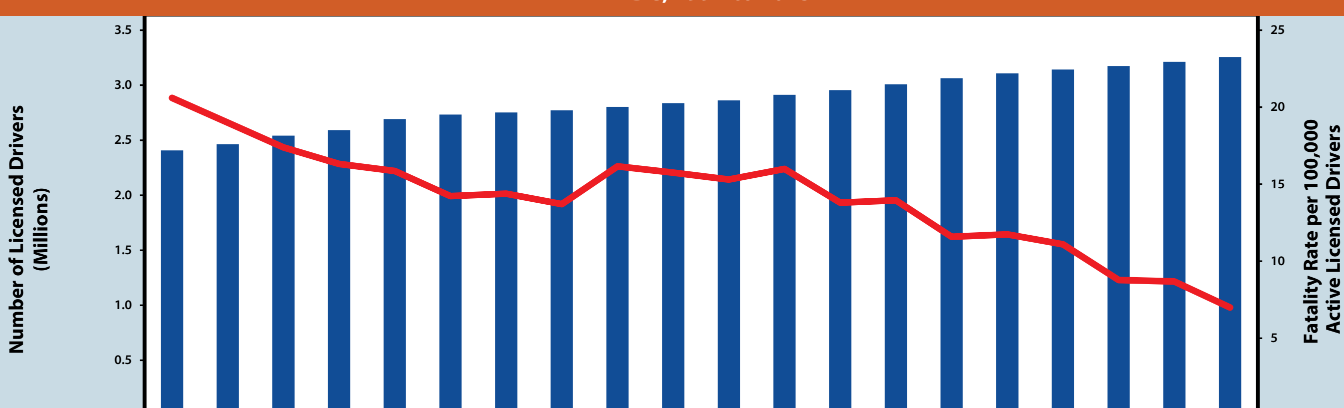
This chapter provides a brief historical overview of motor vehicle crashes (MVCs) and road safety initiatives in BC, and then examines MVC-related trends and MVC contributing factors in BC.

HISTORICAL OVERVIEW OF MVCS IN BC

Over the last 50 years, the population of BC has grown substantially, and the number of active driver's licences and of vehicles has increased. During this time, numerous laws, policies, and other initiatives have been introduced to address road safety and prevent MVCs and related serious injuries and fatalities in BC.

Figure 2.1 shows the number of active driver's licences in BC, which has increased from approximately 2.4 million in 1994 to almost 3.3 million in 2013 (a 35 per cent increase).[1] The MVC fatality rate based on active driver's licences during these years showed a substantial improvement, declining from 20.6 deaths per 100,000 active driver's licences in 1994 down to 7.0 deaths per 100,000 active driver's licences in 2013.

Figure 2.1 **Number of Active Licenced Drivers and Motor Vehicle Crash Fatality Rate per 100,000 Active Licensed Drivers, BC, 1994 to 2013**



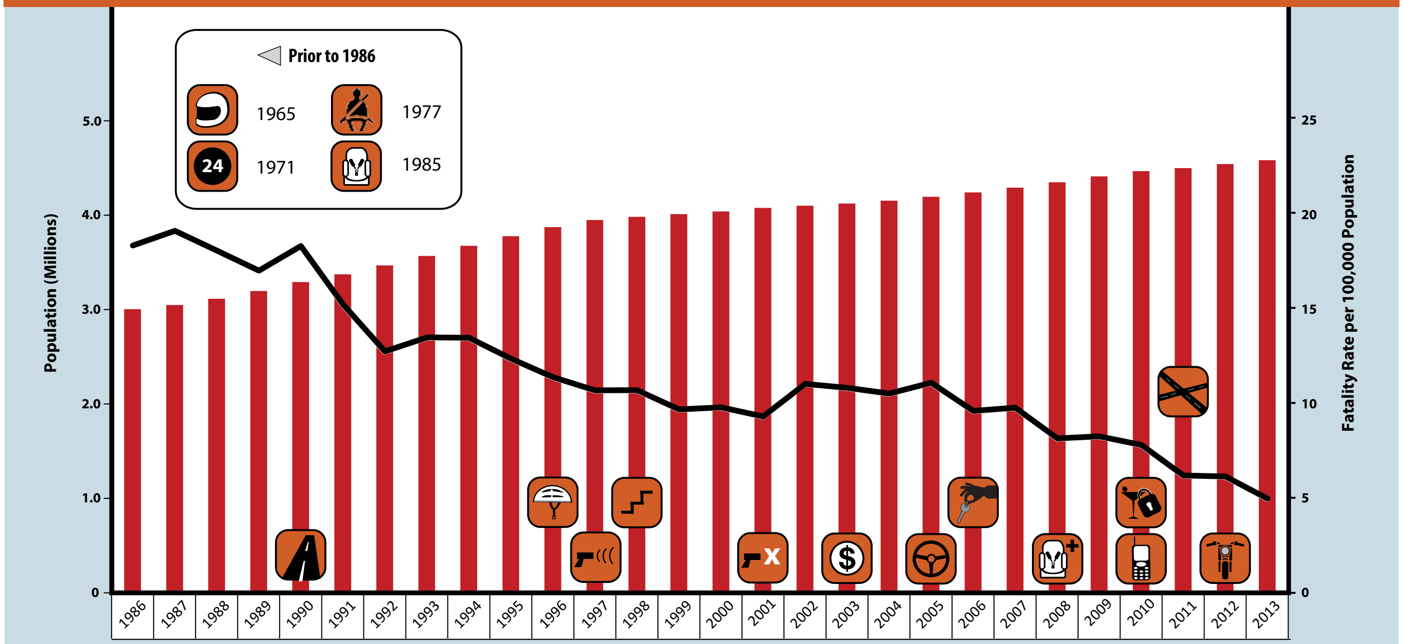
	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Active Licensed Drivers (Millions)	2.41	2.46	2.54	2.59	2.69	2.73	2.75	2.77	2.80	2.84	2.86	2.91	2.96	3.01	3.06	3.11	3.14	3.18	3.21	3.26
MVC Fatality Rate	20.6	19.0	17.4	16.3	15.9	14.2	14.4	13.7	16.2	15.8	15.3	16.0	13.8	14.0	11.6	11.7	11.1	8.8	8.7	7.0
MVC Fatalities	496	468	442	423	427	389	396	380	453	447	438	466	408	420	355	365	349	279	279	228

Year

Notes: An "active licensed driver" is one who holds a valid BC driver's licence (including a Learner or Novice licence). To be valid, the licence must not be suspended, cancelled, or expired on the date of interest. The definition of active drivers used was similar to the one used in numbers after 2002 in the ICBC Business Data Warehouse. This chart provides a crude ratio of motor vehicle-related deaths to the number of active licensed drivers in order to reveal a general trend over time. The ICBC numbers change, especially for the most recent time periods, because of late reporting, corrections, and adjustments.
Sources: Fatality data are from the BC Vital Statistics Agency; driver's licence data are from the Insurance Corporation of BC (ICBC) (data for 1994 to 2002 are from the ICBC mainframe); population estimates are from the BC Stats website, April 2015. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

Figure 2.2

Population Count and Motor Vehicle Crash Fatality Rate per 100,000 Population with Key Dates of Road Safety Initiatives, BC, 1986 to 2013



	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
BC Population	3,003,621	3,048,651	3,114,761	3,196,725	3,292,111	3,373,787	3,468,802	3,567,772	3,676,075	3,777,390	3,874,317	3,948,583	3,983,113	4,011,375
MVC Fatality Rate	18.4	19.2	18.1	17.0	18.3	15.3	12.8	13.5	13.5	12.4	11.4	10.7	10.7	9.7
MVC Fatalities	552	584	564	545	604	515	443	482	496	468	442	423	427	389

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
BC Population	4,039,230	4,076,881	4,100,161	4,123,937	4,155,017	4,195,764	4,241,691	4,290,988	4,349,412	4,410,679	4,465,924	4,499,139	4,542,508	4,582,625
MVC Fatality Rate	9.8	9.3	11.0	10.8	10.5	11.1	9.6	9.8	8.2	8.3	7.8	6.2	6.1	5.0
MVC Fatalities	396	380	453	447	438	466	408	420	355	365	349	279	279	228

Note: See Appendix B for more information about these data sources.
Sources: Fatality data are from the BC Vital Statistics Agency; population estimates are from the BC Stats website, April 2015. Prepared by Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

Event Key

- **1965** Mandatory motorcycle helmet law
- 24 **1971** 24-hour roadside prohibition for drinking drivers
- **1977** Mandatory seat belt law
- **1985** Mandatory child restraint law
- **1990** ICBC Road Improvement Program begins
- **1996** Bicycle helmet law introduced
- **1997** Photo radar introduced
- **1998** Graduated Licensing Program introduced
- **2001** Photo radar program cancelled
- **2003** Traffic enforcement initiatives enhanced through ICBC funding for the Ministry of Justice Road Safety Unit
- **2005** Responsible Driver Program for drinking drivers introduced
- **2006** *Civil Forfeiture Act* introduced allowing forfeiture of vehicles of risky drivers
- **2008** Child restraint law enhanced; mandatory booster seats
- **2010** *Motor Vehicle Act* amendment prohibits the use of handheld electronic devices while driving
- **2010** Immediate roadside prohibitions for impaired driving introduced*
- **2011** Intersection Safety Camera Program upgraded and expanded
- **2012** Additional safety provisions for motorcyclists implemented

** Immediate roadside prohibitions for impaired drivers were suspended temporarily in 2011 until May 2012, to amend related legislation after Judge Sigurdson ruled that the program in part violated constitutional rights.*

Figure 2.2 shows the number and rate of MVC fatalities and measures these fatalities against the growing population of BC from 1986 to 2013. As this graph illustrates, the population of BC increased by more than 50 per cent during the time period (from approximately 3.0 million in 1986 to nearly 4.6 million in 2013), while the number of MVC fatalities per year was reduced by nearly 60 per cent (from 552 MVC deaths in 1986 down to 228 in 2013). Consequently, the MVC fatality rate per 100,000 population improved substantially, declining by 72.8 per cent, from 18.4 deaths per 100,000 population to 5.0 deaths per 100,000 over these 28 years. While this figure shows overall improvement, there are some fluctuations, where some years saw higher levels of MVC fatalities and associated higher MVC fatality rates per 100,000 (e.g., 1993, 2002, 2005).

Figure 2.2 also highlights some of the road safety initiatives introduced in BC from 1986 to 2013, such as new and revised laws about seat belts, helmets, **alcohol impairment**, and driver distraction, as well as initiatives to address speeding, and increased emphasis on education and deterrence from violations. While correlation in the trends of MVC-related fatalities and introduction/cancellation of road safety initiatives does not provide evidence of causation, it does provide compelling information about how legislation and programming may impact road safety outcomes. For example, it is reasonable to assume that the cancellation of the photo radar program in 2001 contributed to the subsequent increase in MVC fatalities, while the introduction of the Immediate Roadside Prohibition Program and prohibition of handheld electronic devices while driving in 2010 likely contributed to the subsequent reduction seen. The successes seen in

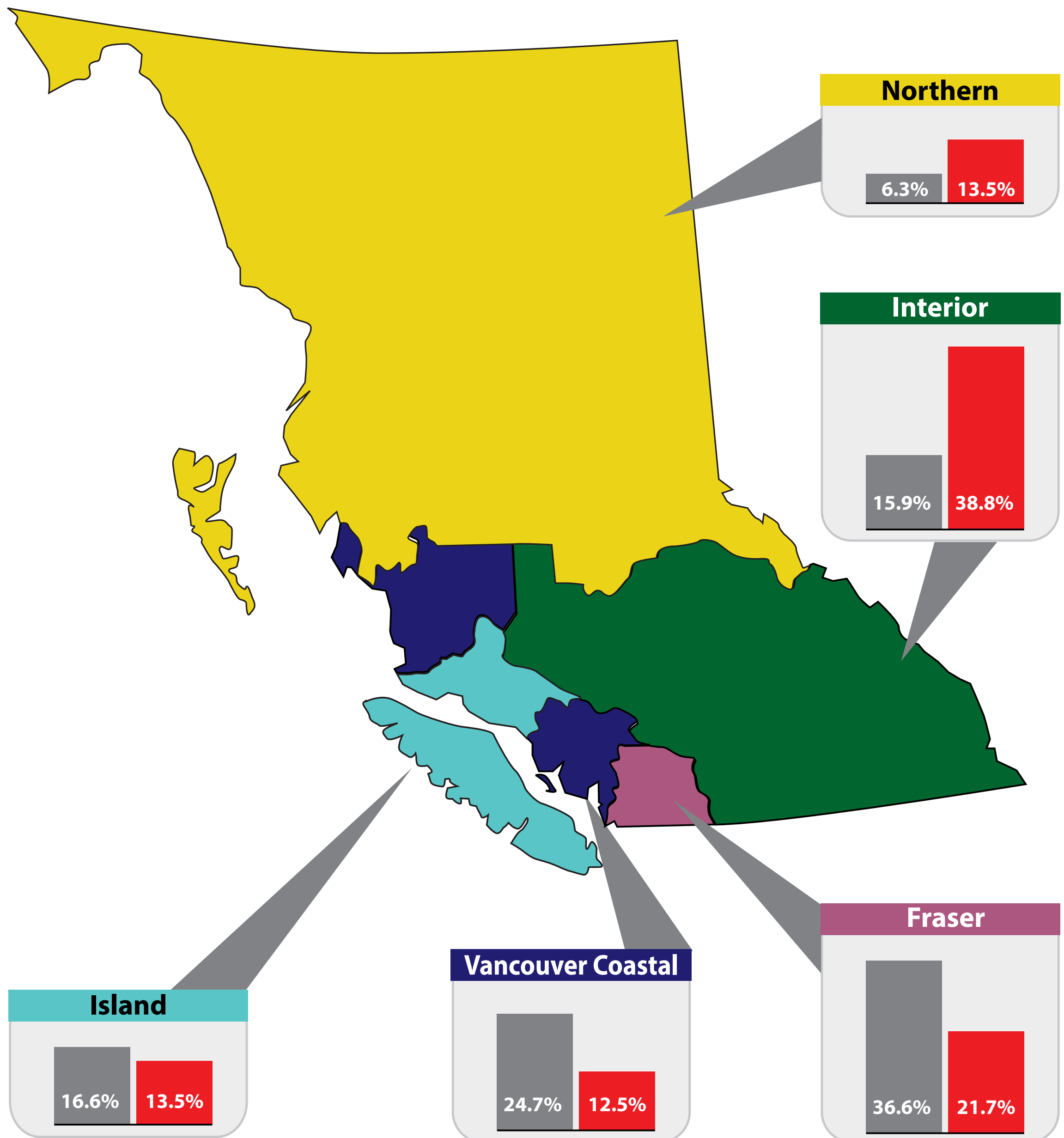
reduced fatalities in BC are likely due to the numerous road system safety initiatives introduced during this time, including safer vehicles, safer roads, and appropriate speed limits, which have all been combined with widespread police enforcement of rules of the road (e.g., seat belt use, **impairment**, speeding).

The initiatives and changes shown in Figure 2.2 are only a sample of events from the last 28 years. Since 2003, the Insurance Corporation of British Columbia (ICBC) has provided funding to the Ministry of Justice's Road Safety Unit (RSU) for enhanced traffic enforcement activities in BC. These initiatives have included road safety research, CounterAttack road checks for impaired driving, Integrated Road Safety Units[i] dedicated to traffic enforcement, and the implementation of new enforcement technologies such as Automated Licence Plate Recognition.[2] In 2011, the RSU also supported the Vancouver Pedestrian Safety Initiative[3] and the completion of an upgrade and expansion of the province's Intersection Safety Camera Program.[2]

Understanding MVCs in BC requires not only an examination of the number and rate of MVC fatalities, but also an examination of who is suffering the burden of MVC-related serious injuries and fatalities, and how that burden is distributed across sub-populations and regions of BC.

[i] Integrated Road Safety Units (IRSUs) are distinct from the Ministry of Justice's Road Safety Unit (RSU). The RSU is a policy unit within the provincial government's Police Services Division, while IRSUs are teams of officers from independent municipal police departments and RCMP traffic services who work together to target high-risk driving behaviours.

Figure 2.3a Proportion of Population and Motor Vehicle Crash Fatalities, by Health Authority, BC, 2012



Health Authority	Population	Number of MVC Fatalities	Percentage of BC Population	Percentage of MVC Fatalities
Northern	284,552	38	6.3	13.5
Interior	722,357	109	15.9	38.8
Vancouver Coastal	1,121,688	35	24.7	12.5
Island	751,809	38	16.6	13.5
Fraser	1,662,102	61	36.6	21.7
Total	4,542,508	281		

Notes: Regional information presented is based on crash location. Percentages are calculated based on population of health authority area. There were five cases in which health authority was unspecified, and these cases are excluded from this figure. See Appendix B for more information about these data sources.
Sources: Fatality data are from the Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia, 2012; population data are from BC Statistics, Population Estimates, 2012. Prepared by BC Injury Research and Prevention Unit, 2014.

EXAMINING MVC TRENDS IN BC

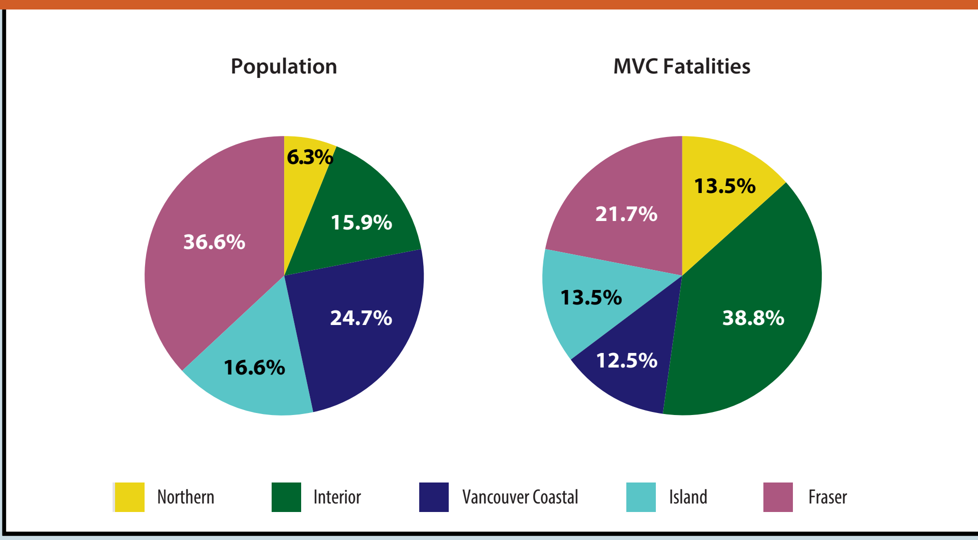
Examining provincial data in greater depth enables the identification of groups that have an increased risk of MVC-related serious injuries and fatalities within the broader population. This in turn helps promote a better understanding of the burden of MVCs in BC, and how to most effectively target prevention and intervention strategies. This section reviews MVCs by region of BC (based on health authority area), sex, and age.

Analysis by Region

BC is divided into five geographic regional health authority areas for health service delivery. Figure 2.3a shows that more than half of the approximately 4.5 million people in BC are concentrated within two of the geographically smallest health authority areas: Fraser Health and Vancouver Coastal Health. In contrast, Northern Health is the most rural and remote health authority, encompassing almost two-thirds of the province geographically, while home to only a small percentage of the total BC population. However, health authority areas can be very diverse, so analyses presented at this level can mask higher rates of fatalities and hospitalizations in particular communities; for example, Vancouver Coastal Health is a diverse region, and low MVC fatality rates in the large urban population in Greater Vancouver may mask higher fatality rates in the more rural and remote areas of the health authority, such as the central BC coast and the Bella Coola Valley.

Figures 2.3a and 2.3b show that the burden of MVCs in BC is also not distributed proportionally to population size among regional health authorities. In 2012, the more rural/remote health authorities, Northern Health and Interior Health, were significantly over represented: Northern Health had 6.3 per cent of the population, but 13.5 per cent of the MVC fatalities occurred there; Interior Health had 15.9 per cent of the population, but 38.8 per cent of the MVC fatalities occurred there. At the same time, much lower proportions of MVC fatalities occurred in the more urban health

Figure 2.3b Proportion of Population and Motor Vehicle Crash Fatalities, by Health Authority, BC, 2012



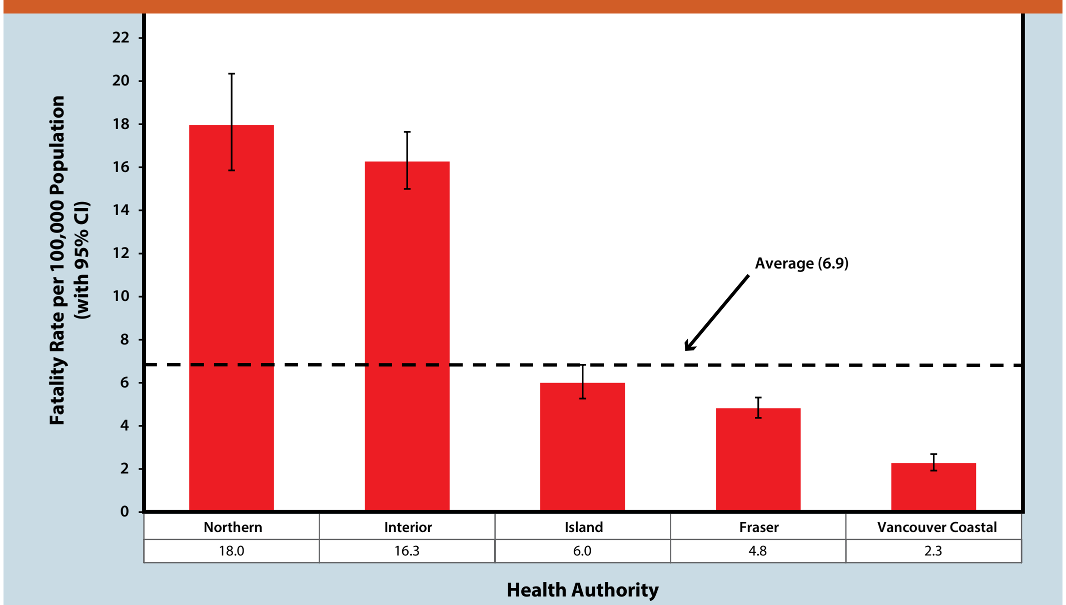
Notes: Regional information presented is based on crash location. Percentages are calculated based on population of health authority area. There were five cases in which health authority was unspecified, and these cases are excluded from this figure. See Appendix B for more information about these data sources.
Sources: Fatality data are from the Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia, 2012; population data are from BC Statistics, Population Estimates, 2012. Prepared by BC Injury Research and Prevention Unit, 2014.

authorities, Vancouver Coastal Health and Fraser Health, compared to their populations. Vancouver Coastal Health had 24.7 per cent of the population, but only 12.5 per cent of the MVC fatalities occurred there. Fraser Health had 36.6 per cent of the population but only 21.7 per cent of the MVC fatalities occurred there.

Regional variation in MVC fatality rates likely reflects the different geographies, specifically, the differences between rural/remote and urban areas and the related differences in infrastructure, speed limits, traffic patterns, and access to emergency services. The variation may also highlight differences in the quality and frequency of road maintenance and traffic enforcement and regional variations in weather. The effect of road locations, road types, and weather will be discussed further in Chapter 7.

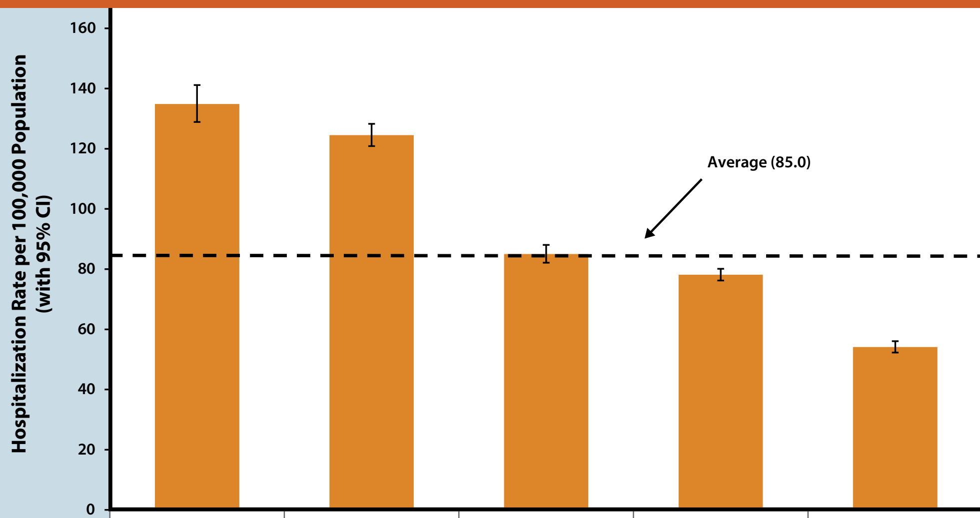
Figure 2.4 shows the average age-standardized MVC fatality rates (2008-2012) per 100,000 population by health authority. The highest rates in BC occurred in Northern Health and Interior Health, at 18.0 and 16.3 fatalities per 100,000, respectively. These rates are higher than the BC average rate of 6.9 per 100,000 for this time period, and considerably higher than rates for other regions (three to nearly eight times higher). The lowest MVC fatality rate is found in Vancouver Coastal Health, at 2.3 fatalities per 100,000.

Figure 2.4 **Age-standardized Motor Vehicle Crash Fatality Rate per 100,000 Population, by Health Authority, BC, 2008-2012**



Notes: Health authority rates are based on the residence of the patient and may not be the same as the location of the crash or the location of the health care service provided. Rates are calculated based on the population of the health authority. Age-standardized rates are calculated using Canada 1991 Census population. See Appendix B for more information about these data sources.
Sources: Fatality data are from the Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia, 2008-2012; population estimates are from the BC Stats website, April 2015. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

Figure 2.5 **Age-standardized Motor Vehicle Crash Hospitalization Rate per 100,000 Population, by Health Authority, BC, 2006-2010**



Northern	Interior	Island	Fraser	Vancouver Coastal
134.9	124.5	85.0	78.1	54.1

Notes: Health authority rates are based on the residence of the patient and may not be the same as the location of the crash or the location of the health care service provided. Rates are calculated based on the population of the health authority. Age-standardized rates are calculated using Canada 1991 Census population. There were fewer than five cases in which health authority was unspecified, and these cases are excluded from this figure. See Appendix B for more information about these data sources.
Sources: Hospitalization data are from the Discharge Abstract Database, Ministry of Health, 2006-2010; population estimates are from the BC Stats website, April 2015. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

Figure 2.5 shows the average age-standardized MVC-related hospitalization rate per 100,000 population in BC for 2006-2010 by the victim's health authority of residence. Similar to fatality rates, this figure demonstrates that residents of Northern and Interior Health had the highest MVC hospitalization rates in BC, at 134.9 and 124.5 per 100,000, respectively, while residents of Vancouver Coastal Health again had the lowest, at 54.1 per 100,000. While the difference in hospitalization rates is not as drastic as the difference in fatality rates between health regions, the rate in Northern Health is still two-and-a-half times higher than the rate in Vancouver Coastal Health.

Higher serious injury and fatality rates in Northern and Interior Health may be linked to challenges specific to rural and remote geographies. For example, this could include longer driving distances between population centres; reduced traffic enforcement on rural/remote and **resource roads**; higher speeds on highways; more interactions with wildlife on roadways; more severe weather conditions, particularly in the winter months; a high volume of commercial vehicle traffic;[j,4,5,6] increased likelihood of impaired driving outside metropolitan areas;[7] and lower restraint use in rural areas.[8]

> **"People living in Northern BC are two and a half times more likely to die in a Motor Vehicle Crash than are their counterparts across the province."**
>
> – D. Bowering, *Crossroads: Report on Motor Vehicle Crashes in Northern BC* [5]

[j] A high volume of commercial vehicle traffic or frequent use by large and heavy vehicles requires specific road design and maintenance to ensure the integrity and ongoing safety of roadways.

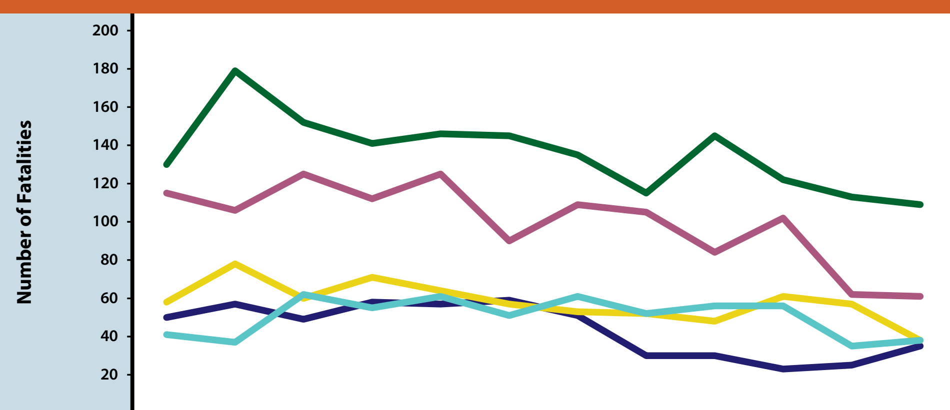
The greater disparity between regions for MVC fatalities may be the result of higher vehicle speeds, and/or of longer emergency response times and greater distances between hospitals and treatment centres in more rural and remote areas, which can impact the outcome of an injury, or whether a serious injury becomes a fatality.[5] Conversely, lower fatality and serious injury rates in urban areas may be linked to factors such as lower posted speeds, increased likelihood of enforcement, and closer proximity to emergency responders and hospitals and treatment centres. These issues will be explored in more detail in Chapter 7.

As shown in Figure 2.6, the total numbers of MVC fatalities in the health authorities reveal somewhat different patterns than the rates presented earlier, with the highest numbers in Interior and Fraser Health (Fraser was second lowest when analyzed by rate), and the lowest in Northern and Island Health (Northern was highest when analyzed by rate). Interior Health has the highest raw numbers of MVC fatalities. However, these data reflect fatalities based on crash location, and as a major corridor into the province for commercial vehicles and tourism, Interior Health may have elevated counts due to the inclusion of non-residents in these data. This figure also shows that year-to-year trends have not been the same across the province, and health regions have experienced increases and decreases in different years than one another. For example, in 2002 in Fraser Health and Island Health there were decreases in the number of MVC fatalities, while in Vancouver Coastal, Northern, and Interior there were increases—including a substantial spike on roads within Interior Health.

Analysis by Sex

In addition to regional differences, MVC fatalities and serious injuries in BC vary by demographic variables, including sex. Research shows that males tend to drive more aggressively than females, are more likely than females to engage in a variety of high-risk road user behaviours (e.g., speeding, impaired driving), and also tend to drive more kilometres[9,10,11,12,13,14] (see Chapter 5 for additional discussions of driver behaviour). Therefore, males are at greater risk of MVC fatalities and serious injuries.

Figure 2.6 **Number of Motor Vehicle Crash Fatalities, by Health Authority, BC, 2001 to 2012**

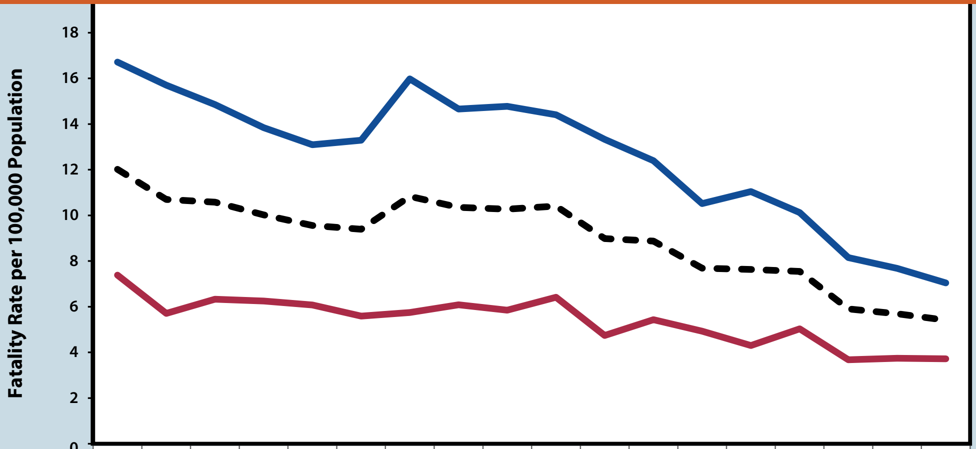


	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Interior	130	179	152	141	146	145	135	115	145	122	113	109
Fraser	115	106	125	112	125	90	109	105	84	102	62	61
Vancouver Coastal	50	57	49	58	57	59	51	30	30	23	25	35
Northern	58	78	60	71	64	57	53	52	48	61	57	38
Island	41	37	62	55	61	51	61	52	56	56	35	38
BC Total	394	457	448	440	453	402	411	354	363	364	292	281

Year

Notes: Health authority is presented based on crash location. Rates are calculated based on population of health authority. There were five cases in which health authority was unspecified, and these cases are excluded from this figure. See Appendix B for more information about this data source.
Source: Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia, 2001-2012. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

Figure 2.7 **Age-standardized Motor Vehicle Crash Fatality Rate per 100,000 Population, by Sex, BC, 1996 to 2013**



	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Male	16.7	15.7	14.9	13.8	13.1	13.3	16.0	14.7	14.8	14.4	13.3	12.4	10.5	11.0	10.1	8.2	7.7	7.0
Female	7.4	5.7	6.3	6.3	6.1	5.6	5.7	6.1	5.8	6.4	4.7	5.4	4.9	4.3	5.0	3.7	3.7	3.7
BC	12.0	10.7	10.6	10.0	9.6	9.4	10.8	10.4	10.3	10.4	9.0	8.9	7.7	7.6	7.5	5.9	5.7	5.4

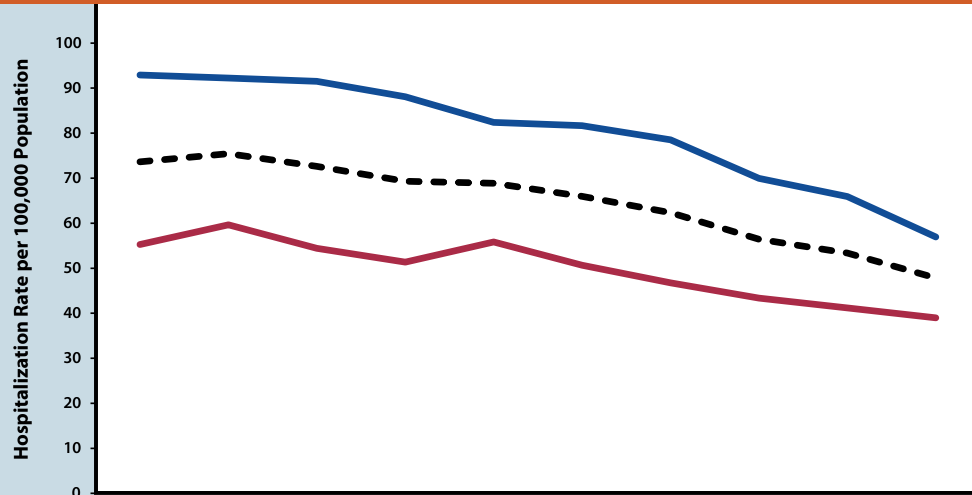
Year

Notes: There were 101 cases where age group was missing, and these cases are excluded from this figure. There were 24 cases where sex was missing, but these cases are included in the total rate. Age-standardized rates are calculated using Canada 1991 Census population. See Appendix B for more information about these data sources.

Sources: Fatality data are from the Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia, 1996-2013; population estimates are from the BC Stats website, April 2015. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

Figure 2.7 shows age-standardized MVC fatality rates in BC analyzed by sex, from 1996 to 2013. Overall, the total age-standardized MVC fatality rate in BC decreased by more than half over these 18 years, from 12.0 fatalities per 100,000 population in 1996 to 5.4 per 100,000 in 2013. The fatality rate for males was more than double the female rate for the majority of years, though the greater decline for males has somewhat narrowed the gap in recent years. The rates decreased from 16.7 to 7.0 per 100,000 population for males and from 7.4 to a low of 3.7 per 100,000 for females from 1996 to 2013. Female rates showed less fluctuation over this time period.

Figure 2.8 **Age-standardized Motor Vehicle Crash Hospitalization Rate per 100,000 Population, by Sex, BC, 2002 to 2011**



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Male	92.9	92.2	91.5	88.1	82.4	81.6	78.5	70.0	65.9	56.9
Female	55.3	59.6	54.4	51.4	55.8	50.6	46.8	43.4	41.2	39.0
BC	73.6	75.4	72.6	69.3	68.9	66.0	62.3	56.4	53.4	47.8

Year

Notes: Age-standardized rates are calculated using Canada 1991 Census population. See Appendix B for more information about these data sources.
Sources: Hospitalization data are from the Discharge Abstract Database, Ministry of Health, 2002-2011; population estimates are from the BC Stats website, April 2015. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

Figure 2.8 shows similar trends in age-standardized MVC serious injury rates in BC as the fatality rates shown in Figure 2.7. From 2002 to 2011, the overall hospitalization rate declined from 73.6 to 47.8 per 100,000 population, with males having a higher rate at all points in time but also experiencing greater decreases over time than females, resulting in the gap between sexes beginning to narrow. For males, the rate declined from 92.9 serious injuries per 100,000 population in 2002 to 56.9 per 100,000 in 2011 (a 39 per cent reduction). For females, the serious injury rate declined from 55.3 to 39.0 per 100,000 population over these 10 years (a 29 per cent reduction). Similar to the trends in fatality rates, the male and female trends for serious injury rate are noticeably different, with a heightened rate for females in 2003 and 2006 that was not observed among males, while for males there was a nearly steady decrease across the years shown.

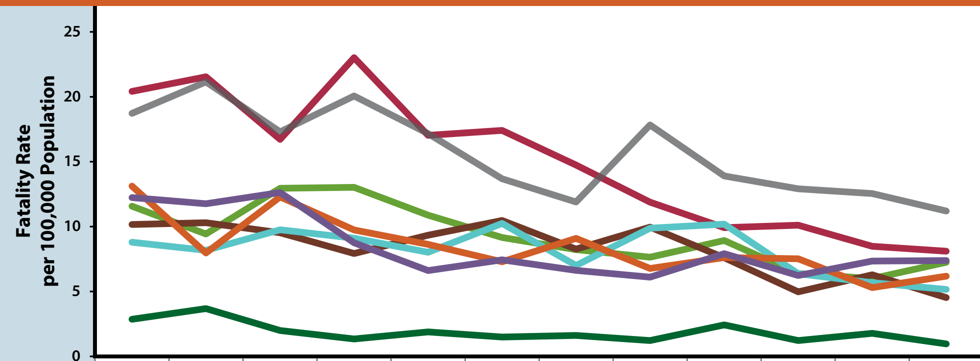
Analysis by Age

Trend analyses suggest that in addition to region and sex, age also plays a role in the burden of MVC fatalities and injuries. Figure 2.9 shows that from 2002 to 2013, there were considerable successes in reducing MVC fatality rates per 100,000 population. The highest fatality rates seen here are among those age 16-25, and 76 and up. The 16-25 age group achieved the greatest decrease in fatality rate overall during this period (60.3 per cent). The rate jumped from 2008 to 2009 among those age 76 and up, and the highest MVC fatality rate was experienced by this age group from 2009 onward.

Figure 2.10 shows that from 2002 to 2011, there were similar trends for hospitalization rates as for fatality rates among the age groups, with those age 16-25 and 76 and up having the highest rates per 100,000 population among the age groups. However,

Figure 2.9

Motor Vehicle Crash Fatality Rate per 100,000 Population, by Age Group, BC, 2002 to 2013



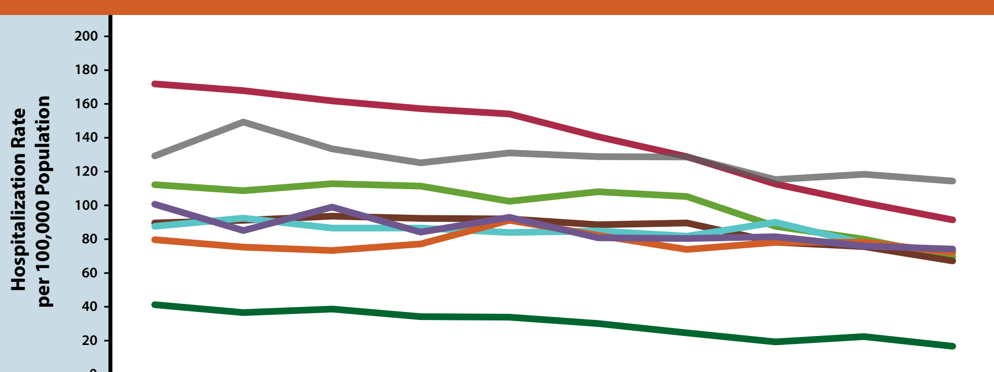
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
0-15	2.9	3.7	2.0	1.3	1.9	1.5	1.6	1.2	2.4	1.2	1.8	1.0
16-25	20.4	21.5	16.7	23.0	17.0	17.4	14.7	11.9	9.9	10.1	8.5	8.1
26-35	11.6	9.4	13.0	13.0	10.9	9.2	8.2	7.6	8.9	6.4	6.0	7.2
36-45	10.2	10.3	9.5	7.9	9.3	10.5	8.3	10.0	7.6	5.0	6.3	4.5
46-55	8.8	8.2	9.8	9.1	8.0	10.2	7.0	9.9	10.2	6.4	5.7	5.2
56-65	13.1	8.0	12.3	9.7	8.6	7.3	9.1	6.8	7.6	7.5	5.3	6.2
66-75	12.2	11.8	12.6	8.8	6.6	7.4	6.6	6.1	7.9	6.2	7.3	7.4
76+	18.7	21.1	17.3	20.1	17.2	13.7	11.9	17.8	13.9	12.9	12.5	11.2

Year

Notes: There were 63 cases where age group was missing, and these cases are excluded from this figure. See Appendix B for more information about these data sources.
Sources: Fatality data are from the Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia, 2002-2013; population estimates are from the BC Stats website, April 2015. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

Figure 2.10

Motor Vehicle Crash Hospitalization Rate per 100,000 Population, by Age Group, BC, 2002 to 2011



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
0-15	41.3	36.6	38.7	34.2	33.9	30.1	24.6	19.3	22.4	16.7
16-25	171.9	167.8	161.8	157.2	154.2	140.6	128.8	112.7	101.5	91.4
26-35	112.2	108.7	112.8	111.4	102.4	108.0	105.3	87.6	80.1	69.5
36-45	89.6	91.2	93.6	92.3	92.0	88.6	89.6	78.3	75.7	67.2
46-55	87.6	92.5	86.5	86.6	84.0	84.9	81.8	90.0	77.4	72.9
56-65	79.7	75.3	73.3	77.2	91.2	82.4	73.9	78.1	78.3	72.2
66-75	100.7	85.1	98.9	84.2	92.9	80.9	80.5	81.5	76.0	74.2
76+	129.3	149.3	133.4	125.2	131.1	128.9	128.7	115.3	118.4	114.4

Year

Notes: Rates are calculated using age-specific population. See Appendix B for more information about these data sources.
Sources: Hospitalization data are from the Discharge Abstract Database, Ministry of Health, 2002-2011; population estimates are from the BC Stats website, April 2015. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

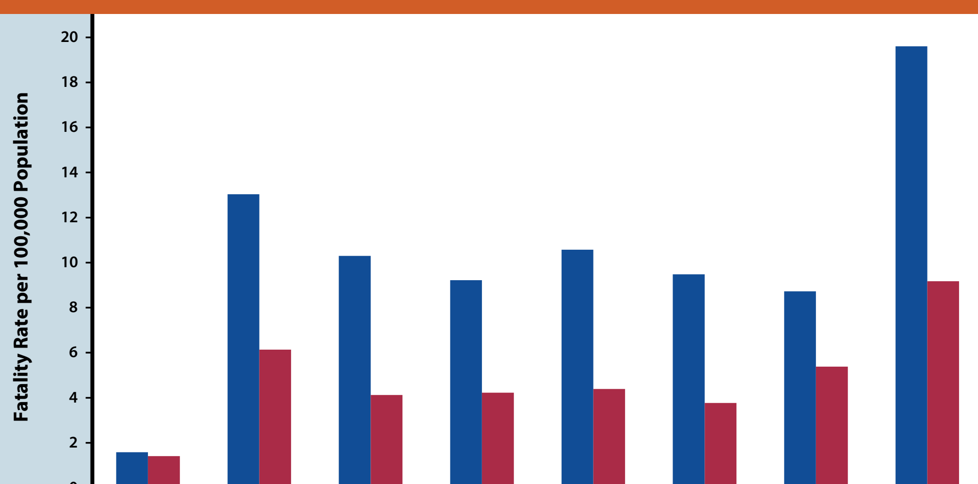
much like fatality rates, in 2009 those age 76 and up surpassed those age 16-25 in serious injury rates and have remained the group most burdened by hospitalizations per 100,000 population ever since. Unlike the fatality trends, there were no striking increases in rates for 2005 and 2009.

Figures 2.11 and 2.12 show MVC fatality and hospitalization rates by age group and sex in BC for 2009-2013 and 2007-2011, respectively. These figures show that males have higher fatality and serious injury rates than females in all age groups over age 16. As these two figures show, the MVC fatality and hospitalization rates per 100,000 population are lowest for males and females less than 16 years old. For fatality rates, both sexes have their highest rate within the 76 and up age group, but for hospitalization rates, the highest rates differ by age group and sex, with males having the highest hospitalization rates at age 16-25, and females having the highest at age 76 and up.

A U-shaped curve is often observed when age-specific MVC risks are charted: fatality and hospitalization rates are high for younger road users, decrease for those in middle age groups, and increase again for older road users.[9] Figures 2.11 and 2.12 reflect this U-shape, though it is most pronounced for males. These figures also demonstrate that the increase in risk of suffering a fatality or of sustaining a serious injury due to an MVC increases dramatically at age 16. Since individuals can only drive once they are 16 years old, this suggests that when youth begin to drive they are at much higher risk of being killed or seriously injured in an MVC—for both males and females, but particularly for young males. (See Chapter 5 for additional discussions of driver behaviour).

Evidence indicates that factors that influence the level of risk among younger drivers may include limited driving experience, immaturity, poor risk perception, peer influence, and a greater tendency toward

Figure 2.11 **Motor Vehicle Crash Fatality Rate per 100,000 Population, by Sex and Age Group, BC, 2009-2013**

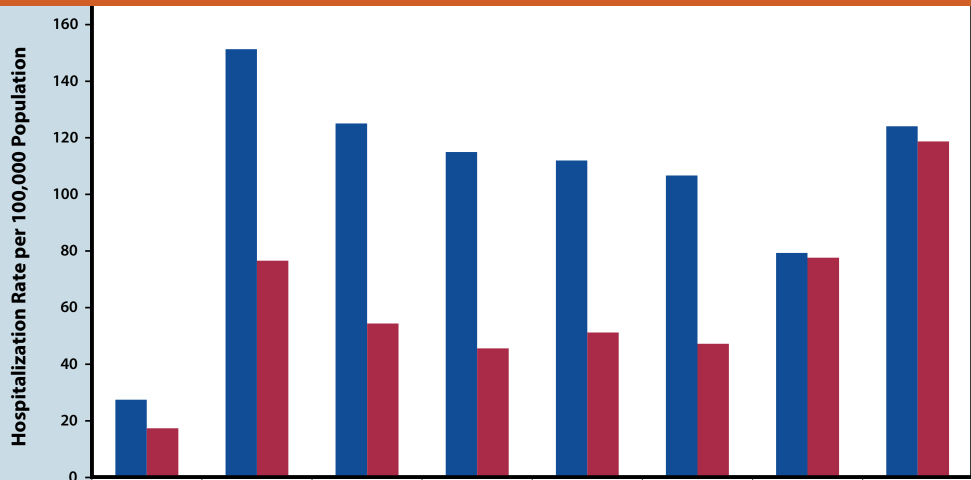


	0-15	16-25	26-35	36-45	46-55	56-65	66-75	76+
Male	1.6	13.0	10.3	9.2	10.6	9.5	8.7	19.6
Female	1.4	6.1	4.1	4.2	4.4	3.8	5.4	9.2

Age Group

Notes: Rates are calculated using age- and sex-specific population numbers. There were 19 cases where age group and/or sex was missing, and these cases are excluded from this figure. See Appendix B for more information about these data sources.
Sources: Fatality data are from the Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia, 2009-2013; population estimates are from the BC Stats website, April 2015. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

Figure 2.12 Motor Vehicle Crash Hospitalization Rate per 100,000 Population, by Sex and Age Group, BC, 2007-2011



	0-15	16-25	26-35	36-45	46-55	56-65	66-75	76+
Male	27.5	151.3	125.1	115.0	112.0	106.7	79.3	124.1
Female	17.4	76.6	54.4	45.6	51.3	47.2	77.6	118.7

Age Group

Notes: Rates are calculated using age- and sex-specific population numbers. See Appendix B for more information about these data sources.
Sources: Hospitalization data are from the Discharge Abstract Database, Ministry of Health, 2007-2011; population estimates are from the BC Stats website, April 2015. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

higher-risk driving.[9,15,16,17] A report by the Organisation for Economic Co-operation and Development concluded that driving experience is of greater relevance than age in considerations of young driver safety.[18]

Factors that influence the level of risk among older drivers may include age-related visual, cognitive, and/or motor function impairments (e.g., reduced peripheral vision, range of motion, and judgment and reaction times), medical conditions, and medication use, all of which can diminish driving performance and safety.[19,20,21] Increased risk of fatality and serious injury among older age groups may also be linked to age-related physical frailty: older adults may be less able to withstand and recover from physical trauma, and those who are involved in MVCs are therefore more likely than younger people to sustain serious or fatal injuries.[22,23] Chapters 3 and 4 provide a more in-depth discussion regarding road users and their related risk factors.

FACTORS CONTRIBUTING TO MVCS IN BC

In addition to understanding which regions and sub-populations are experiencing the greatest burden of MVC fatalities and serious injuries in BC, it is important to examine the factors that contribute to MVCs.

Road System Use

From a system perspective, one overall contributing factor to MVC risk for a population is the number of vehicles on the road—in other words, traffic volume[24] and distance traveled.[25] It is generally recognized that, at a population level, the less traffic volume and the fewer annual vehicle kilometres per capita traveled, the lower the MVC fatalities per 100,000 population.[24,25] For example, a study in Norway showed that 66.8 per cent of the variation in injury MVC rate between counties was explained by traffic volume.[24]

Public transit is one way to reduce vehicle volume. Evidence shows that as annual per capita public transit passenger distances increase[25] or the number of annual transit trips per capita increase,[26] the traffic fatalities per 100,000 population decreases. Public transit is also a safe option for travel: research has shown its high safety rates in comparison to private vehicles. For example, a study of US transportation-related fatalities from 2000 to 2009 shows that fatalities per billion-miles traveled are much lower for public buses, urban mass transit like light rail, and commuter heavy rail (0.1, 0.2, and 0.4, respectively) compared to car and light truck drivers and passengers (7.3), and motorcyclists (212.6).[27] Research from the UK confirms similarly low MVC fatality rates per billion passenger-kilometres for light rail, heavy rail, and bus (0.00002, 0.1, and 0.1, respectively), compared to private cars (3.0) or **motorcycles** (112.0).[28] Furthermore, an international study including data from Sweden, Denmark, Great Britain, The Netherlands, and Norway estimated that bus passengers had half the injury rate relative to car drivers.[24] Overall, public transit benefits road safety by providing a safe alternative to private vehicle travel while reducing road traffic volume. Public transportation will be discussed further in Chapters 3 and 7.

Top MVC Contributing Factors in BC

For each police-attended MVC, police identify contributing factors. These are events and circumstances that are perceived to directly contribute to the MVC, as determined by the attending police officer,[29(p.xi)] and are recorded when an accident report is filed.[30] These MVC contributing factors fall within four broad categories:

1) *Human conditions* – such as **road user distraction** (distraction of a driver or other road user), driver inattention, or impairment of a driver or other road user.
2) *Human actions* – such as driver error, speeding, or failing to yield right of way.
3) *Environmental conditions* – such as road condition, weather,[k] or wild animals.
4) *Vehicle condition* – such as defective tires or defective brakes.[29(p.12),30]

These four categories roughly reflect the four pillars of the Safe System Approach (SSA) employed in the safe system framework used in this report—safe road users, safe speeds, safe roadways, and safe vehicles—though the framework allows greater emphasis on speed by setting it apart as its own pillar (safe speeds), and combines human condition and human action into one pillar (safe road users). Contributing factors identified in police reports are subject to the attending police officers' and witnesses' interpretations of the contributing factors to the crash. They are also not based on an SSA; instead, they focus on human contributing factors and other factors related to the *Motor Vehicle Act* rather than providing a broader framework in which prevention and harm reduction through vehicle design, roadway design and conditions, and speed zone limits would be of similar emphasis. (See Chapter 1 and Appendix B for more information).

Police may assign up to four contributing factors to each road user involved in an MVC (i.e., vehicle, motorcycle, cyclist, or pedestrian),[31] so each MVC may have multiple contributing factors, all of which help to explain the events leading to the MVC. In some cases a particular contributing factor may be clearly dominant and additional contributing factors may not be assigned. For example, if it is known that a driver fell asleep at the wheel, entered the oncoming lane and collided with an oncoming vehicle, contributing factors would include "fell asleep" (human condition) and "driving on wrong side of road" (human action), but since the driver falling asleep is clearly the main cause of the MVC, it is not likely that any contributing factors would be assigned to the second vehicle.[30]

[k] Road condition includes considerations such as ice, snow, slush, and water, while weather includes fog, sleet, rain, and snow.

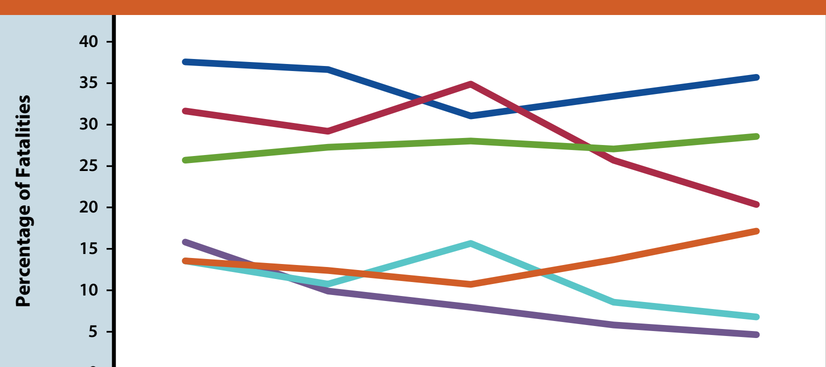
> “The Immediate Roadside Prohibition program has demonstrated success in reducing impaired-related MVC fatalities.”

As shown in Figure 2.13, overall, the top contributing factors to MVCs with fatalities that were reported on MVC incident report forms by police in BC between 2008 and 2012 were speed, impairment, and **distraction**. The proportion of MVC fatalities with speed as a contributing factor declined from 2008 to 2010 but increased again, reaching nearly 2009 proportions by 2012. The percentage of MVC fatalities with impairment as a contributing factor decreased from 31.6 per cent to 20.4 per cent over these five years, despite a pronounced increase in 2010.

Evaluations of the Immediate Roadside Prohibition program for drivers with a **blood alcohol content (BAC)** level of 0.5 milligrams of alcohol per 100 millilitres of blood introduced in BC in 2010 have demonstrated its success in reducing alcohol-involved MVC fatalities.[32,33] These results are visible in the substantial decreases seen in impairment-related MVC fatalities in the years following its introduction (Figure 2.13).

The proportion of MVC fatalities with distraction as a contributing factor increased from 25.7 to 28.6 per cent from 2008 to 2012. This figure suggests that while distracted driving legislation introduced in 2010 may have had a small as well as brief effect in curbing the increase in distraction-related fatalities, this factor increased again slightly the following year. Further monitoring and analysis of the impact of this legislation will be important in the coming years. While road condition is not one of the top three contributing factors, the increase shown in recent years also warrants further monitoring.

Figure 2.13 **Proportion of Motor Vehicle Crash Fatalities, by Top Contributing Factor, BC, 2008 to 2012**

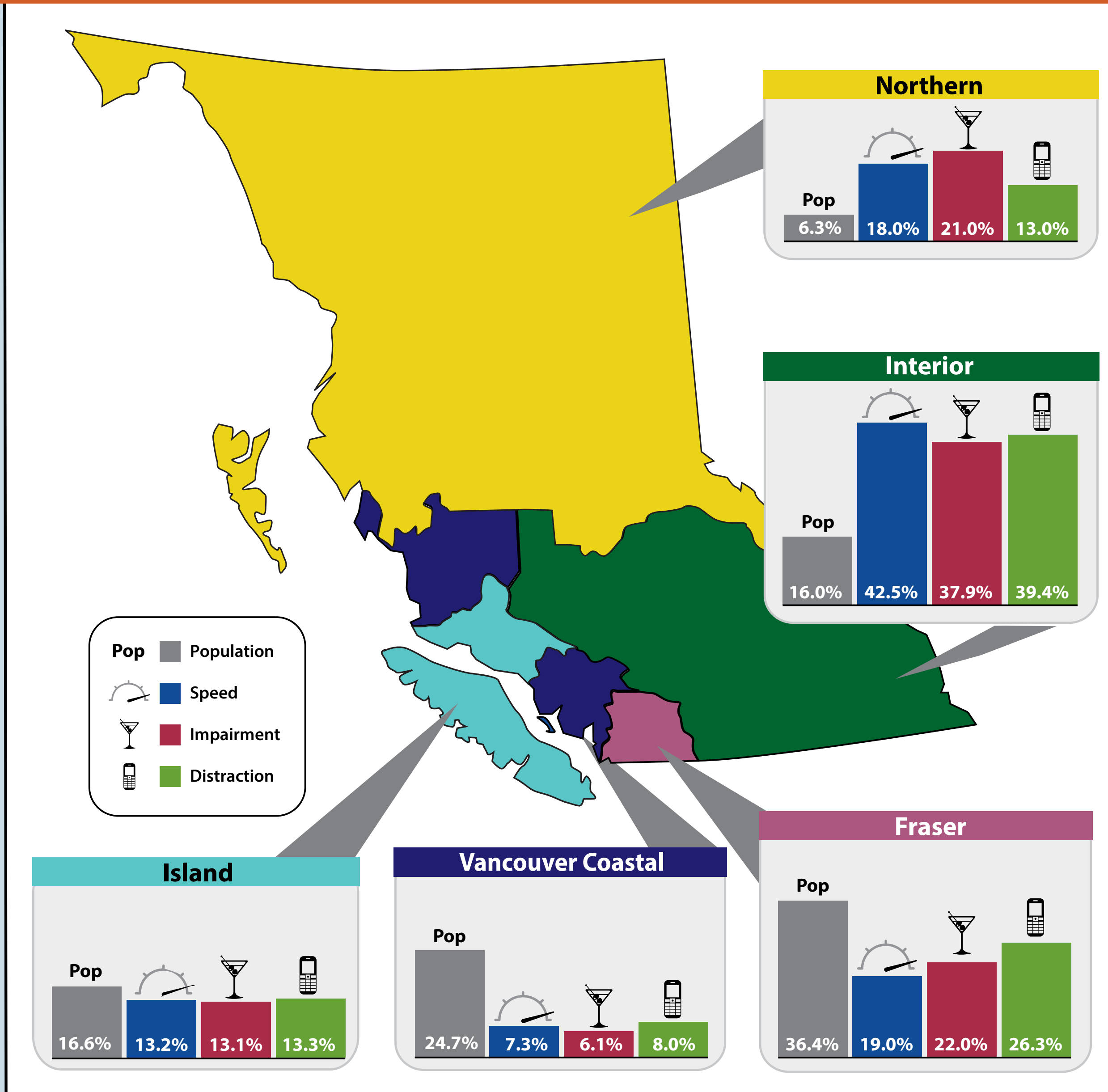


	2008	2009	2010	2011	2012
Speed	37.6	36.6	31.0	33.6	35.7
Impairment	31.6	29.2	34.9	25.7	20.4
Distraction	25.7	27.3	28.0	27.1	28.6
Driver Error/Confusion	15.8	9.9	8.0	5.8	4.6
Driving on Wrong Side of Road	13.6	10.7	15.7	8.6	6.8
Road Condition	13.6	12.4	10.7	13.7	17.1

Year

Notes: "Impairment" includes alcohol involvement, ability impaired by alcohol, alcohol suspected, drugs illegal, ability impaired by drugs, drugs suspected, and ability impaired by medication. "Distraction" includes use of communication/video equipment, driver inattention, and driver internal/external distraction. "Driver error/confusion" includes gas/brake pedal confusion. "Road condition" includes ice, snow, slush, and/or water on the road. Data are based on police reports from police-attended motor vehicle crashes; therefore, contributing factors reported emphasize human error rather than other systemic factors (e.g., vehicle design, roadway design). See Appendix B for more information about this data source.
Source: Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia, 2008-2012. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

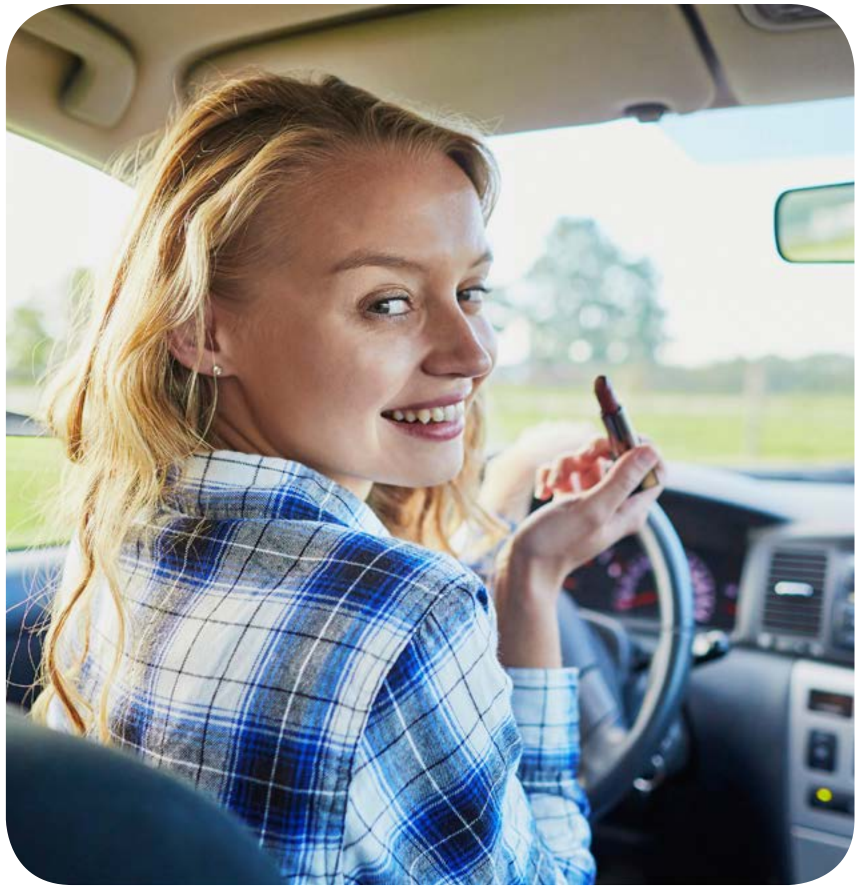
Figure 2.14 Proportion of Population and Motor Vehicle Crash Fatalities for the Top Three Contributing Factors, by Health Authority, BC, 2009-2013



Health Authority	Population	Percentage of BC Population	Number of Speed-related Fatalities	Percentage of Speed-related Fatalities	Number of Impairment-related Fatalities	Percentage of Impairment-related Fatalities	Number of Distraction-related Fatalities	Percentage of Distraction-related Fatalities
Northern	282,826	6.3%	94	18.0%	90	21.0%	57	13.0%
Interior	721,190	16.0%	222	42.5%	162	37.9%	172	39.4%
Vancouver Coastal	1,110,349	24.7%	38	7.3%	26	6.1%	35	8.0%
Island	748,797	16.6%	69	13.2%	56	13.1%	58	13.3%
Fraser	1,637,014	36.4%	99	19.0%	94	22.0%	115	26.3%
BC Total	4,500,175		522		428		437	

Notes: Regional information presented is based on crash location. "Population" is the average population for 2009 to 2013. Population percentage is calculated based on the population of health authority area. There were cases in which health authority was unspecified, and these cases are excluded from this figure. "Speed-related" fatalities are deaths where one or more vehicles involved in a crash had any one of the contributing factors: unsafe speed, exceeding speed limit, excessive speed over 40 km/h, and/or driving too fast for conditions. "Distraction-related" fatalities are deaths where one or more vehicles involved in the crash had any one of the contributing factors: use of communication/video equipment, driver internal/external distraction, and/or driver inattention. "Impaired-related" fatalities are deaths where one or more vehicles involved in the crash had any one of the contributing factors of: alcohol involvement, prescribed medication and/or drug involvement listed. Data are based on police reports from police-attended motor vehicle crashes; therefore, contributing factors reported emphasize human error rather than other systemic factors (e.g., vehicle design, roadway design). Victim may or may not be the impaired person involved in the crash. See Appendix B for more information about these data sources.
Sources: Fatality data are from the Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia 2009-2013; population estimates are from the BC Stats website, April 2015. Prepared by BC Injury Research and Prevention Unit, 2015; and the Office of the Provincial Health Officer, 2015.

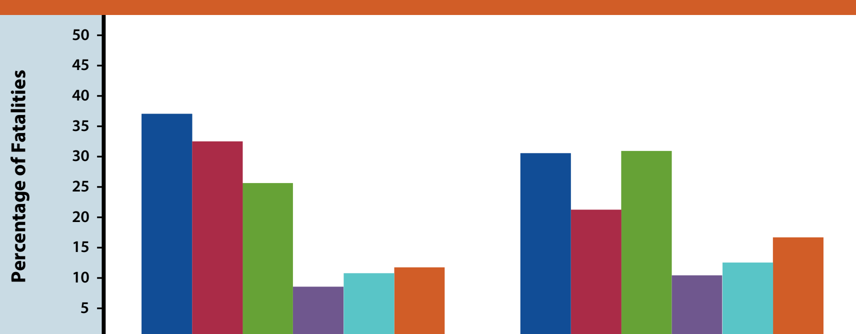
Figure 2.14 shows the distribution of the population and the top three contributing factors to MVCs based on regional health authority for 2009-2013.The figure shows a generally uneven distribution of MVCs with these contributing factors relative to the population. The higher relative proportions occurred in Interior Health and Northern Health for all three factors, while Vancouver Coastal Health and Fraser Health had relatively lower proportions for all three factors.



Exploring these top contributing factors by sex and age enables a greater understanding of which sub-populations are at greatest risk of an MVC fatality due to these factors. Figure 2.15 shows that for 2008-2012 male and female MVC fatalities share the same top three human contributing factors (speed, impairment, and distraction). However, a greater proportion of male MVC fatalities involved speed and impairment, while a slightly higher proportion of female MVC fatalities involved speed and distraction.

Figure 2.15

Proportion of Motor Vehicle Crash Fatalities, by Top Contributing Factor and Sex, BC, 2008-2012



	Male	Female
Speed	37.0	30.6
Impairment	32.5	21.3
Distraction	25.6	30.9
Driver Error/Confusion	8.5	10.4
Driving on Wrong Side of Road	10.8	12.5
Road Condition	11.8	16.7

Sex

Notes: "Impairment" includes alcohol involvement, ability impaired by alcohol, alcohol suspected, drugs illegal, ability impaired by drugs, drugs suspected, and ability impaired by medication. "Distraction" includes use of communication/video equipment, driver inattentive, and driver internal/external distraction. "Driver error/confusion" includes gas/brake pedal confusion. "Road condition" includes ice, snow, slush, and/or water on the road. Data are based on police reports from police-attended motor vehicle crashes; therefore, contributing factors reported emphasize human error rather than other systemic factors (e.g., vehicle design, roadway design). Fewer than five cases had sex data missing, and these cases are excluded from this figure. See Appendix B for more information about this data source.
Source: Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia, 2008-2012. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

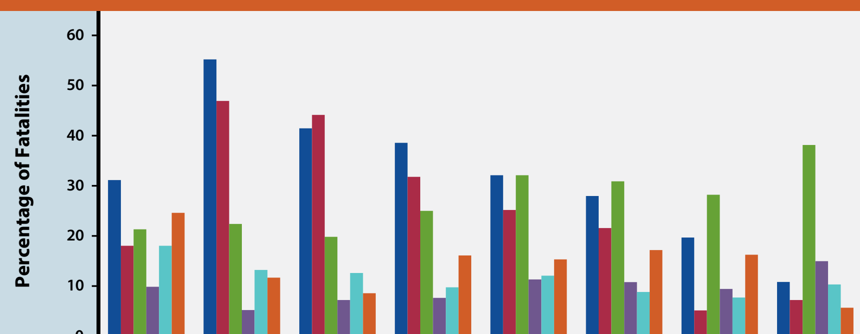
Figure 2.16 provides further insight into the impact of MVC fatalities by top contributing factor for 2008-2012, by age group. As this figure demonstrates, speed and impairment are a substantial proportion of the burden of contributing factors to MVC fatalities for ages 16-25, while the burden of these factors decreases as age increases. Distraction is shown to be a considerable contributing factor in MVC fatalities across all ages, but is lower among younger sub-populations and increases in proportion among older age groups.

SUMMARY

Over the last few decades there has been an increase in road users in BC, based on increases in the size of the BC population and in the number of active driver's licences. The figures presented in this chapter show substantial decreases in the rates of motor vehicle crash (MVC) fatalities per 100,000 active licensed drivers and per 100,000 population. Further exploration of related geographical data for BC highlights a higher burden of MVC fatalities and serious injuries in Northern and Interior Health Authorities. Higher rates of MVC fatalities and serious injuries were seen among males and two age groups: youth age 16-25 and older adults age 76 and up. From a system perspective, the volume of roadway traffic contributes to the number of MVCs. The top human contributing factors for MVCs with fatalities were speed, distraction, and impairment, with more recent years showing increases in speed and distraction, and decreases in impairment.

The next two chapters will examine road users in BC.

Figure 2.16 **Proportion of Motor Vehicle Crash Fatalities, by Top Contributing Factor and Age Group, BC, 2008-2012**



	0-15	16-25	26-35	36-45	46-55	56-65	66-75	76+
Speed	31.1	55.2	41.4	38.6	32.1	27.9	19.7	10.8
Impairment	18.0	46.9	44.1	31.8	25.2	21.6	5.1	7.2
Distraction	21.3	22.4	19.8	25.0	32.1	30.9	28.2	38.1
Driver Error/Confusion	9.8	5.2	7.2	7.6	11.3	10.8	9.4	14.9
Driving on Wrong Side of Road	18.0	13.2	12.6	9.7	12.0	8.8	7.7	10.3
Road Condition	24.6	11.7	8.6	16.1	15.3	17.2	16.2	5.7

Age Group

Notes: "Impairment" includes alcohol involvement, ability impaired by alcohol, alcohol suspected, drugs illegal, ability impaired by drugs, drugs suspected, and ability impaired by medication. "Distraction" includes use of communication/video equipment, driver inattentive, and driver internal/external distraction. "Driver error/confusion" includes gas/brake pedal confusion. "Road condition" includes ice, snow, slush, and/or water on the road. Data are based on police reports from police-attended motor vehicle crashes; therefore, contributing factors reported emphasize human error rather than other systemic factors (e.g., vehicle design, roadway design). There were 19 cases in which age group was unknown, and these cases are excluded from this figure. See Appendix B for more information about this data source.

Source: Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia, 2008-2012. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

Chapter 3

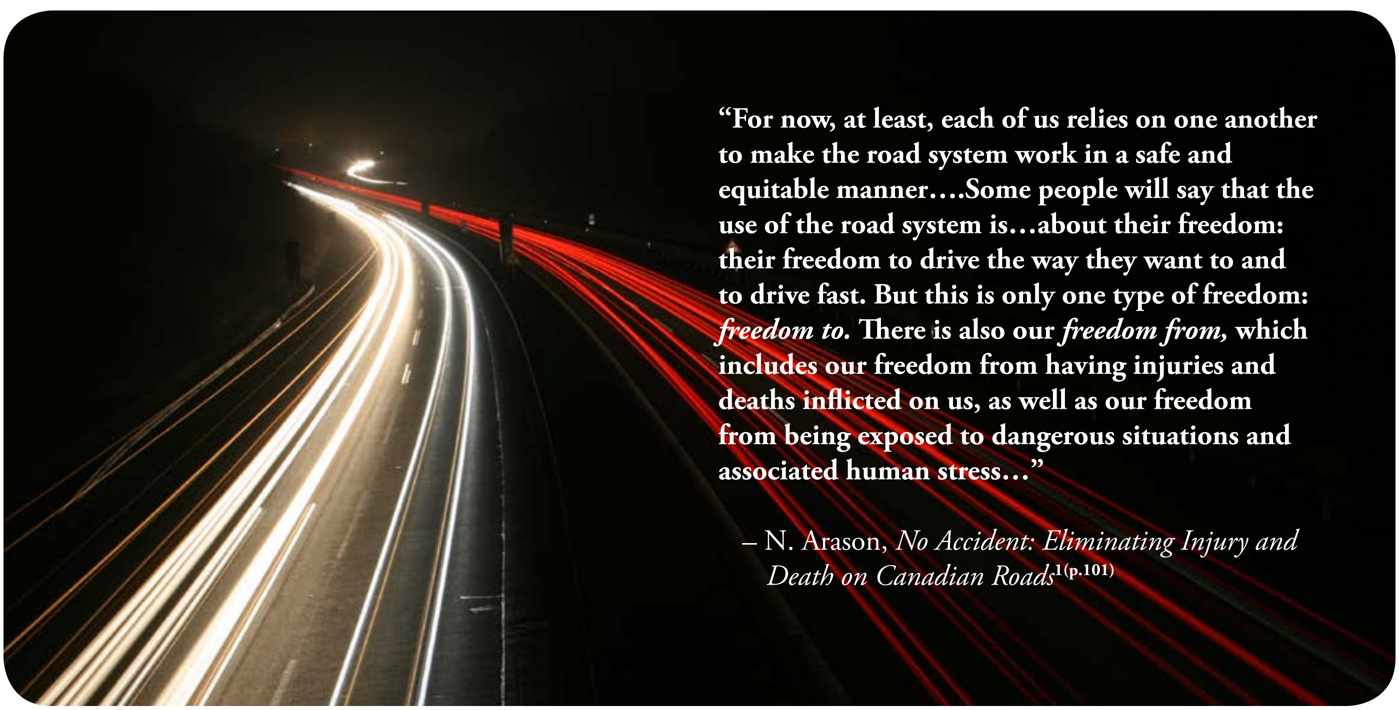
Drivers and Passengers

INTRODUCTION

Roadways are shared by a mix of road users that includes drivers and passengers of motor vehicles such as passenger vehicles, trucks, and motorcycles, as well as cyclists and pedestrians. Pedestrians, cyclists, and motorcyclists are all considered vulnerable road users because they do not have the protection of an enclosed vehicle,[2] which puts them at a greater risk of serious injury and death from motor vehicle crashes (MVCs) compared to road users inside vehicles. While drivers have the protection of a vehicle, they are still the road users most frequently impacted by MVCs in BC.

Safety of road users will be explored over three chapters. This chapter will examine the burden and distribution of fatalities and serious injuries and the impact of MVCs on drivers and passengers. Chapter 4 will explore vulnerable road users in greater detail, and Chapter 5 will examine road user behaviour and conditions.

Fatality and serious injury rates for motorcyclists, cyclists, pedestrians, and passengers (where applicable) are calculated using the BC population as the denominator, but rates for drivers are calculated using BC drivers with active driver's licences as the denominator. See Chapter 1 and Appendix B for more information.



"For now, at least, each of us relies on one another to make the road system work in a safe and equitable manner….Some people will say that the use of the road system is…about their freedom: their freedom to drive the way they want to and to drive fast. But this is only one type of freedom: *freedom to.* There is also our *freedom from,* which includes our freedom from having injuries and deaths inflicted on us, as well as our freedom from being exposed to dangerous situations and associated human stress…"

– N. Arason, *No Accident: Eliminating Injury and Death on Canadian Roads*[1(p.101)]

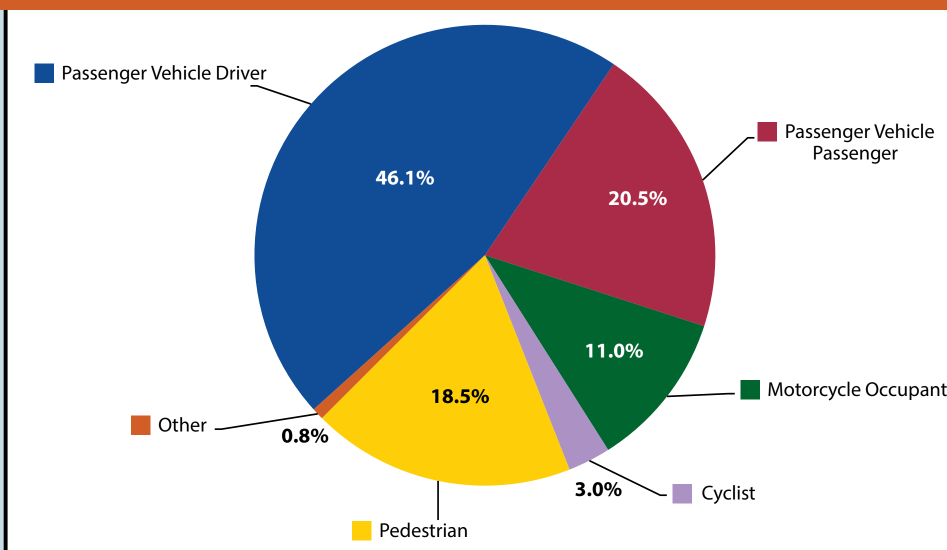
FATALITIES AND SERIOUS INJURIES AMONG ROAD USERS IN BC

Not all road user types share the burden of MVCs equally. As shown in Figure 3.1, vehicle drivers represent the largest proportion of MVC fatalities in BC at 46.1 per cent for 2009-2013. This is followed by vehicle passengers at 20.5 per cent, pedestrians at 18.5 per cent, motorcycle occupants at 11.0 per cent, and cyclists at 3.0 per cent. Over this period vehicle occupants accounted for 66.6 per cent of deaths, while vulnerable road users accounted for 32.5 per cent.

Figure 3.2 shows the percentage of road user types that experienced MVC serious injuries, represented by hospitalizations, for 2007-2011. Vehicle occupants (drivers and passengers) represent the largest portion of MVC hospitalizations at 54.4 per cent, followed by motorcyclists at 20.6 per cent, pedestrians at 15.0 per cent, and cyclists at 6.4 per cent (a total of 42.0 per cent among vulnerable road users).

Figure 3.3 shows the rates of MVC fatalities for five road user groups from 2009 to 2013. Across all five years, passenger vehicle drivers had the highest MVC fatality rate at 4.0 per 100,000 population in 2009, dropping to 2.7 in 2012 and 2013. The rates for vehicle passengers declined over the five years, and the pedestrian rate overtook the vehicle passenger rate beginning in 2012. The motorcyclist fatality rate also saw an overall decrease over this time period, from 1.1 per 100,000 population in 2009 to 0.6 per 100,000 in 2013.

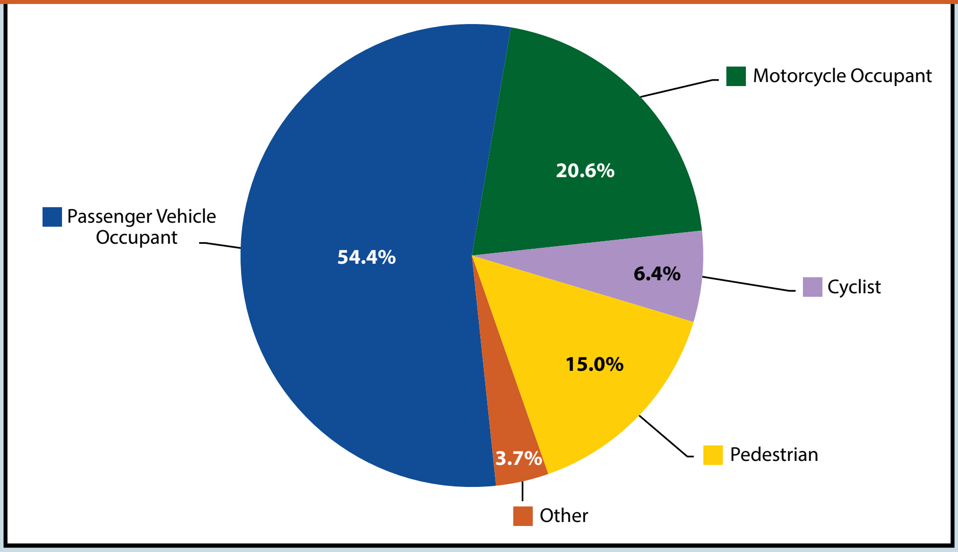
Figure 3.1 **Proportion of Motor Vehicle Crash Fatalities, by Road User Type, BC, 2009-2013**



Notes: "Passenger vehicle" includes cars, trucks, sport-utility vehicles, commercial vehicles and heavy trucks, and excludes motorcycles. "Motorcycle occupant" includes motorcycle drivers and passengers. See Appendix B for more information about this data source.
Source: Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia, 2009-2013. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

Figure 3.2

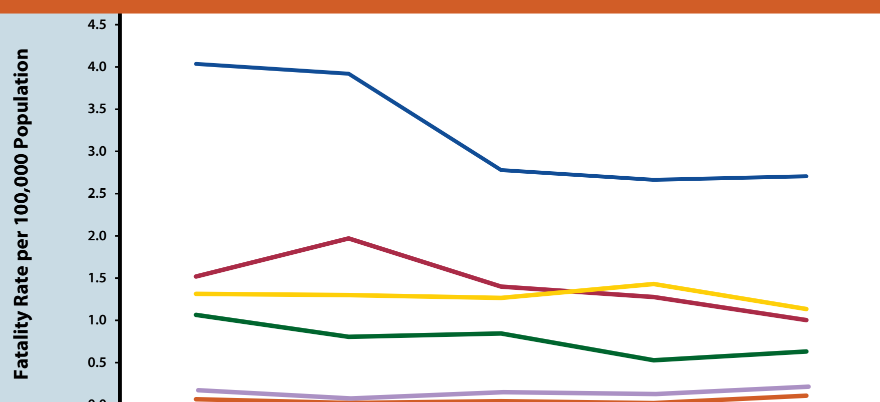
Proportion of Motor Vehicle Crash Hospitalizations, by Road User Type, BC, 2007-2011



Notes: "Passenger vehicle occupant" includes drivers and passengers of cars, trucks, sport-utility vehicles, commercial vehicles and heavy trucks, and excludes motorcycle occupants. "Motorcycle occupant" includes motorcycle drivers and passengers. See Appendix B for more information about this data source.
Source: Discharge Abstract Database, Ministry of Health, 2007-2011. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

Figure 3.3

Motor Vehicle Crash Fatality Rate per 100,000 Population, by Road User Type, BC, 2009 to 2013



	2009	2010	2011	2012	2013
Passenger Vehicle Driver	4.0	3.9	2.8	2.7	2.7
Passenger Vehicle Passenger	1.5	2.0	1.4	1.3	1.0
Motorcycle Occupant	1.1	0.8	0.8	0.5	0.6
Cyclist	0.2	0.1	0.2	0.2	0.3
Pedestrian	1.3	1.3	1.3	1.4	1.1
Other	0.1	0.0	0.0	0.0	0.1

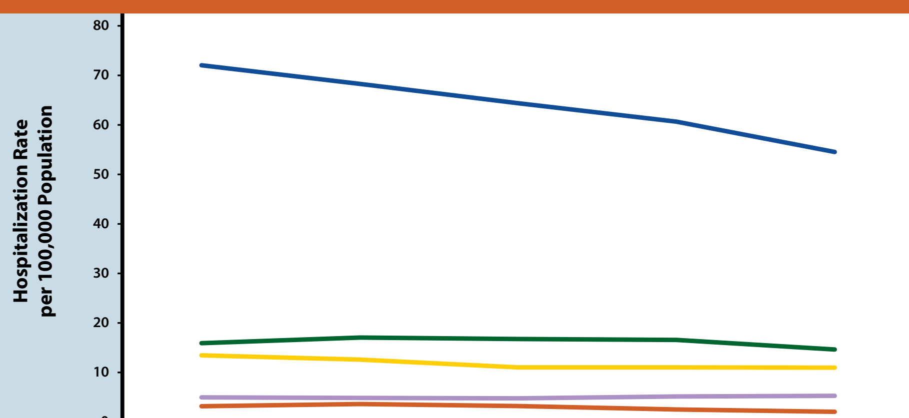
Year

Notes: "Passenger vehicle" includes cars, trucks, sport-utility vehicles, commercial vehicles and heavy trucks, and excludes motorcycles. "Motorcycle occupant" includes motorcycle drivers and passengers. See Appendix B for more information about these data sources.
Sources: Fatality data are from the Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia, 2009-2013; population estimates are from the BC Stats website, April 2015. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

Figure 3.4 shows the rates of serious injuries per 100,000 population resulting from MVCs between 2007 to 2011, by road user type. In all five years, passenger vehicle occupants had the highest rate of hospitalizations, steadily decreasing over the period from 72.0 per 100,000 in 2007 to 54.5 per 100,000 in 2011—a 24.3 per cent decrease. All other road user types, including motorcycle occupants, cyclists, and pedestrians, had fairly steady hospitalization rates over the period with only minor fluctuations. Motorcycle occupants had the second highest rate between 2007 and 2011, at 15.9 to 14.6 per 100,000, followed by pedestrians (13.4 to 11.0 per 100,000) and cyclists (5.0 to 5.3 per 100,000).

There is considerable variation in rates and numbers of road user fatalities and serious injuries in the different regions of BC. These regional differences can be important for understanding the challenges faced by some road user groups based on their environment (for example, a rural area in

Figure 3.4 **Motor Vehicle Crash Hospitalization Rate per 100,000 Population, by Road User Type, BC, 2007 to 2011**



	2007	2008	2009	2010	2011
Passenger Vehicle Occupant	72.0	68.3	64.4	60.6	54.5
Motorcycle Occupant	15.9	17.0	16.8	16.5	14.6
Cyclist	5.0	4.8	4.8	5.1	5.3
Pedestrian	13.4	12.6	11.0	11.0	11.0
Other	3.2	3.6	3.2	2.5	2.0

Year

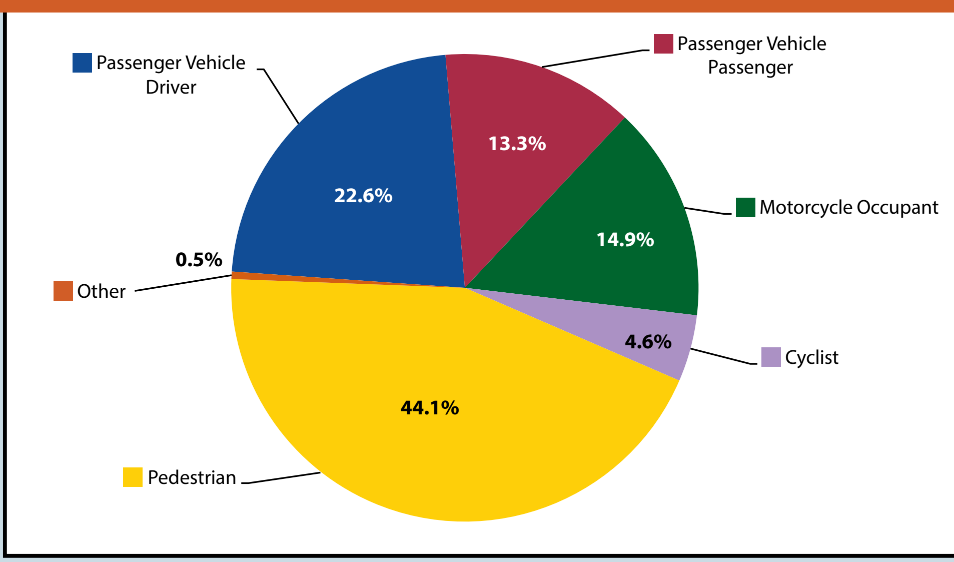
Notes: "Passenger vehicle" includes cars, trucks, sport utility vehicles, commercial vehicles and heavy trucks, and excludes motorcycles. "Motorcycle occupant" includes motorcycle drivers and passengers. "Other" includes animal-drawn vehicles driven on roads governed by the *Motor Vehicle Act*. See Appendix B for more information about these data sources.
Sources: Hospitalization data are from the Discharge Abstract Database, Ministry of Health, 2007-2011; population estimates are from the BC Stats website, April 2015. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

comparison to an urban centre). Figure 3.5 shows MVC fatalities by road user type in the urban centre of Greater Vancouver. For the five-year period 2009-2013, pedestrians experienced the highest burden of MVC fatalities in Greater Vancouver, accounting for 44.1 per cent of MVC fatalities. Comparatively, the proportion of vehicle driver fatalities amounted to just over half that of pedestrians, at 22.6 per cent. For more information about MVCs at regional levels, see the MVC reports produced by regional health authorities.[i]

The overall declining trend in BC in road user serious injuries since 2007 and fatalities since 2009, shown in Chapter 1, is likely due to multiple factors, including increased public transportation options,[3] improvements in roadway engineering, increased traffic enforcement, changing public attitudes and behaviours towards road safety (reflected in behaviour changes such as decreased alcohol-impaired driving and increased seat belt use), and evolving vehicle designs that increasingly incorporate safety features for both assisting drivers to avoid crashes and better protecting road users when crashes do occur (e.g., **electronic stability control**, greater numbers of **air bags**).[4,5] However, ongoing and emerging challenges to road safety include the overall population growth in BC, which is likely to increase stress on existing roadway infrastructure as well as competition among road users for road and roadside space.[6] In addition, northern, rural, remote, and Aboriginal communities continue to be faced with high levels of distracted and impaired driving and speed-related MVCs, and with geographically unique road safety challenges such as commercial vehicle corridors and wildlife.[5,7]

The remainder of this chapter will examine trends in MVC fatalities and serious injuries in BC for drivers and passengers. Vulnerable road users will be discussed in Chapter 4.

Figure 3.5 **Proportion of Motor Vehicle Crash Fatalities, by Road User Type, Greater Vancouver, 2009-2013**



Notes: "Passenger vehicle" includes cars, trucks, sport utility vehicles, commercial vehicles and heavy trucks, and excludes motorcycles. "Motorcycle occupants" includes motorcycle drivers and passengers. Greater Vancouver excludes the Fraser Valley region. See Appendix B for more information about this data source.
Source: Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia, 2009-2013. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

[i] Some of these reports are accessible via the website of the Office of the Provincial Health Officer (www.health.gov.bc.ca/pho/reports).

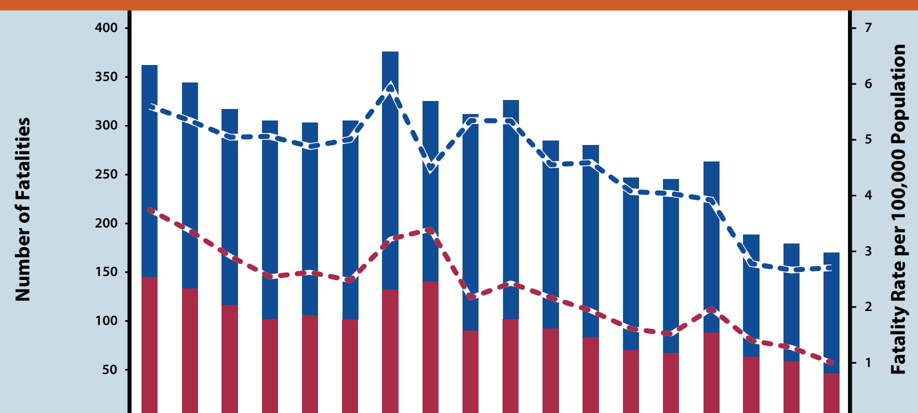
FATALITIES AND SERIOUS INJURIES AMONG DRIVERS AND PASSENGERS

Considering that all MVCs involve at least one driver, it is no surprise that they represent the largest road user group impacted by MVCs, as seen in Figures 3.1 and 3.3. This section provides an overview of the impact of MVCs on drivers and passengers (referred to as "passenger vehicle occupants" when combined) over time, and provides analyses based on age and sex.

Every year in BC there are hundreds of fatalities and thousands of serious injuries among vehicle occupants that result from MVCs. Figure 3.6 shows the MVC-related fatality counts and rates per 100,000 population for drivers and passengers from 1996 to 2013. Drivers suffered a higher number and rate of fatalities compared to vehicle passengers in all years. Overall, there was a 51.6 per cent decrease in the driver fatality rate, and a 42.9 per cent decrease in the number of driver fatalities. There was a 73.3 per cent decrease in the passenger fatality rate and a 68.3 per cent decrease in the number of passenger fatalities over these 18 years. There were some minor fluctuations in the rates and number of MVC-related fatalities for drivers and passengers over this period, with a few noticeable changes (such as increases in fatality rates and counts in 2002 and decreases in 2011). These changes may be associated with policy and legislation changes in 2001 (e.g., the cancellation of photo radar) and 2010 (e.g., introduction of the Immediate Roadside Prohibition [IRP] for driving while impaired by alcohol).

Figure 3.7 shows the counts and rates for driver and passenger serious injuries between 2002 and 2011. Both the total number of hospitalizations and the rate of hospitalizations per 100,000 population decreased over these 10 years, with the rate decreasing 41.9 per cent and the number decreasing 36.2 per cent over the period.

Figure 3.6 **Motor Vehicle Driver and Passenger Fatality Counts and Rates per 100,000 Population, BC, 1996 to 2013**



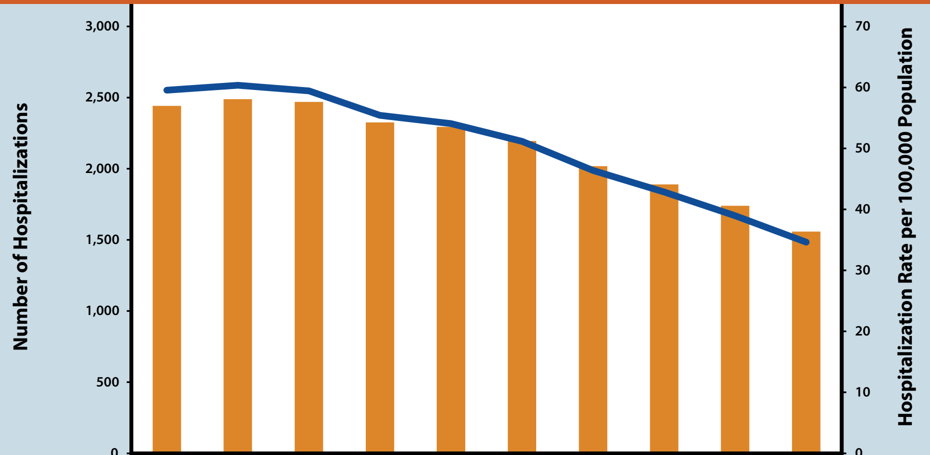
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Number of Driver Fatalities	217	211	201	203	197	204	244	185	222	224	193	197	177	178	175	125	121	124
Number of Passenger Fatalities	145	133	116	102	106	101	132	140	90	102	92	83	70	67	88	63	58	46
Total Vehicle Occupant Fatalities	362	344	317	305	303	305	376	325	312	326	285	280	247	245	263	188	179	170
Driver Fatality Rate	5.6	5.3	5.0	5.1	4.9	5.0	6.0	4.5	5.3	5.3	4.6	4.6	4.1	4.0	3.9	2.8	2.7	2.7
Passenger Fatality Rate	3.7	3.4	2.9	2.5	2.6	2.5	3.2	3.4	2.2	2.4	2.2	1.9	1.6	1.5	2.0	1.4	1.3	1.0

Year

Notes: "Drivers" and "passengers" include drivers and passengers of cars, trucks, sport-utility vehicles, commercial vehicles and heavy trucks, and exclude motorcycle occupants. See Appendix B for more information about these data sources.
Sources: Fatality data are from the Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia, 1996-2013; population estimates are from the BC Stats website, April 2015. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

Figure 3.7

Motor Vehicle Driver and Passenger Hospitalization Count and Rate per 100,000 Population, BC, 2002 to 2011



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Number of Hospitalizations	2,442	2,489	2,470	2,326	2,294	2,195	2,018	1,890	1,740	1,558
Hospitalization Rate	59.6	60.4	59.4	55.4	54.1	51.2	46.4	42.9	39.0	34.6

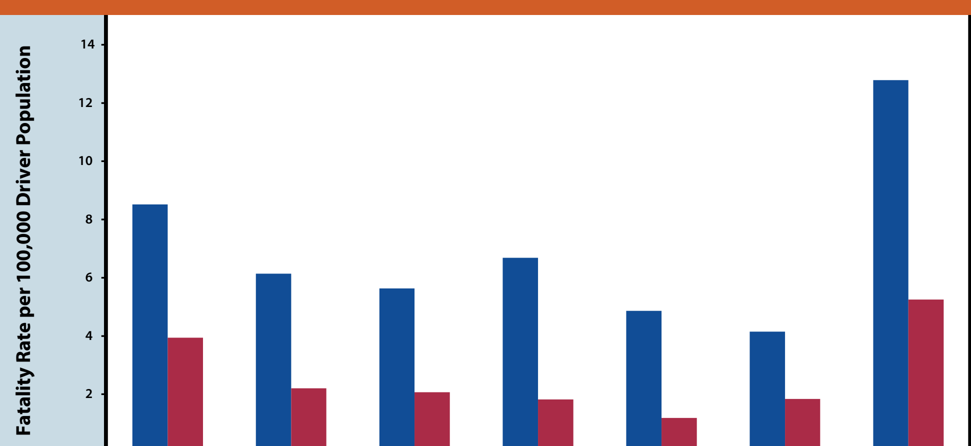
Year

Notes: "Drivers" and "passengers" include drivers and passengers of cars, trucks, sport-utility vehicles, commercial vehicles and heavy trucks, and exclude motorcycle occupants. See Appendix B for more information about these data sources.
Sources: Hospitalization data are from the Discharge Abstract Database, Ministry of Health, 2002-2011; population estimates are from the BC Stats website, April 2015. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health,

Drivers represent the largest number of both MVC fatalities and serious injuries. Figure 3.8 presents the fatality rate per 100,000 driver population by age group and sex for 2009-2013. Males have higher fatality rates than females across all age groups. Drivers

Figure 3.8

Motor Vehicle Crash Average Annual Driver Fatality Rate per 100,000 Driver Population, by Sex and Age Group, BC, 2009-2013



	16-25	26-35	36-45	46-55	56-65	66-75	76+
Male	8.5	6.1	5.6	6.7	4.9	4.1	12.8
Female	3.9	2.2	2.1	1.8	1.2	1.8	5.3

Age Group

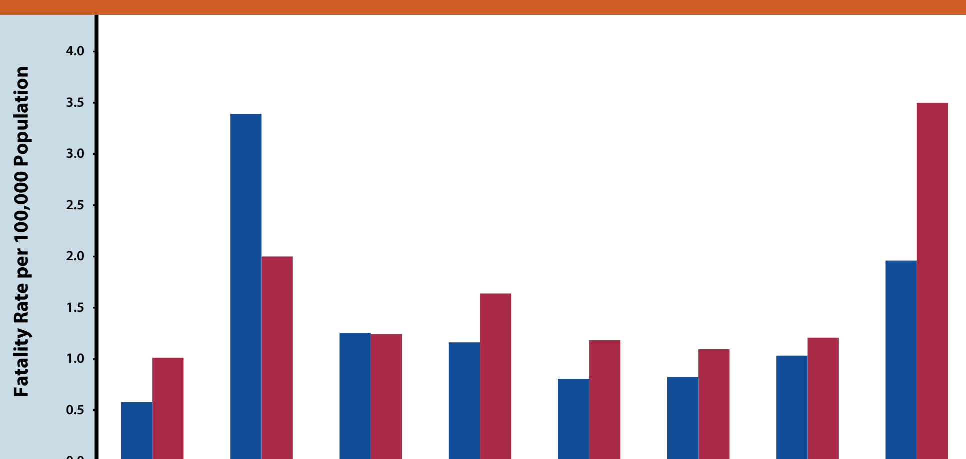
Notes: "Driver" includes drivers of cars, trucks, sport-utility vehicles, commercial vehicles and heavy trucks, and excludes motorcycle occupants. Five-year average rates are calculated using age- and sex-specific driver population numbers (Sept. 2014), based on active BC driver's licences. Not all individuals who hold driver's licences own or operate vehicles in BC. There were fewer than five cases where the driver was under 16 years old, and these cases are excluded from this figure. See Appendix B for more information about these data sources.
Sources: Fatality data are from the Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia (ICBC), 2009-2013; driver population data are from the Business Information Warehouse, ICBC, as of September 30, 2014.
Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

age 76 and up have the highest fatality rate for both males and females, at 12.8 fatalities per 100,000 driver population for males and 5.3 per 100,000 driver population for females. The second highest driver fatality rates for both males and females are found among younger drivers age 16-25, at 8.5 fatalities per 100,000 driver population for males and 3.9 per 100,000 driver population for females.

Vehicle passengers have the second highest fatality rate among road user groups, as shown earlier in Figures 3.1 and 3.3. Figure 3.9 shows passenger fatality rates by age group and sex for 2009-2013. Similar to the findings for driver fatality rates, the two age groups with the highest passenger fatality rates were those age 16-25 and those age 76 and up. However, unlike the findings for driver fatality rates, female passengers have higher fatality rates per 100,000 population than male passengers for all age groups except those aged 16 to 35. A higher rate of passenger fatalities for females may reflect, at least in part, the tendency for males to drive when travelling with female partners. A 2010 survey conducted by the Institute of Advanced Motorists in the UK found that men were four times more likely to drive when male-female couples drove together.[8]

Figure 3.10 presents hospitalization rates for drivers and passengers combined for 2007-2011 in BC by sex and age. It shows that male drivers and passengers have the highest serious injury rate per 100,000 population for most age groups. This difference becomes less pronounced among the higher age groups. Similar to fatality rates for drivers and passengers, the hospitalization rate per 100,000 population among male vehicle occupants is highest among those age 16-25 and 76 and up, whereas the hospitalization for females is highest among those age 66 and up, followed by those age 16-25.

Figure 3.9 **Motor Vehicle Crash Passenger Fatality Rate per 100,000 Population, by Sex and Age Group, BC, 2009-2013**

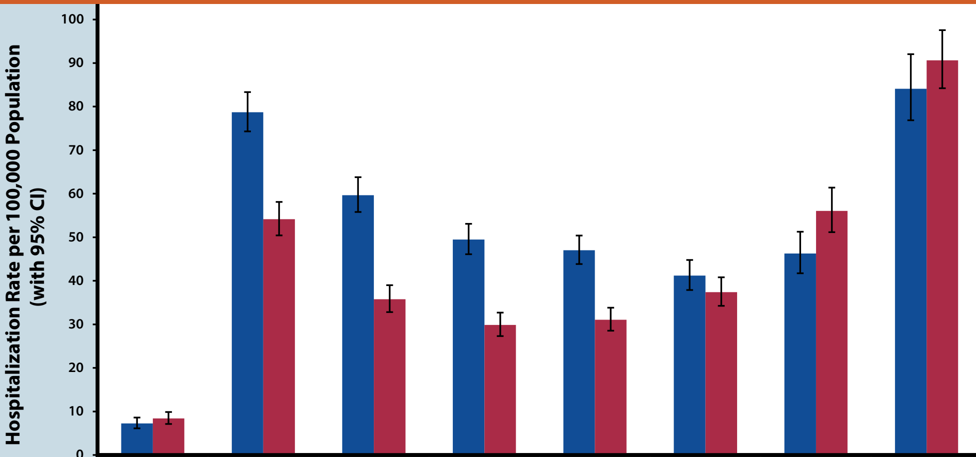


	0-15	16-25	26-35	36-45	46-55	56-65	66-75	76+
Male	0.6	3.4	1.3	1.2	0.8	0.8	1.0	2.0
Female	1.0	2.0	1.2	1.6	1.2	1.1	1.2	3.5

Age Group

Notes: "Passenger" includes passengers of cars, trucks, sport-utility vehicles, commercial vehicles and heavy trucks, and excludes motorcycle occupants. Rates are calculated using age- and sex-specific population numbers. There were six cases where age group was missing, and these cases are excluded from this figure. See Appendix B for more information about these data sources.
Sources: Fatality data are from the Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia, 2009-2013; population estimates are from the BC Stats website, April 2015. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

Figure 3.10 **Motor Vehicle Driver and Passenger Hospitalization Rate per 100,000 Population, by Sex and Age Group, BC, 2007-2011**



	0-15	16-25	26-35	36-45	46-55	56-65	66-75	76+
Male	7.3	78.7	59.7	49.5	47.0	41.2	46.3	84.1
Female	8.4	54.1	35.8	29.9	31.1	37.4	56.1	90.7

Age Group

Notes: "Motor vehicle occupant" includes drivers and passengers of cars, trucks, sport-utility vehicles, commercial vehicles and heavy trucks, and excludes motorcycle occupants. Rates are calculated using age- and sex-specific population numbers. See Appendix B for more information about these data sources.
Sources: Hospitalization data are from the Discharge Abstract Database, Ministry of Health, 2007-2011; population estimates are from the BC Stats website, April 2015. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

Worldwide, young drivers are disproportionately involved in MVCs and MVC-related fatalities. The Organisation for Economic Co-operation and Development reports that the MVC-related fatality rate for drivers age 18-24 was consistently more than double the fatality rate of drivers over 25 years-old between 1980 and 2004.[9] Research indicates that young age alone is not a risk factor for MVCs and MVC-related fatalities; instead, lack of driving experience is a risk factor, which can be exacerbated by variables such as a young age, sex, and gender.[9,10,11,12] (See sidebar: *The Interaction of Driver Experience, Age, and Gender*.) A younger age can be an exacerbating factor because it is associated with immaturity, status-seeking behaviour, greater propensity for risk-taking (e.g., not wearing a seat belt), susceptibility to impact of peers as passengers, and increased likelihood of driving while impaired.[9,12,13]

The Interaction of Driver Experience, Age, and Gender

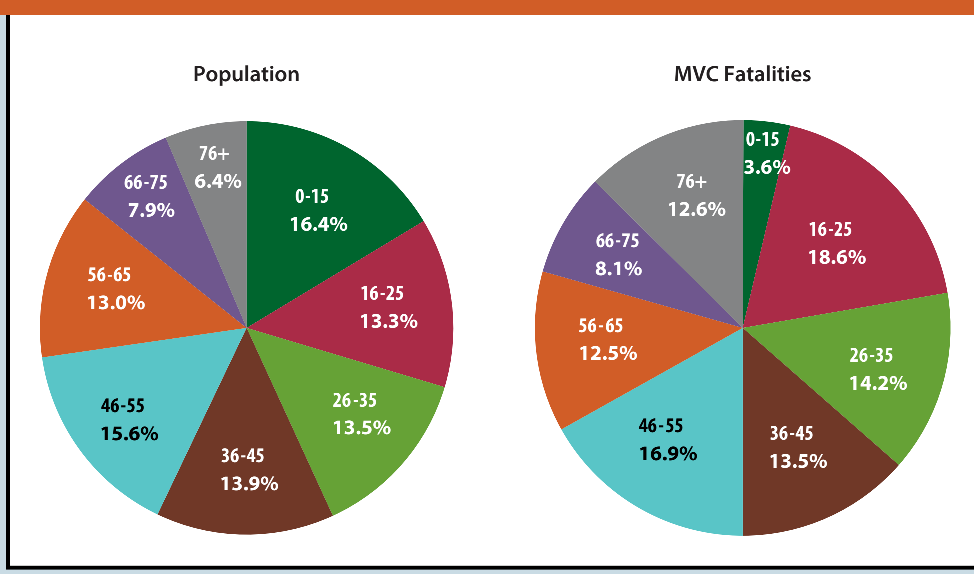
In their 2006 report on young drivers, the Organisation for Economic Co-operation and Development and the European Conference of Ministers of Transport highlighted the connection between driver experience, age, and gender:

> Young men drive more than young women, and have more fatal crashes per kilometre driven. Furthermore, research has revealed that they are generally more inclined toward risk-taking, sensation-seeking, speeding and anti-social behaviour than their female counterparts. They are also more likely to over-estimate their driving abilities and [are] more susceptible to the influence of their friends.
>
> It is precisely the interaction of experience and age-related factors, exacerbated by gender differences, that makes young drivers' risk situation unique, although experience has a greater overall impact on risk reduction than age. While men have more crashes than women at any age, the impact of gender is particularly strong among the young and exacerbates the negative effects of both age and inexperience.[9]

As shown in Figure 3.11, a disproportionate burden of MVC fatalities is seen among youth. For 2009-2013, youth age 16-25 made up only 13.3 per cent of the provincial population but accounted for 18.6 per cent of MVC fatalities. Examining Traffic Accident System data from the Insurance Corporation of British Columbia (ICBC) further reveals that on average for 2008-2012, the top reported contributing factors for MVC fatalities in BC among young drivers age 16 to 25 were speed (79.4 per cent), alcohol (55.9 per cent), and distraction (34.6 per cent).[14]

As with younger drivers, older drivers (those age 76 and up) are also overrepresented among MVC fatalities, at 12.6 per cent in comparison to their 6.4 per cent of the population (see Figure 3.11). A report from the Traffic Injury Research Foundation (TIRF) suggests that older drivers have an elevated risk of dying due to frailty, which increases sharply after age 80.[15] The *BC Road*

Figure 3.11 **Proportion of BC Population and Motor Vehicle Crash Fatalities, by Age Group, BC, 2009-2013**



Notes: "Fatalities" include deaths resulting from motor vehicle crashes involving all types of vehicles, including motorcycles. There were 16 cases where age group was missing, and these cases are excluded from this figure. See Appendix B for more information about these data sources.
Sources: Fatality data are from the Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia, 2009-2013; population estimates are from the BC Stats website, April 2015. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

Safety Strategy: 2015 and Beyond notes that the province's aging population is a factor in road safety policy, given that people age 60 and up are the fastest-growing group of licensed drivers in BC.[16] Canada's *Road Safety Strategy 2015* considers older drivers and age-related impairment within the category of medically at-risk drivers, including "driver performance, related to the aging process, deemed to be outside the boundaries of normal driving behaviour (e.g., compromised cognitive function or decision-making, vision-related problems, limited physical motor functions) that may result in MVCs."[17]As such, older drivers will be discussed in Chapter 5 with medically at-risk drivers.

MVCS AMONG COMMERCIAL VEHICLES

Hundreds of thousands of cars, vans, trucks, buses, and other types of vehicles are used for work-related purposes in BC.[18] Trucking represents 15.7 per cent of the commercial transportation industry in BC, and there are more than 60,000 professional drivers in the province's trucking industry.[19] However, there are many other types of drivers and vehicles that make up and support commercial industry.

Commercial drivers are those who drive as part of their core business activity[18] (e.g., bus drivers, taxi drivers, couriers, emergency vehicle drivers, drivers of heavy commercial vehicles).[20] They are often at heightened risk for MVCs due to spending many more hours driving than the average driver, but they are also subject to higher levels of training, testing, and regulatory standards than other drivers, such as medical examinations and driver fitness standards.[21,22,23] **Occupational drivers** are those who are required to drive for work-related purposes, but driving is not their principal occupation. They are not necessarily professional drivers, and they have generally not received related specialized training or testing (e.g., community health professionals; real estate agents; workers in retail, wholesale, service industries).[18]

In 2007 in BC, there were 2,204 reported injury and fatal collisions involving light and medium commercial vehicles (in this case defined as vehicles under 10,900 kg). Of these, 2,124 resulted in injuries and 80 resulted in fatalities. The same year there were 1,098 MVCs involving heavy commercial vehicles (in this case defined as vehicles with

a gross vehicle weight of 10,900 kg or heavier). Of these, 1,042 resulted in injuries (1,411 injuries) and 56 resulted in fatalities (65 fatalities). The top two reported human contributing factors for MVCs involving light and medium commercial vehicles, and heavy commercial vehicles were driver inattention (22.3 per cent and 18.3 per cent of MVCs, respectively) and speed (13.7 per cent and 12.8 per cent of MVCs, respectively).[24]

Of all MVC fatalities that occurred in BC for 2009-2013, 19.3 per cent involved **heavy vehicles**, in this case defined as vehicles over 10,900 kg and including construction vehicles and buses.[14]

Figure 3.12 shows that the rate of MVCs per 100,000 licensed heavy commercial vehicles (in this case defined as vehicles with a gross vehicle weight of 11,795 kg or more) have declined more than 15.7 per cent overall across the 11 years presented. There were 21,900 crashes per 100,000 licensed heavy commercial vehicles in 2003, and 18,460 crashes per 100,000 licensed heavy commercial vehicles in 2013. The decrease seen from 2007 to 2010 may be related to a number of federal and provincial initiatives to improve safety in this industry (see discussion later in this chapter). However, the crash rate was still high in 2013 at almost one crash per five heavy commercial vehicles.

Figure 3.12 **Heavy Commercial Vehicle Crash Rate per 100,000 Licenced Heavy Commercial Vehicles, BC, 2003 to 2013**

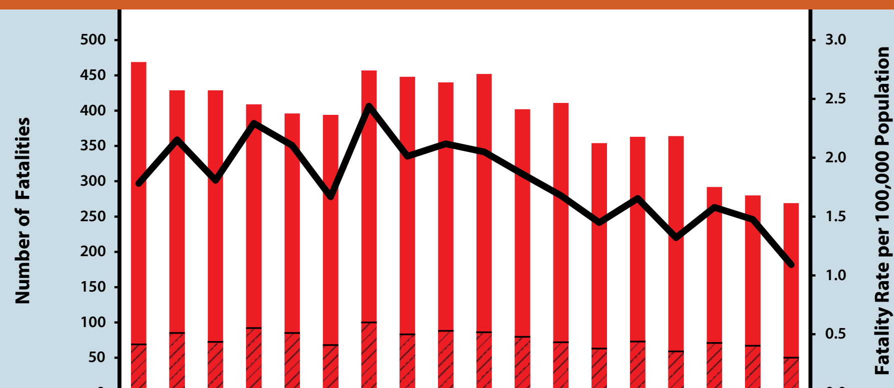
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Crash Rate	21,900	21,900	22,340	22,560	22,750	21,610	19,670	18,130	18,720	18,660	18,460

Year

Notes: "Heavy commercial vehicles" for this figure include commercial vehicles greater than or equal to 11,795 kg. Rates are calculated using the total number of licenced vehicles, based on Insurance Corporation of British Columbia records as a proxy denominator.
Source: Adapted from British Columbia Trucking Association. 2015. *Collisions Involving Heavy Commercial Vehicles.*[25] Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

As shown in Figure 3.13, fatalities from MVCs that involved a commercial vehicle had some year-to-year variation between 1996 to 2013 but decreased overall in both number and rate per 100,000 population. These decreases are slightly lower than, but are reflective of, the larger reduction in the number of MVC fatalities in BC during these years. In 2013, the 50 commercial vehicle-related fatalities accounted for 18.6 per cent of the 269 total MVC fatalities that year.

Figure 3.13 **Fatalities from Motor Vehicle Crashes Involving a Commercial Vehicle, Count and Rate per 100,000 Population, BC, 1996 to 2013**



	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Number of MVC Fatalities	469	429	429	409	396	394	457	448	440	452	402	411	354	363	364	292	280	269
Number of Fatalities Involving a Commercial Vehicle	69	85	72	92	85	68	100	83	88	86	79	72	63	73	59	71	67	50
Commercial Vehicle MVC Fatality Rate	1.8	2.2	1.8	2.3	2.1	1.7	2.4	2.0	2.1	2.0	1.9	1.7	1.4	1.7	1.3	1.6	1.5	1.1
Commercial Vehicle-related Proportion of Fatalities	14.7	19.8	16.8	22.5	21.5	17.3	21.9	18.5	20.0	19.0	19.7	17.5	17.8	20.1	16.2	24.3	23.9	18.6

Year

Notes: "Commerical vehicle" includes heavy vehicles, such as trucks, trailers, tractors, buses, and construction vehicles. See Appendix B for more information about these data sources.

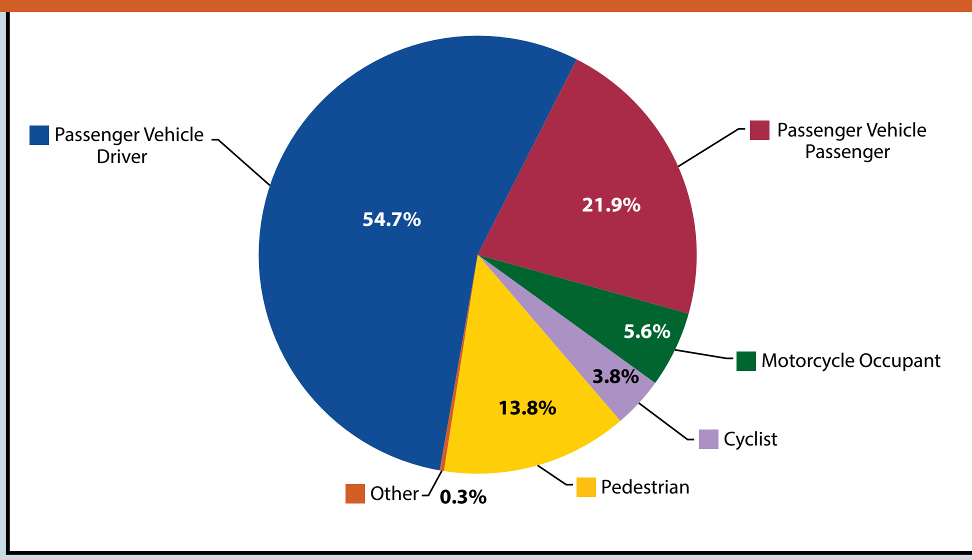
Sources: Fatality data are from the Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia, 1996-2013; population estimates are from the BC Stats website, April 2015. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

Figure 3.14 shows that among fatal MVCs that involved a commercial vehicle for 2009-2013, the majority of the fatalities were experienced by vehicle drivers (54.7 per cent), followed by vehicle passengers (21.9 per cent) and pedestrians (13.8 per cent).

Figure 3.15 shows the rate of fatalities from MVCs in BC that involved one or more commercial vehicles for 2009-2013, presented by age group and sex. It demonstrates that males had higher rates of related fatalities in all age categories except 0-15. Fatalities among females ranged from 0.6 to 1.6 fatalities per 100,000 population and males ranged from 1.7 to 3.0 per 100,000.

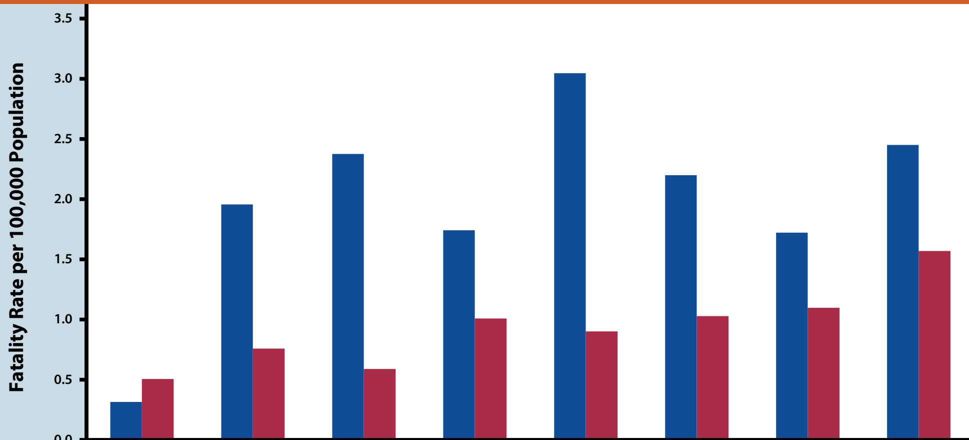
According to a 2009 TIRF report on best practices for truck safety, compared to other regions in Canada, fatal MVCs in BC involving heavy commercial vehicles (in this case 4,536 kg or heavier) were more likely to involve speeding, drivers over the age of 41 years, single-vehicle collisions, run-off-the-road collisions, head-on collisions, curved and graded roads, winter driving conditions, poor road conditions, and poor weather conditions. In addition, heavy truck injury MVCs in BC were more likely to involve speeding, driver inexperience and inattention, single-vehicle collisions, run-off-the-road collisions, head-on collisions, poor road conditions, and curved graded roads.[26] The Police Traffic Accident System identified falling asleep as a contributing factor in police reports for only 3 per cent of MVCs involving heavy commercial vehicles in BC from 2009 to 2013;[14] however, this is likely an under-reporting of falling asleep incidents due to a reluctance to self-report (see Appendix B). Transport Canada cites fatigue as a factor in as many as 30 per cent of fatal heavy vehicle collisions in Canada.[27] Some commercial drivers acknowledge that financial and/or other work-related pressures can lead them to drive when it is no longer safe to do so (e.g., when fatigued).[7]

Figure 3.14 **Proportion of Fatalities Involving a Commercial Vehicle, by Road User Type, BC, 2009-2013**



Notes: "Commerical vehicle" includes heavy vehicles, such as trucks, trailers, tractors, buses, and construction vehicles. "Passenger vehicle" includes cars, trucks, sport-utility vehicles, commercial vehicles and heavy trucks, and excludes motorcycles. "Motorcycle occupant" includes motorcycle drivers and passengers. See Appendix B for more information about this data source.
Source: Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia, 2009-2013. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

Figure 3.15 **Motor Vehicle Crashes Involving a Commercial Vehicle, Fatality Rate per 100,000 Population, by Sex and Age Group, BC, 2009-2013**



	0-15	16-25	26-35	36-45	46-55	56-65	66-75	76+
■ Male	0.3	2.0	2.4	1.7	3.0	2.2	1.7	2.5
■ Female	0.5	0.8	0.6	1.0	0.9	1.0	1.1	1.6

Age Group

Notes: "Commercial vehicle" includes heavy vehicles, such as trucks, trailers, tractors, buses, and construction vehicles. Rates are calculated using age- and sex-specific population numbers. There were seven cases where age group and/or sex was missing, and these cases are excluded from this figure. See Appendix B for more information about these data sources.
Sources: Fatality data are from the Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia, 2009-2013; population data are from BC Vital Statistics, 2009-2013. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

For commercial and occupational drivers, MVCs that occur during working hours are defined as workplace injuries. Further, if someone is struck by a vehicle (as a vehicle occupant, pedestrian, or other road user type) while working, it is also considered a workplace injury. MVCs are the leading cause of traumatic workplace injuries and fatalities in the province.[29] For 2009-2013, an average of 1,316 MVC-related insurance claims were made to WorkSafe BC, the provincial workers' compensation system, each year.[m,29] WorkSafe BC incurs costs for workers who are injured or killed on the job. In 2009-2013 in BC, MVCs cost the workers' compensation system an average of $56.6 million per year (totalling $283 million over these five years).[29]

"Freight companies are in business to haul maximum loads in minimum time. But to do so, North American carriers are mandated to abide by a series of policies, legalities, licences, certificates, permits, and other official documents that allow them to move goods across state, provincial, and country borders. They need to find the competitive edge within this jungle of official demands and expectations….To succeed in the highly competitive enterprise of transportation, drivers and/or freight executives may cut corners to reduce trip time, save storage costs, decrease operating costs, or increase the size of loads."

– J.P. Rothe, *Driven to Kill: Vehicles as Weapons*[28(p.62)]

[m] WorkSafe BC's MVC-related claims data do not reflect every worker-involved MVC in BC, as some workers are involved in MVCs with third-party liability, or choose to report the incident to ICBC rather than to WorkSafe BC.

MEASURES TO PROMOTE DRIVER AND PASSENGER SAFETY

A Safe System Approach (SSA) emphasizes the need to improve all aspects of the road system to promote safety for all road users, including vehicle occupants (drivers and passengers). This section provides a limited discussion about measures that promote driver and passenger safety, including restraint use, licensing, commercial driver training, and increasing public transportation. Safety measures related to driver conditions are addressed in Chapter 5. Roadway and vehicle improvements are discussed in Chapters 7 and 8, respectively.

Increase Restraint Use

In Canada, federal laws require that all new vehicles in Canada have restraints installed.[30] Provincial laws regulate the use of seat belts and child restraints,[4] and seat belt use has been mandatory in BC since 1977.[31] In BC, both drivers and passengers may be ticketed for not wearing seat belts, and it is the driver's responsibility to ensure that all passengers under age 16 are appropriately restrained (individuals 16 and up are responsible for ensuring their own seat belts are on).[31] The use of approved restraints for child passengers 18 kg and under has been legislated since March 1985,[24] and specific restraint requirements for children under age 9 have been required since 2007.[32] BC law sets out stages of appropriate restraint use for child vehicle occupants, including rear- and forward-facing infant seats, and booster seats, based on a child's size, weight, and age (for more information see the ICBC website at www.ICBC.com).[33,34] The RCMP identifies non-use of seat belts as one of their top five road safety concerns.[35]

The proper use of restraints—seat belts and child restraint systems—by vehicle drivers and passengers has been shown to reduce the risk of MVC-related injuries and fatalities[27,31] by 40 to 50 per cent or more[36,37] and save an estimated 1,000 lives in Canada each year.[4] Seat belt use is associated with reduced risk and severity of MVC-related injuries, particularly when used in conjunction with vehicle air bags.[38,39] Child car seats have repeatedly been found to significantly reduce the risk of serious injury or fatality among child passengers involved in MVCs. Studies have found reductions that varied from 20 to more than 80 per cent, depending on the type of restraint, front or back seat position, correct use, and the age of the

child population considered.[40] However, many people are still not using restraints. According to RoadSafetyBC, among MVC vehicle occupant fatalities in BC from 2008 to 2012, about one-in-five victims (20.5 per cent) were not using a restraint at the time of the crash.[41]

According to a Transport Canada observational seat belt study conducted in 2009, women were more likely than men to wear seat belts, and seat belt use increased with age.[42] This study also found that rates of seat belt use in Canada were higher among those in the front seats of a vehicle than among passengers in the rear seats, and were slightly higher among occupants of passenger cars (94.8 per cent) and minivans and sport-utility vehicles (95.4 per cent) compared to pickup trucks (92.0 per cent).[42] One US study found that child passengers were more likely to be properly restrained in vehicles where drivers wore their seat belts.[43] Even when children are old enough to secure their own restraints, a driver's attitude toward safety have a significant influence on children's attitudes and behaviours.[43]

Whether restraints were used during an MVC has also been found to impact the length of hospital stay for injured victims. Table 3.1 shows that among all MVC-related patients hospitalized in BC in 2001-2008, the average hospital stay was one day longer for vehicle occupants who had been unrestrained than for those who had used a seat belt. When this is examined by geography to compare crashes in rural and urban settings, no difference in hospital stay was reported in urban settings, but among patients in rural communities the average hospital stay was three days longer for those who did not wear a seat belt compared to those who were restrained during the MVC. This may be related to higher speeds in rural areas and an associated greater severity of injuries sustained from MVCs involving higher speeds. While length of hospital stay is not necessarily an accurate measure of injury severity, it can provide a relative understanding of the potential harms and costs associated with injuries sustained when a person is unrestrained during an MVC.

Analysis regarding seat belt use in rural areas compared to urban areas showed that location makes a difference on whether individuals wear a seat belt. According to one study, BC had a relatively high rate of seat belt use overall in 2009-2010, at 96.9 per cent—higher than the Canadian national average rate of 95.3 per cent.[42] However, when this pattern of seat belt use/non-use was examined further, the study showed that while BC had the second highest rate of seat belt use in urban centres

Table 3.1 **Motor Vehicle Crash Patient Count, Proportion and Mean Hospital Stay, by Restraint Use and Urban or Rural Location, BC, 2001-2008**

	URBAN		RURAL		ALL	
RESTRAINT USE	Patient Count (per cent)	Mean Hospital Stay (days)	Patient Count (per cent)	Mean Hospital Stay (days)	Patient Count (per cent)	Mean Hospital Stay (days)
Restrained	1,641 (74%)	14.2	535 (61%)	13.4	2,176 (70%)	14.0
Unrestrained	583 (26%)	14.2	337 (39%)	16.6	920 (30%)	15.2

Note: Total number of patients=3,096.
Source: Bell N, BC Trauma Registry. Personal Communication; 2010 Apr.

(97.3 per cent), the province ranked only fifth highest in rural areas (91.6 per cent—slightly lower than the overall Canadian rate of 92.0 per cent).[42] Figure 3.16 depicts these results showing the disparity between rural and urban areas. Lower seat belt use in rural areas may be due, at least in part, to the perception that there are generally lower levels of enforcement in rural areas, and thus less risk of being caught,[44] or possibly a perception that there are fewer vehicles on **rural roads** and so crashes are less likely.

Evaluations of a number of restraint promotion and enforcement programs suggest that effective strategies for encouraging restraint use include the use of seat belt checkpoints, ticketing and associated penalties for seat belt violations (e.g., fines, penalty points), and high-visibility campaigns to increase the perception that violators will be caught.[45,46,47] To address the issue of lower occupant restraint use in northern BC, stakeholder groups implemented the North Central Seat Belt Initiative in 2003 (see sidebar: *The North Central Seat Belt Initiative*).[44]

Figure 3.16

Rural and Urban Seat Belt Non-use, BC and Canada, 2009-2010

	BC	Canada
Rural	8.4	8.0
Urban	2.7	4.2
Overall	3.1	4.7

Region

Note: See Appendix B for more information about this data source.
Source: Transport Canada. 2011. *Rural and Urban Surveys of Seat Belt Use in Canada 2009-2010.*[42] Prepared by Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

The North Central Seat Belt Initiative

The North Central Seat Belt Initiative (NCSBI) was a community-based initiative that began in 2003 to promote road safety in north-central BC, and involved local and regional road safety stakeholders, including the RCMP and the Insurance Corporation of British Columbia. The NCSBI raised awareness of the importance of restraint use, increased enforcement, conducted annual regional seat belt use surveys, and helped foster a competitive spirit among local communities. An evaluation of the NCSBI found that between 2003 and 2007 the program was associated with annual reductions of 3 per cent in the frequency of instances of motor vehicle crash injuries sustained without restraint use in north-central BC.[44]

Support Expanded Driver's Licence Programs

Another measure to promote the safety of all road users is rooted in driver's licences, including the training and processes by which drivers earn and maintain their licences. The process to obtain a driver's licence varies by jurisdiction, and in many countries with high levels of road safety, graduated licensing programs (GLPs) are used to ensure that drivers learn to operate a vehicle safely. Research suggests that GLPs introduced in jurisdictions within Canada, Australia, New Zealand, and the United States have contributed to reducing MVC rates among young, and new, drivers.[48,49,50]

Effective GLPs contain multiple elements that function together as a system.[51] These include extending the period of time for learning to operate the vehicle; exposing new drivers to lower risk situations, including limiting the number of peer passengers; rewarding good driving behaviour; responding to violations with more severe penalties; and encouraging practice and progressive development of skills to improve driver proficiency.[52,53] Most GLPs have three phases—a learner phase, a novice phase, and the final full privilege licence. The components and restrictions contained in GLPs during these stages vary by jurisdiction. The following initiatives have been shown to reduce MVCs: setting a sufficiently long minimum time for the first (learner) phase; restricting nighttime driving; limiting the number of passengers allowed in the vehicle for learner and/or novice drivers; and requiring a blood alcohol level of zero for all drivers in the learner and novice phases.[51]

BC's Graduated Licensing Program (BC GLP) was introduced in 1998 and was enhanced with further restrictions in 2003. The program resembles those in other jurisdictions, and its primary goal is to allow drivers to gain experience under lower-risk conditions[54,55] by requiring all new drivers to pass through a Learner's (L) stage and a Novice (N) stage before being eligible for a full-privilege Class 5 driver's licence.[55] The program includes an initial period of driver supervision, as well as restrictions on carrying passengers and driving at night, and a lower blood alcohol content (BAC) requirement than other drivers (they must maintain a BAC of zero—or 0.0 milligrams of alcohol per 100 millilitres of blood).[56,57,58] The L-stage lasts a minimum of 12 months and requires a supervisor in the vehicle at all times; the N-stage lasts for another 24 months, which can be reduced to 18 months with an ICBC-approved driver training course.[59,60,61]

Adoption of the BC GLP has resulted in a reduction in new driver involvement in MVCs.[56,62,63] After the program was enhanced in October 2003, an ICBC study estimated a 28 per cent reduction in MVCs involving BC GLP drivers in the first three years of the expanded program (2004 to 2006). These indicators of success included 31 fewer fatal MVCs and 4,137 fewer injury MVCs involving learner or novice drivers during those three years.[63]

Another initiative to promote road safety is the assignment of penalty points to drivers for certain driving offences. Drivers who accumulate more than three points in a 12-month period must pay additional driver penalty point premiums that increase with the number of penalty points.[64] In addition to these points, a driver identified as high risk by the Superintendent of Motor Vehicles (including drivers with a high number of penalty points,[n] or a motor vehicle-related *Criminal Code* conviction such as impaired or dangerous driving) may be subject to administrative interventions through RoadSafetyBC's Driver Improvement Program, ranging from a warning to a driving prohibition, which prevents the

[n] Typically nine or more penalty points within a two-year period, or two points for drivers in the BC GLP.

driver from legally driving.[53,65] However, some drivers will continue to drive without a valid driver's licence. The BC Ministry of Justice reports that this is a chronic problem on BC roads,[66] though there are currently no statistics available to reflect the actual number of people driving without a licence in BC.

Enhance Road Safety among Commercial Vehicle Drivers

Several organizations currently work to foster road safety among commercial vehicle drivers (the safety of commercial vehicles is discussed in Chapter 8). Transport Canada's Motor Carrier Division regulates extra-provincial carriers and commercial vehicle drivers (truck and bus carriers who transport goods or passengers across provincial or international boundaries), and provincial and territorial authorities regulate commercial vehicle drivers within their jurisdictions.[67] Transport Canada also develops safety fitness certification requirements and sets hours of service standards for federally-regulated (extra-provincial) buses and trucks, in order to promote commercial driver safety and prevent MVCs caused by fatigued drivers.[68]

Government and other organizations across BC have worked to promote safety among commercial and occupational vehicle drivers in the province.[29,70,71] The 2005 TruckSafe Strategy was a joint initiative involving WorkSafe BC, ICBC, the BC Trucking Association, the Ministry of Transportation and Infrastructure, and the RCMP, which aimed for practical and workable solutions to eliminate or reduce serious injuries and deaths resulting from MVCs involving commercial trucks.[18] Key TruckSafe Strategy projects have included the implementation of the Fraser Canyon Highway Safety Corridor in 2006 (see sidebar) and the establishment of the Trucking Safety Council of BC in 2008.[18] SafetyDriven is an industry organization affiliated with the Trucking Safety Council of BC. It represents the occupational health and safety needs of those in commercial and trucking industries, and provides training, resources, and information with the goal of eliminating workplace fatalities and injuries in BC's trucking, transportation, and related industries.[18,72]

A 2009 TIRF report outlines several best practices for improving truck driver safety in BC. A sampling of the recommendations included the following: to review commercial vehicle driver licensing standards, conduct in-person driver recruitment and selection, implement professional competence certification for truck drivers, and implement a recognition and incentive program for safe driving, among others.[26]

The Fraser Canyon Highway Safety Corridor

The 192-kilometre Fraser Canyon Highway Safety Corridor was the first designated highway safety corridor in Canada. The location was chosen due to its comparatively high volume of commercial vehicles, and the challenges presented by the road's design and severe weather conditions. Safety measures introduced in 2006 in the corridor include road improvements (e.g., shoulder rumble strips); increased RCMP enforcement focusing on speeding and aggressive driving; and increased vehicle safety checks.[18] The program's initial success was followed by some rebound in MVC fatalities, but overall the program remains a model for other truck safety corridors.[69]

Also in 2009, WorkSafe BC partnered with the BC Automobile Association Traffic Safety Foundation to form Road Safety at Work[o] (RSAW), with a mandate to address key road safety issues affecting BC workplaces. RSAW is now managed by the Justice Institute of BC and comprises three programs:

- Fleet Safety – aimed at improving the road safety performance of BC's more than 215,000 employers.
- Care Around Roadside Workers – focused on improving the safety of all roadside workers in BC, such as flag persons, road construction workers, emergency responders, and telecommunication and utility workers.
- Winter Driving Safety – focused on reducing the number and severity of MVCs during winter months by encouraging all drivers to adapt their driving behaviour to accommodate winter hazards (e.g., snow, ice).[73]

Overall, the industry involvement in initiatives to improve safety among commercial vehicle drivers is promising, and achievements have been observed, such as the declining rate of heavy commercial vehicle crashes shown earlier in Figure 3.12. See Chapters 5 and 8 for additional discussions of commercial vehicles.

Increase Public Transportation

Globally, it is recognized that safe public transportation systems, particularly in urban areas, can increase overall road safety.[74] The World Health Organization (WHO) suggests that governments can increase road safety by ensuring safe, accessible, and affordable public transportation.[74] In addition to reducing traffic volume, public transit offers a method of travel that is very safe for its passengers and can increase health through active transportation. The WHO reports that in high-income countries, public transit is much safer than private means of transportation,[74] specifically public transportation by bus or by train.[75] Data from the US show that bus occupants have a fatality rate of 0.4 per 100 million person-trips compared to 9.2 for other vehicle occupants.[76] Data from the European Union for 2001-2002 showed that rail transport had 0.035 deaths per 100 million passenger-kilometres and bus transport had 0.07; personal car transportation was an order of magnitude higher at 0.7 deaths per 100 million passenger-kilometres.[75] Additionally, research has shown that as public transportation ridership in urban areas increases, MVC fatalities per 100,000 population decreases.[77]

[o] Road Safety at Work was formerly known as the Occupational Road Safety Partnership.

The WHO has also identified ways to increase the use of public transportation, such as providing a well-functioning, convenient, and comfortable mass transit system; coordinating modes of transport such as cycling, driving, and walking with public transportation systems (e.g., providing secure bicycle shelters; allowing bicycles on board buses, trains, and ferries; creating park-and-ride facilities).[78] The WHO highlights the importance of giving roadway priority to high-occupancy vehicles, such as city buses, in order to reduce overall distance travelled per capita and thus reduce risk of MVCs.[75] Strategies that deter people from driving personal vehicles, such as distance-based insurance, can also be used to encourage public transit use.[79]

Increasing public transit is consistent with the *BC Road Safety Strategy: 2015 and Beyond*, which recognizes the importance of public transportation in reducing private car use and thus MVCs, as well as in supporting healthy physical activity and reducing our impact on the environment.[16] (See Chapter 7 for further discussion of public transit.)

SUMMARY

As discussed in this chapter, vehicle occupants (drivers and passengers) make up the majority of motor vehicle crash (MVC) fatalities and hospitalizations, although these rates have been decreasing in recent years. Male drivers have higher MVC fatality rates than female drivers at every age, while females are more likely than males to die as passengers at most ages. Overall, youth age 16-25 and older adults age 76 and up are disproportionately represented among MVC occupant fatality victims. Over the last 18 years, there has been a slight decrease in the rate of MVC fatalities that involve a commercial vehicle; however, in 2013 nearly one in five MVC fatalities still involved a heavy commercial vehicle. Measures to promote driver and passenger safety discussed in this chapter included increasing the use of restraints, supporting expanded driver's licence programs, increasing initiatives to prevent commercial vehicle MVCs, and increasing opportunities for public transportation.

The next chapter will investigate motor vehicle crashes that involve vulnerable road users in BC.

Chapter 4

Vulnerable Road Users

INTRODUCTION

As described in Chapter 3, motorcyclists,[p] cyclists,[q] and pedestrians are all considered vulnerable road users because they do not have the protection of an enclosed vehicle.[1,2,3] This puts them at greater risk of serious injury and death from a motor vehicle crash (MVC) compared to road users inside vehicles. This chapter will examine the burden and distribution of fatalities and serious injuries among these vulnerable road user groups in greater detail.

When motor vehicles were invented and introduced onto roadways, a cultural shift toward a motor vehicle-centred roadway began that continues today.[5] As a result, non-motorized travellers such as pedestrians and cyclists have experienced a change in their use of roadways and therefore, a change in their safety on the road. Injury rates of vulnerable road users in MVCs have been studied in northern Europe and North America.[6,7,8] These studies all showed vulnerable road users had higher injury rates (per trip or vehicle mile) than motor vehicle occupants; in fact, rates for motorcyclists were 10 to 25 times higher, pedestrians 1.5 to 7 times higher, and cyclists 2 to 9 times higher.[6,7,8] In the new vision of road safety, in which fatalities and serious injuries are considered preventable and in which a Safe System Approach (SSA) is used, vulnerable road users are given priority and roadways and vehicles are designed with these road users in mind.

"No longer is it acceptable to assume pedestrian injury is inevitable when motor vehicles share the road system with vulnerable road users. In the modern era of road safety, jurisdictions can assume a safe system approach and include pedestrians and other vulnerable road users as an essential component of the system and one that is given top priority."

– Canadian Council of Motor Transport Administrators, *Countermeasures to Improve Pedestrian Safety in Canada*[4(p.5)]

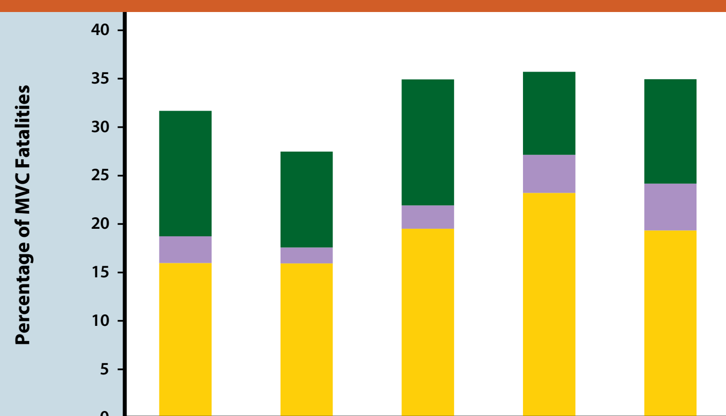
[p] Some definitions of "vulnerable road user" exclude motorcyclists. They are included in this category in this report because they lack the protection or enclosure of a vehicle, and because their smaller size reduces their visibility to other motor vehicle drivers.
[q] In this report "cyclist" refers to a person riding a bicycle, as well as riders or passengers of other pedal-powered vehicles, including children's or "adult" tricycles, tandem bicycles, and other configurations of pedal cycles.

Together, vulnerable road users make up a substantial proportion of MVC fatalities and serious injuries; however, this is not a homogeneous group, as each type of vulnerable road user uses roadways differently, follows different laws, and has its own road safety challenges. Since there are currently no accurate measures of the numbers of pedestrians, cyclists, and to some extent motorcyclists, on the road it is not possible to determine an accurate denominator for each road user group; as such, rates in this section are based on the BC population. This results in lower rates per 100,000 population for some road user types than if a road user group denominator were available, and may also result in small fluctuations in fatality or serious injury counts appearing as large changes in rates over time. For further discussion, see Chapter 1 and Appendix B.

FATALITIES AND SERIOUS INJURIES AMONG VULNERABLE ROAD USERS

Figure 4.1 shows vulnerable road user fatalities in BC from 2009 to 2013. During this time, the number of vulnerable road user MVC fatalities declined from 115 to 94; however, because there was a sharper decrease in fatalities for other road users during this time, the proportion of vulnerable road user deaths increased from 31.7 per cent in 2009 to 34.9 per cent in 2013.[9] The highest proportion of fatalities among vulnerable road users were pedestrians for all years depicted, generally growing in proportion over the years with a slight dip in 2010. Motorcyclists were the next highest proportion, followed by cyclists.

Figure 4.1 **Proportion of Total Motor Vehicle Crash Fatalities, by Vulnerable Road User Type, BC, 2009 to 2013**



	2009	2010	2011	2012	2013
Motorcycle Occupant	12.9	9.9	13.0	8.6	10.8
Cyclist	2.8	1.6	2.4	3.9	4.8
Pedestrian	16.0	15.9	19.5	23.2	19.3
Total Percentage among MVC Fatalities	31.7	27.5	34.9	35.7	34.9
Number of Vulnerable Road User Fatalities	115	100	102	100	94

Year

Notes: "Vulnerable road users" are those who use the road without the protection of an enclosed vehicle. "Motorcycle occupant" includes motorcycle drivers and passengers. See Appendix B for more information about this data source.
Source: Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia, 2009-2013. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

Figure 4.2 shows the proportion of total MVC serious injuries among vulnerable road users for 2007 to 2011. In 2007, a total of 1,473 vulnerable road users experienced serious injuries, representing 38.7 per cent of MVC serious injuries. By 2013 this number had decreased to 1,388 but the proportion of MVC hospitalizations had increased to 45.7 per cent. Therefore, similarly to fatalities, while the overall rate of serious injuries from MVCs is decreasing in BC, an increasing percentage of those injuries are among vulnerable road users. Motorcyclists had the highest burden of MVC hospitalizations, followed by pedestrians and then cyclists.

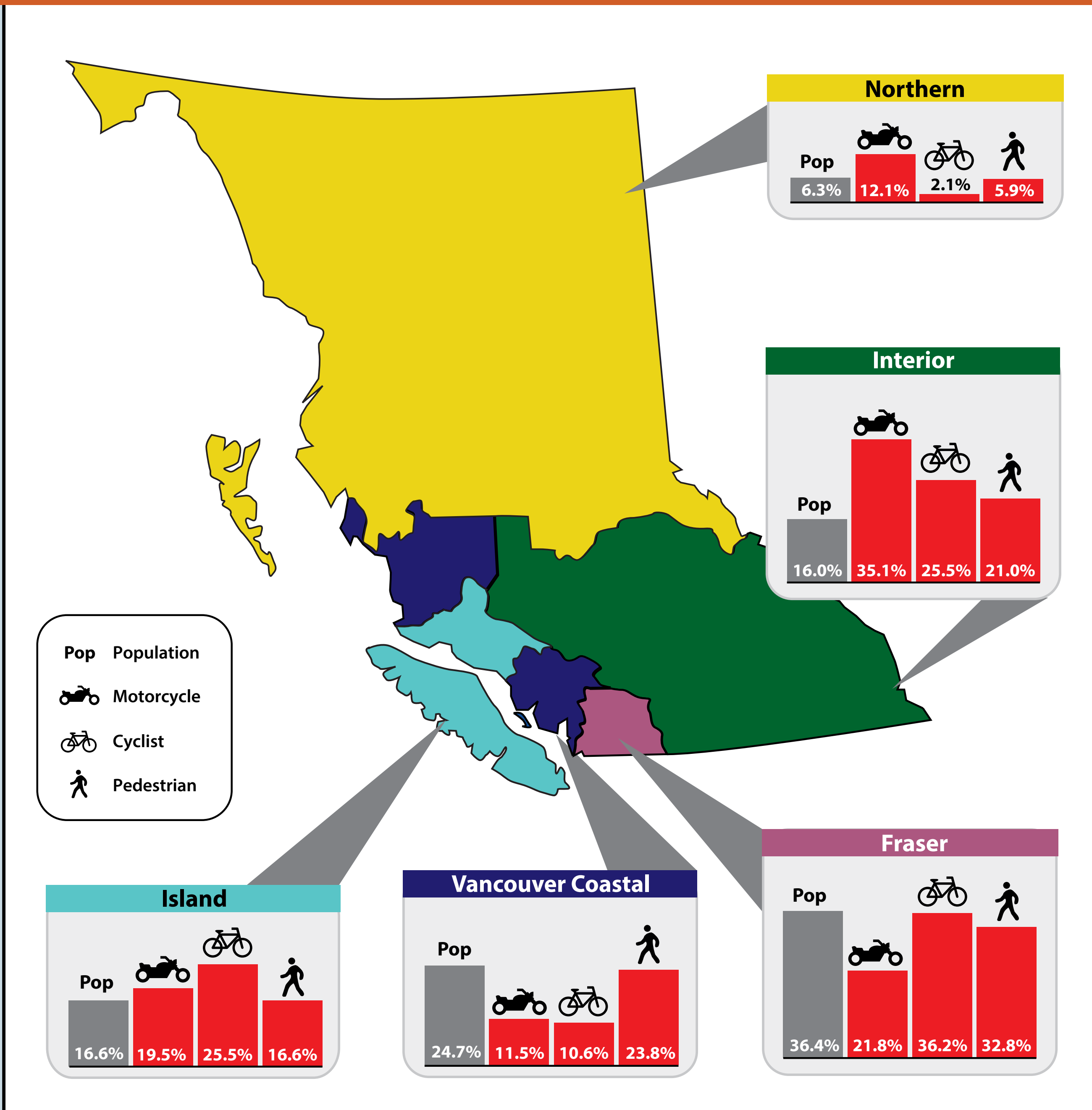
Figure 4.2 **Proportion of Total Motor Vehicle Crash Hospitalizations, by Vulnerable Road User Type, BC, 2007 to 2011**

	2007	2008	2009	2010	2011
Motorcycle Occupant	18.0	20.2	21.3	22.3	21.7
Cyclist	5.6	5.7	6.1	6.9	7.8
Pedestrian	15.2	14.9	14.0	14.9	16.2
Total Percentage among MVC Hospitalizations	38.7	40.8	41.4	44.1	45.7
Number of Vulnerable Road User Hospitalizations	1,473	1,498	1,435	1,460	1,388

Year

Notes: "Vulnerable road users" are those who use the road without the protection of an enclosed vehicle. "Motorcycle occupant" includes motorcycle drivers and passengers. See Appendix B for more information about this data source.
Source: Discharge Abstract Database, Ministry of Health, 2007-2011. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

Figure 4.3 Proportion of Population and Motor Vehicle Crash Fatalities, by Vulnerable Road User Type and Health Authority, BC, 2009-2013



Health Authority	Population	Percentage of BC Population	Number of Motorcyclist Fatalities	Percentage of Motorcyclist Fatalities	Number of Cyclist Fatalities	Percentage of Cyclist Fatalities	Number of Pedestrian Fatalities	Percentage of Pedestrian Fatalities
Northern	282,826	6.3%	21	12.1%	1	2.1%	17	5.9%
Interior	721,190	16.0%	61	35.1%	12	25.5%	61	21.0%
Vancouver Coastal	1,110,349	24.7%	20	11.5%	5	10.6%	69	23.8%
Island	748,797	16.6%	34	19.5%	12	25.5%	48	16.6%
Fraser	1,637,014	36.4%	38	21.8%	17	36.2%	95	32.8%
BC Total	4,500,175		174		47		290	

Notes: Regional information presented is based on crash location. "Population" is the average population for 2009-2013. Population percentage is calculated based on the population of the health authority area. There were cases in which health authority was unspecified, and these cases are excluded from this figure. "Motorcycle occupant" includes motorcycle drivers and passengers. See Appendix B for more information about these data sources.
Sources: Fatality data are from the Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia 2009-2013; population estimates are from the BC Stats website, April 2015. Prepared by BC Injury Research and Prevention Unit, 2015; and the Office of the Provincial Health Officer, 2015.

Figure 4.3 shows the distribution of motorcycle occupant, cyclist, and pedestrian MVC fatalities that occurred in the regional health authorities compared to their proportion of the BC population for 2009-2013. Motorcycle occupant fatalities were disproportionately high in Interior and Northern Health, and comparably low in Vancouver Coastal and Fraser Health. Cyclist fatalities were disproportionately high in Island and Interior Health, and comparably low in Northern and Vancouver Coastal Health. Among all the vulnerable road user groups shown in Figure 4.3, pedestrians were the closest to having a proportionate distribution of fatalities to population throughout the province.

One study in BC found that cyclists and pedestrians had higher injury and fatality rates than motor vehicle occupants when compared using crude rate estimates for the number of trips made (measured in 100 million person-trips) or distance travelled (measured in 100 million kilometres). Specifically, from 2005 to 2007 cyclists had 1,398 injuries per 100 million person-trips (compared to 713 for vehicle occupants) and 264 injuries per 100 million kilometres travelled (compared to 72 for vehicle occupants). Cyclists also had 13.8 fatalities per 100 million person-trips (compared to 9.6 for vehicle occupants) and 2.6 fatalities per 100 million kilometres (compared to 1.0 for vehicle occupants). Pedestrians had 392 injuries and 14.7 fatalities per 100 million person-trips and 196 injuries and 7.4 fatalities per 100 million kilometres travelled.[8]

Measures to Promote Vulnerable Road User Safety

There are many ways to increase the safety of vulnerable road users. Infrastructure can be adapted to suit the needs of all road users, rather than focusing on vehicles. Many jurisdictions (e.g., New York City[10]) have made substantial changes to infrastructure, and have considerably reduced MVC injuries and fatalities (see Chapter 7). Another key way to increase the safety of all vulnerable road users is to shift the burden of legal responsibility away from them and onto vehicle drivers. Other jurisdictions have incorporated this idea into their policies and legislation, shifting laws to favour vulnerable road users. For example, European countries such as the Netherlands have implemented strict liability laws, which put the liability for cyclist injuries resulting from an MVC onto the involved vehicle driver by default,[11] and Indian law has put liability on the vehicle owner and required insurance to compensate the victim of an MVC or their heirs regardless of fault.[12] Another example is in Ontario, where the recently passed *Making Ontario's Roads Safer Act* (effective September 1, 2015) includes increased fines for "dooring" cyclists and a requirement that vehicle drivers maintain a distance of at least one metre when passing cyclists on highways.[13]

The remainder of this chapter will explore challenges and opportunities to prevent injury and death for motorcyclists, cyclists, and pedestrians.

MOTORCYCLISTS

Fatalities and Serious Injuries among Motorcyclists

According to the Insurance Corporation of British Columbia (ICBC), motorcycles represent approximately 3 per cent of insured vehicles in BC, yet are involved in about 11 per cent of MVC fatalities.[14] Motorcyclists lack the protection and safety features of an enclosed vehicle but are travelling at high speeds with other vehicles, a dangerous combination that can create an increased risk of serious injury and death. ICBC reports that in 2013 there were 2,200 MVCs that involved at least one motorcycle in BC. These MVCs resulted in approximately 1,500 injured victims and 29 fatalities.[15] Research in the United States has found that per vehicle mile travelled, motorcyclists have a 34-fold higher risk of death in an MVC than people driving other types of vehicles.[16] Another US study found that while 20 per cent of passenger vehicle

MVCs result in injury or death, 80 per cent of motorcyclist MVCs did so.[17]

Figure 4.4 shows the number and rate per 100,000 population of motorcycle fatalities in BC from 1996 to 2013. Both the number and rate slowly climbed between 1996 and 2005 followed by a variable plateau period until 2009, and a subsequent decline through 2012.

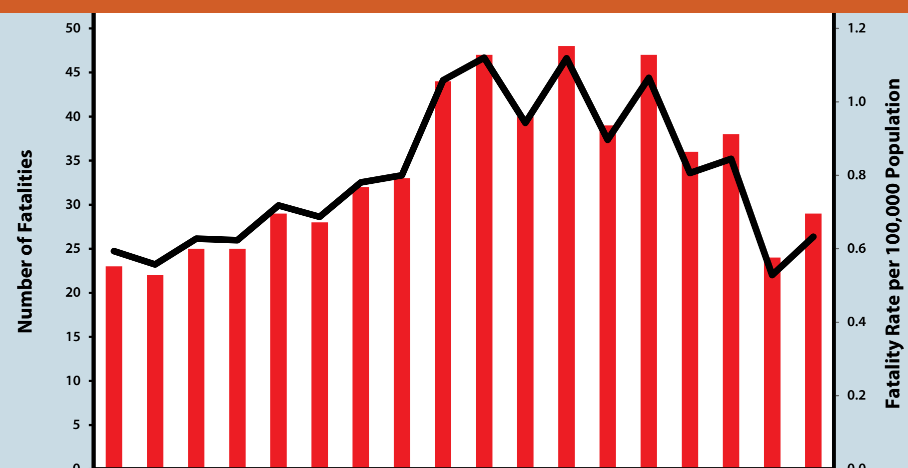
Figure 4.5 shows the number and rate per 100,000 population of MVC hospitalizations of motorcycle occupants from 2002 to 2011. While both the numbers and rates rose, plateaued, and dropped over the time period shown, the 2002 and 2011 rates were very similar, at 15.0 per 100,000 population in 2002 and 14.6 per 100,000 in 2011.

Similar to the findings presented in Chapter 2 of this report, the BC Ministry of Justice reports that the fatality rate between 1996 and 2010 for motorcycle drivers under age 25 is about 15 times higher than the fatality rate for those over age 25.[3]

Figure 4.6 shows the rates of motorcycle occupant fatalities for 2009-2013, by sex

Figure 4.4

Motor Vehicle Crash Motorcycle Occupant Fatality Count and Rate per 100,000 Population, BC, 1996 to 2013

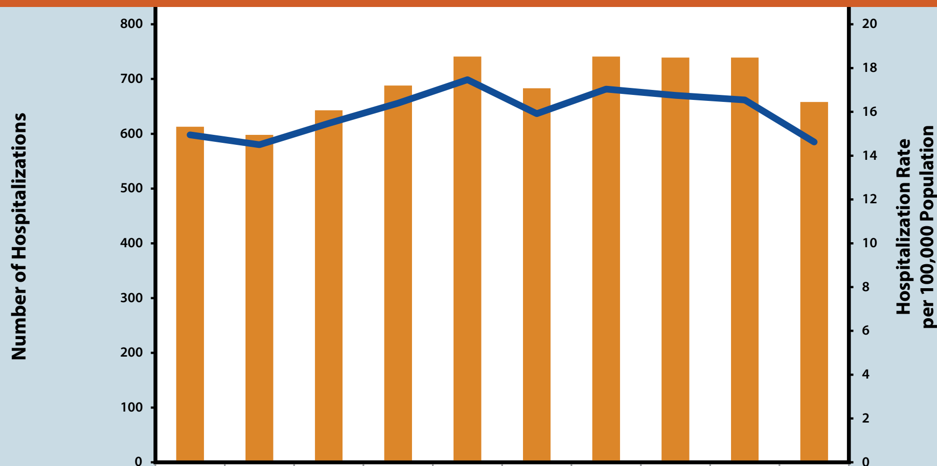


	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Number of Fatalities	23	22	25	25	29	28	32	33	44	47	40	48	39	47	36	38	24	29
Fatality Rate	0.59	0.56	0.63	0.62	0.72	0.69	0.78	0.80	1.06	1.12	0.94	1.12	0.90	1.07	0.81	0.84	0.53	0.63

Year

Notes: "Motorcycle occupant" includes motorcycle drivers and passengers. See Appendix B for more information about these data sources.
Sources: Fatality data are from the Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia, 1996-2013; population estimates are from the BC Stats website, April 2015. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

Figure 4.5 **Motor Vehicle Crash Motorcycle Occupant Hospitalization Count and Rate per 100,000 Population, BC, 2002 to 2011**



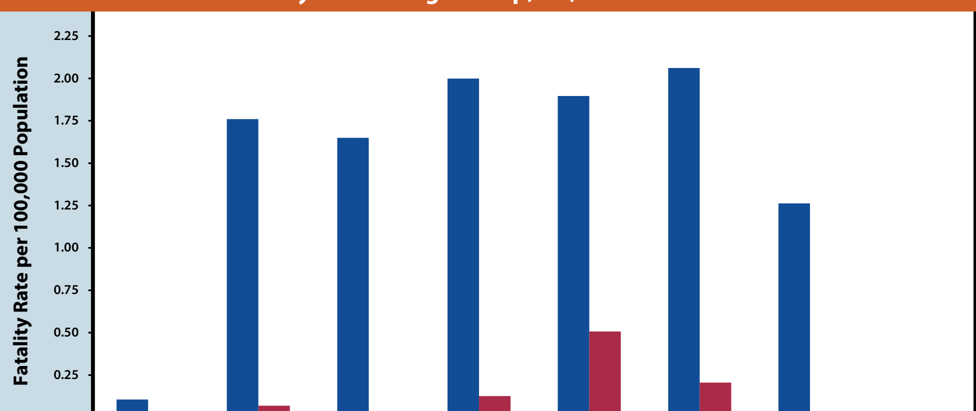
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Number of Hospitalizations	613	598	643	688	741	683	741	739	739	658
Hospitalization Rate	15.0	14.5	15.5	16.4	17.5	15.9	17.0	16.8	16.5	14.6

Year

Notes: "Motorcycle Occupant" includes motorcycle drivers and passengers. See Appendix B for more information about these data sources.
Sources: Hospitalization data are from the Discharge Abstract Database, Ministry of Health, 2002-2011; population estimates are from the BC Stats website, April 2015. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

and age group. Male motorcycle occupants were far more likely to experience an MVC fatality than females. The burden of MVC motorcycle occupant fatalities was highest among males aged 16 to 65, ranging between 1.65 and 2.06 per 100,000 population, and a slightly lower occurrence for males age 66-75 years of age at 1.26 fatalities per 100,000. For females, the highest rate was among those 46-55 years of age.

Figure 4.6 **Motor Vehicle Crash Motorcycle Occupant Fatality Rate per 100,000 Population, by Sex and Age Group, BC, 2009-2013**



	0-15	16-25	26-35	36-45	46-55	56-65	66-75	76+
Male	0.11	1.76	1.65	2.00	1.90	2.06	1.26	0.00
Female	0.00	0.07	0.00	0.13	0.51	0.21	0.00	0.00
BC	0.05	0.94	0.82	1.05	1.19	1.13	0.62	0.00

Age Group

Notes: "Motorcycle occupant" includes motorcycle drivers and passengers. Data should be interpreted with caution due to small numbers. Rates are calculated using age- and sex-specific population numbers. See Appendix B for more information about these data sources.
Sources: Fatality data are from the Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia, 2009-2013; population estimates are from the BC Stats website, April 2015. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

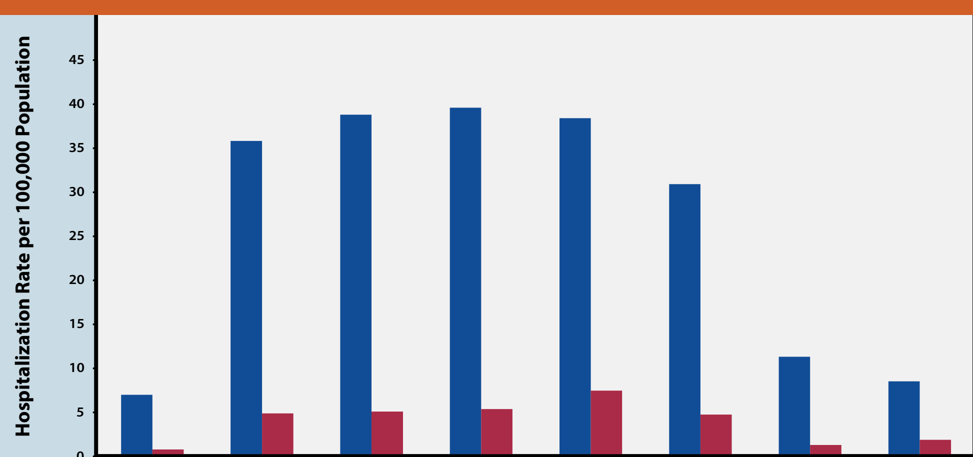
Figure 4.7 shows the hospitalization rates per 100,000 population for motorcycle occupants for 2007-2011, by sex and age group. Male motorcycle occupants were far more likely to be hospitalized as a result of an MVC than females in all age groups. For both sexes, there was a hill-shaped curve, with the predominance of hospitalizations occurring among both males and females between 16 and 65 years of age. The highest rate among men was 39.6 hospitalizations per 100,000 population for those age 36-45, and among females was 7.5 hospitalizations per 100,000 for those age 46-55.

The causes of MVCs involving motorcycles are similar to those of other vehicles. On average for the period of 2008-2012, the top contributing factors reported by police for MVCs involving motorcyclists were speed (41.8 per cent), distraction (33.2 per cent), and alcohol (20.1 per cent).[18] These motorcycle-related MVC fatalities are also not distributed evenly throughout the year. For 2008-2012 the highest numbers of fatalities among motorcyclists were observed in July and August, while the lowest numbers were found in November and December,[18] likely reflecting the increased number of motorcyclists on the roadways in the summer months.[19]

Measures to Promote Motorcycle Safety

While motorcyclists may be inherently more prone to both MVC-related injuries and fatalities as a result of not having the protection of an enclosed vehicle, there are many ways to increase the safety of motorcycle drivers and passengers. In 2008, the BC Coroners Service Death Review Panel on Motorcycle Fatalities made a number of recommendations pertaining to motorcycle safety education. These recommendations included promoting awareness of the safety value of full-coverage riding gear, re-evaluating motorcycle training school standards and instructor certification, and educating other drivers about vulnerable road users,

Figure 4.7 **Motor Vehicle Crash Motorcycle Occupant Hospitalization Rate, by Sex and Age Group, BC, 2007-2011**



	0-15	16-25	26-35	36-45	46-55	56-65	66-75	76+
Male	7.0	35.8	38.8	39.6	38.4	30.9	11.3	8.5
Female	0.8	4.9	5.1	5.4	7.5	4.7	1.3	1.9
BC	4.0	20.7	21.9	22.3	22.8	17.8	6.2	4.7

Age Group

Notes: "Motorcycle occupant" includes motorcycle drivers and passengers. Rates are calculated using age- and sex-specific population numbers. See Appendix B for more information about these data sources.
Sources: Hospitalization data are from the Discharge Abstract Database, Ministry of Health, 2007-2011; population estimates are from the BC Stats website, April 2015. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

including information about the challenge of seeing motorcyclists on the road and the difficulty of assessing the speed at which they are traveling.[20] In 2012, the provincial government addressed some of these recommendations in new motorcycle safety legislation.[21] This legislation included updated fines, updated requirements for motorcycle drivers and passengers to wear helmets that meet specified safety standards,[20] increased visibility of licence plates, and a requirement that passengers keep their feet firmly planted on the foot pegs or floorboards of the motorcycle, or be appropriately seated in a sidecar.[3]

Research has demonstrated that the use of helmets by motorcyclists reduces the occurrence of fatalities and injuries and the severity of injuries when they are sustained. A 2008 Cochrane review found that motorcycle helmets reduce the risk of fatality by 42 per cent, and the risk of MVC-related head injury by 69 per cent.[22] Research on helmet use and injury outcomes in Washington State found that unhelmeted riders were three times more likely to sustain head injuries in an MVC than riders wearing helmets.[23] It also found that among hospitalized motorcyclists, unhelmeted motorcyclists sustained more severe injuries, had longer hospital stays (on average), and were more likely to be re-admitted to hospital for follow-up treatment, and/or to die from their injuries.[23] The study concluded that helmet use is strongly associated with reduced probability and severity of injury, fewer motorcyclist fatalities, and reduced economic impacts.[23]

To help increase safety for younger motorcyclists, research supports graduated licensing programs (GLPs) that allow new motorcycle drivers to gain experience under lower-risk driving conditions.[24,25] Multiple reviews and reports have suggested features for licensing programs for motorcycles, including several features common to other GLPs, such as having three driver stages (learner, novice, and full-privilege) and having restrictions on speed, alcohol, carrying passengers, and nighttime driving. These reports also recommend several additional components specific to motorcycles, such as the following:

- Setting the minimum driving age for motorcycles above the minimum driving age for other vehicles.
- Requiring a regular driver's licence before becoming eligible for a motorcycle licence.
- Disallowing passengers.
- Requiring a minimum number of hours-of-practice.
- Advanced on- and off-road skill testing.
- Requiring re-testing for any person who wants to register a motorcycle who has not had one registered in the recent past (e.g., 5-10 years).[20,24,25]

In BC, new drivers and drivers in the BC GLP must complete a graduated licensing program for motorcycles similar to that for other motor vehicles. However, currently, drivers who have already obtained a full-privilege driver's licence are eligible for a full-privilege motorcycle licence after a 30-day learner's stage.[26] In 2010, BC's Office of the Superintendent of Motor Vehicles—now RoadSafetyBC—within the Ministry of Justice proposed that this 30-day period be extended to six months.[27]

CYCLISTS

Similar to motorcyclists, cyclists do not have the protection of an enclosed vehicle in the event of an MVC, and so can be very vulnerable as road users. Nevertheless, according to BC's *Motor Vehicle Act*, cyclists have the same rights and responsibilities as drivers of vehicles.[28]

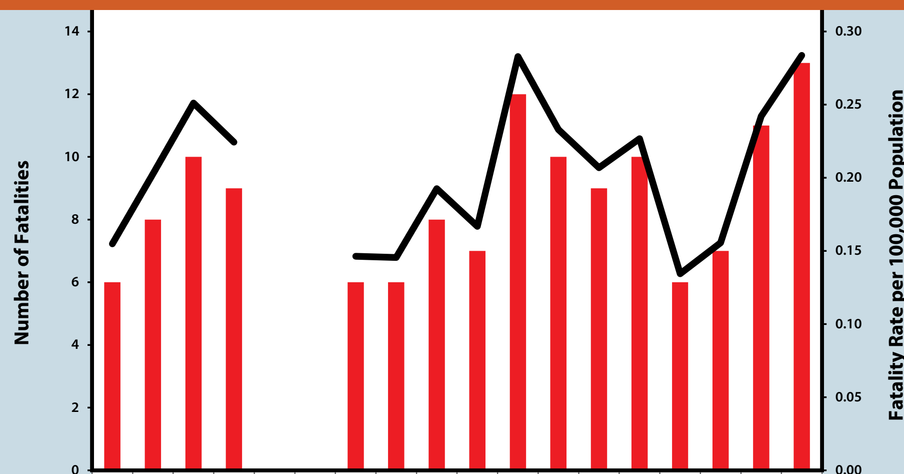
According to Statistics Canada data from 2011, the Victoria Capital Regional District had the highest proportion of people who reported commuting to work by bicycle (5.9 per cent) of all Census Metropolitan Areas in Canada.[29] Kelowna also had a relatively high bicycle use level at 2.6 per cent of commuters, and Metro Vancouver followed at 1.8 per cent.[29] The provincial government supports and promotes cycling because of its environmental, economic, and health benefits, with the goal of providing "safe, accessible and convenient bicycle facilities on the province's highways."[30] Campaigns like the annual Bike to Work Week and Bike to School Week raise awareness of the environmental and health benefits of cycling, and promote safe cycle commuting by offering cycling skills workshops and training materials.[31,32,33]

Fatalities and Serious Injuries among Cyclists

In 2007 there were approximately 1,300 MVCs involving cyclists in BC, causing approximately 1,300 injured cyclists and 10 cyclist fatalities. By 2013 this had increased to approximately 1,500 MVCs resulting in approximately 1,500 injured cyclists and 13 cyclist fatalities.[r,34] This represents an increase in cyclist-involved MVCs of about 15 per cent over those seven years.[35]

Figure 4.8 shows the counts and rates of MVC cyclist fatalities between 1996 and

Figure 4.8 **Motor Vehicle Crash Cyclist Fatality Count and Rate per 100,000 Population, BC, 1996 to 2013**



	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Number of Fatalities	6	8	10	9	*	*	6	6	8	7	12	10	9	10	6	7	11	13
Fatality Rate	0.15	0.20	0.25	0.22	*	*	0.15	0.15	0.19	0.17	0.28	0.23	0.21	0.23	0.13	0.16	0.24	0.28

Year

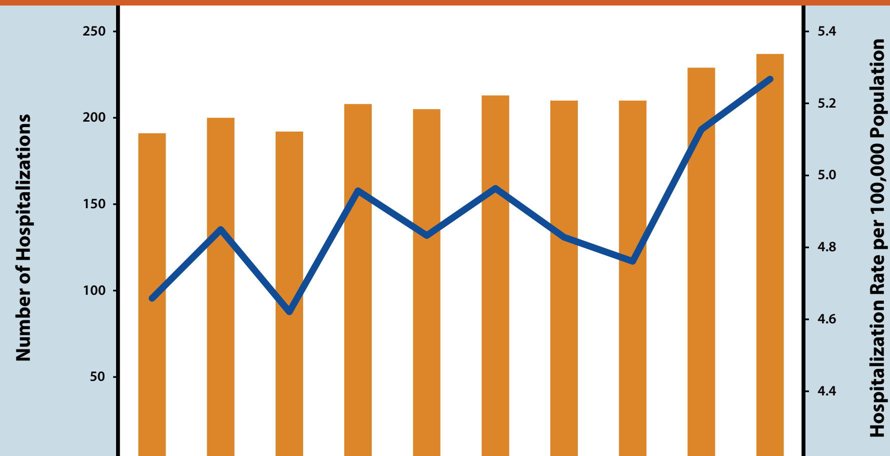
Notes: "*" Indicates numbers less than five, and their associated rates. Data should be interpreted with caution due to small numbers. See Appendix B for more information about these data sources.
Sources: Fatality data are from the Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia, 1996-2013; population estimates are from the BC Stats website, April 2015. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

[r] Note that the figures 1,500 and 1,300 reflect ICBC data rounded to the nearest 100. ICBC data differ from police-reported data, as police do not attend all MVCs, and not all MVCs are reported to police.

2013. While both the numbers and rates were variable over the period, there was an increasing trend in cyclist-involved incidents. While there were only six cyclist fatalities or 0.15 fatalities per 100,000 population in 1996, there were 13 fatalities or 0.28 per 100,000 population in 2013. The variation resulting from small numbers makes it impossible to state whether these show any definitive trend but it is clear that the risk is not decreasing and has remained steady in the context of a decrease in overall MVC fatalities.

Figure 4.9 shows MVC-related cyclist hospitalizations due to serious injuries over the ten-year period from 2002 to 2011. The numbers and rates are more stable than for fatalities but indicate that both increased over this period. In 2002 there were 191 serious injuries, and a rate of 4.7 per 100,000 population; by 2011 the number of hospitalizations had increased to 237, and a rate of 5.3 per 100,000. This represents an increase of 27.7 per cent in the number of hospitalizations, or an increase of 12.8 per cent in the rate of hospitalizations

Figure 4.9 Motor Vehicle Crash Cyclist Hospitalization Count and Rate per 100,000 Population, BC, 2002 to 2011



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Number of Hospitalizations	191	200	192	208	205	213	210	210	229	237
Hospitalization Rate	4.7	4.8	4.6	5.0	4.8	5.0	4.8	4.8	5.1	5.3

Year

Note: See Appendix B for more information about these data sources.
Sources: Hospitalization data are from the Discharge Abstract Database, Ministry of Health, 2002-2011; population estimates are from the BC Stats website, April 2015. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

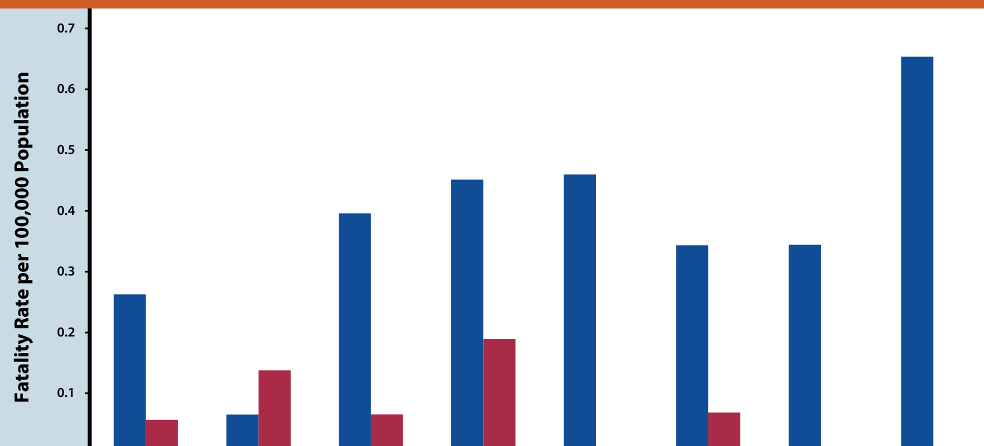
per 100,000 population. Due to challenges with available denominator data as discussed, it is unknown whether the increases shown in Figures 4.8 and 4.9 reflect an increase in the number of cyclists and/or distances cycled, or an increase in the absolute risk.

Figure 4.10 breaks down the 47 cyclist fatalities in the most recent five years for which there are data available. It shows cyclist fatality rates resulting from MVCs for 2009-2013 by sex and age group. Males had much higher fatality rates per 100,000 population than women in all age groups except 16-25 years of age. The highest fatality rate for male cyclists was among those aged 76 and up at 0.65 per 100,000 population, and the lowest was among those aged 16-25 at 0.07 per 100,000. Cyclist fatality rates among females were highest among those aged 36-45 at 0.19 per 100,000 population. These patterns should be interpreted with caution due to small numbers and since the total number and demographic information of cyclists in BC is currently not known. As such, it is unknown the extent to which these higher rates may be linked to a larger number of male cyclists or cyclists age 76 and up, or to greater risk-taking behaviour or vulnerability.

Figure 4.11 examines the 1,099 hospitalizations of cyclists in the most recent five years for which there are data available. It depicts the rate of cyclist-involved MVC serious injuries for 2007-2011, by sex and age group. Males had higher rates of hospitalizations compared to females in all categories. The highest rates among males were between 16 and 55 years of age. Females had much lower and more variable rates, with the highest rate being among those age 26-35 (4.0 serious injuries per 100,000 population). As noted with the fatality data, this information should be interpreted with caution since the total number of cyclists and their age and sex are not known.

In MVCs involving cyclists for 2008-2012, the top contributing factors identified in police reports differ somewhat to those identified for other MVCs. Those MVCs

Figure 4.10 **Motor Vehicle Crash Cyclist Fatality Rate per 100,000 Population, by Sex and Age Group, BC, 2009-2013**

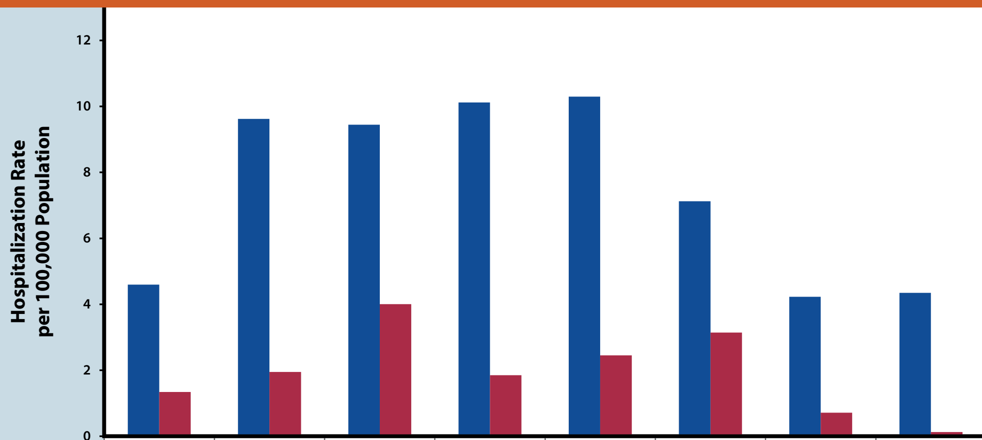


	0-15	16-25	26-35	36-45	46-55	56-65	66-75	76+
Male	0.26	0.07	0.40	0.45	0.46	0.34	0.34	0.65
Female	0.06	0.14	0.07	0.19	0.00	0.07	0.00	0.00
BC	0.16	0.10	0.23	0.32	0.23	0.21	0.17	0.28

Age Group

Notes: Data should be interpreted with caution due to small numbers. Rates are calculated using age- and sex-specific population numbers. See Appendix B for more information about these data sources.
Sources: Fatality data are from the Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia, 2009-2013; population estimates are from the BC Stats website, April 2015. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

Figure 4.11 **Motor Vehicle Crash Cyclist Hospitalization Rate per 100,000 Population, by Sex and Age Group, BC, 2007-2011**



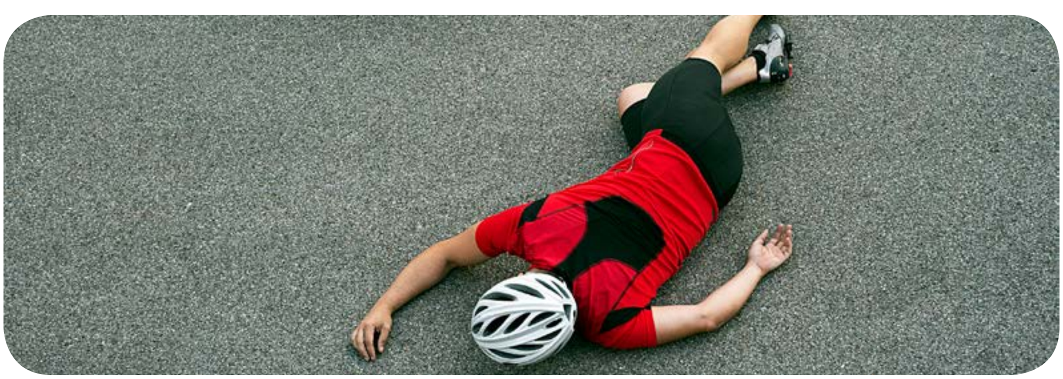
	0-15	16-25	26-35	36-45	46-55	56-65	66-75	76+
Male	4.6	9.6	9.4	10.1	10.3	7.1	4.2	4.3
Female	1.3	2.0	4.0	1.9	2.5	3.1	0.7	0.1
BC	3.0	5.9	6.7	5.9	6.3	5.1	2.4	1.9

Age Group

Notes: Data should be interpreted with caution due to small numbers. Rates are calculated using age- and sex-specific population numbers. See Appendix B for more information about these data sources.
Sources: Hospitalization data are from the Discharge Abstract Database, Ministry of Health, 2007-2011; population estimates are from the BC Stats website, April 2015. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

involving at least one cyclist were most often attributed to motor vehicle drivers being distracted (44.2 per cent) and failing to yield the right of way (25.6 per cent).[18] The third most common factor identified in these reports was alcohol impairment (18.6 per cent), however data do not indicate whether the driver or cyclist was intoxicated.[18]

Similar to motorcycles, cyclist-involved MVCs are not evenly distributed throughout the year, but instead are more concentrated during summer months. Between 2008 and 2012, almost half (46.8 per cent) of cyclist fatalities occurred during the summer months from July to September, when there is an increase in the number of cyclists on the road.[18,19] Time of day is also important—in 2007, more than 30 per cent of cyclist MVCs happened between the hours of 3 p.m. and 6 p.m (likely related to work and school commuting).[36] Lastly, some sections of roadways are more prone to MVCs involving cyclists than others. In 2007, more than half (54.6 per cent) of all cyclist-involved MVCs took place at **intersections**.[36] Intersections will be discussed in Chapter 7.



Measures to Promote Cyclist Safety

The safety of cyclists is linked to all the pillars of an SSA. This includes initiatives that provide universal cycling safety training for children, adults, and motor vehicle drivers; those that have the potential to enhance cycling infrastructure; consideration of all-season cycling infrastructure and roadway maintenance (e.g., hazard removal); and increased safety through legislation, reduced motor vehicle speed limits, **traffic calming** techniques, and increased enforcement.[37]

Figure 4.12 provides examples of several measure that have been associated with increased cycling safety. A few examples of these include the following:

- Designated bicycle travel routes, such as **protected cycling paths**,[38,39,40] **painted cycling lanes**[41,42] and designated residential road cycling routes.
- Bike routes that do not require bicyclists to ride between parked and moving motor vehicles.[38,43,44]
- Intersections and traffic signals prioritizing cyclists.[41,45]
- Reduced motor vehicle speeds, especially speeds of 30 km/h and less.[39,46,47]
- Removal of obstacles (e.g., bollards, street furniture, streetcar and train tracks), debris, and potholes from bike routes.[43]

Some jurisdictions that have successfully implemented changes to infrastructure are highlighted in Chapter 7.

Results of a survey of 1,402 Vancouver residents who cycle highlight the importance of roadway infrastructure and safety on promoting cycling as a method of transportation. The top five deterrents to cycling identified were: an icy or snowy route; roadways with high motor vehicle traffic

Figure 4.12 Sample of Infrastructure Measures to Increase Cyclist Safety

Protected Cycling Path

Painted Cycling Lane

Intersection Prioritizing Cyclists

Notes: Photo credit for "Protected Cycling Paths" and "Intersection Prioritizing Cyclists" – Ken Ohrn. Photo credit for "Painted Cycling Lane" – BC Ministry of Transportation and Infrastructure. Reproduced with permission.
Sources: "Protected Cycling Paths" and "Intersection Prioritizing Cyclists" source – Photographer Ken Ohrn. "Painted Cycling Lane" source – BC Ministry of Transportation and Infrastructure, CC BY-NC-ND 2.0 (see: https://creativecommons.org/licenses/by-nc-nd/2.0/).

volume; a route where motor vehicles travel above 50 km/h; a route with glass or debris; and a route with risk from motor vehicle drivers who do not drive safely near cyclists.[48]

As described earlier, other jurisdictions in Europe, India, and even Canada have successfully implemented policies and legislation that increase responsibility on vehicle drivers, as a motivator to drive more safely around vulnerable road users and to provide legal protection for cyclists in the case of an MVC.

When MVCs do happen, helmets are an effective measure to protect cyclists from head injuries. The BC *Motor Vehicle Act* states that all cyclists, including cycle passengers, must wear approved bicycle safety helmets.[49] A Cochrane review published in 2009 concluded that bicycle helmet legislation protects against head injuries for cyclists.[50] In BC in 2007, cyclists involved in MVCs while wearing helmets were less prone to severe head injury than those who were unhelmeted at the time of the MVC. For cyclists injured in MVCs in BC that year, the most severe type of injuries incurred were head injuries, present in 14.9 per cent of unhelmeted cyclists, compared to 11.8 per cent of cyclists who had been wearing helmets.[36] Safe Kids Canada has reported that the influence of adults is an important consideration in whether or not children wear bicycle helmets.[51] One US study concluded that a combination of legislation and education may be more effective at increasing bicycle helmet use among children than education alone.[52]

Other measures include education, universal cycling safety training, high-visibility clothing, legislative penalties, and increased enforcement.[37]

“Cyclists involved in MVCs while wearing helmets were less prone to severe head injury than those who were unhelmeted at the time of the MVC.”

PEDESTRIANS

Fatalities and Serious Injuries among Pedestrians

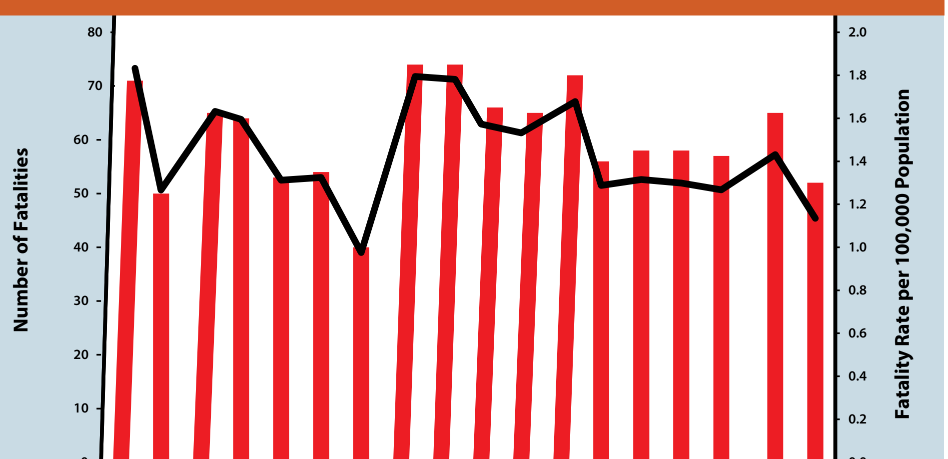
According to ICBC, there were approximately 2,200 MVCs involving at least one pedestrian in BC in 2013. These MVCs resulted in 2,300 injured pedestrians and 52 pedestrian fatalities.[35] Children and seniors are especially vulnerable subgroups and will be the topic of specific analysis in the next two sections.

Figure 4.13 shows the number and rate of pedestrian-involved MVC fatalities from 1996 to 2013. The number of pedestrian fatalities has fluctuated year-to-year over these 18 years, hitting a low of 40 fatalities in 2002 and a peak of 74 in 2003 and 2004. Fluctuations in the fatality rate per 100,000 population aligns closely with the yearly changes in the counts; however, there is not an obvious downward trend in either the absolute number of pedestrian fatalities or the rate of fatalities per 100,000 over time. This suggests that more can be done to prevent pedestrian fatalities. BC has not achieved the clear decreases in pedestrian fatalities that other jurisdictions have, such as those who have been on track to meet the targets agreed upon in the 2002 European Conference of Ministers of Transport, including Luxembourg, Portugal, France, Denmark, Switzerland, Netherlands, Germany, Latvia, and Norway.[53]

Figure 4.14 shows the number and rate of pedestrian-involved MVC hospitalizations from 2002 to 2011. The number fluctuates over the years, starting in 2002 with 565 serious injuries and a rate of 13.8 per 100,000 population, then decreasing to 493 hospitalizations and a rate of 11.0 per 100,000 in 2011. This represents a 12.7 per cent decrease in the number of pedestrian hospitalizations and a 20.3 per cent decrease in the rate per 100,000 of pedestrian hospitalizations.

Most pedestrian injuries and fatalities are associated with the motor vehicle driver and/or the pedestrian performing at least one unsafe action at the time of the crash.[4,54] For the period of 2008-2012,

Figure 4.13 **Motor Vehicle Crash Pedestrian Fatality Count and Rate per 100,000 Population, BC, 1996 to 2013**

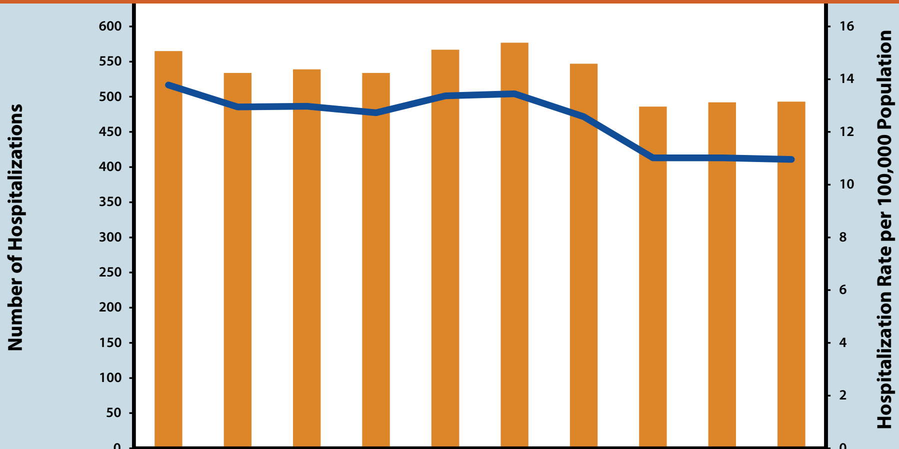


	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Number of Fatalities	71	50	65	64	53	54	40	74	74	66	65	72	56	58	58	57	65	52
Fatality Rate	1.8	1.3	1.6	1.6	1.3	1.3	1.0	1.8	1.8	1.6	1.5	1.7	1.3	1.3	1.3	1.3	1.4	1.1

Year

Note: See Appendix B for more information about these data sources.
Sources: Fatality data are from the Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia, 1996-2013; population estimates are from the BC Stats website, April 2015. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

Figure 4.14 **Motor Vehicle Crash Pedestrian Hospitalization Count and Rate per 100,000 Population, BC, 2002 to 2011**



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Number of Hospitalizations	565	534	539	534	567	577	547	486	492	493
Hospitalization Rate	13.8	12.9	13.0	12.7	13.4	13.4	12.6	11.0	11.0	11.0

Year

Note: See Appendix B for more information about these data sources.
Sources: Hospitalization data are from the Discharge Abstract Database, Ministry of Health, 2002-2011; population estimates are from the BC Stats website, April 2015. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

the top contributing factors reported by police in their reports for MVCs with a pedestrian fatality were pedestrian error/confusion (31.0 per cent), distraction of the driver or pedestrian (29.3 per cent), alcohol (19.0 per cent), driver failing to yield the right of way (9.5 per cent), and speed (8.8 per cent).[18] Pedestrian distraction, including texting or talking on a cell phone while crossing the street, has been found to increase the risk of pedestrian MVCs.[4,55]

Vulnerable Pedestrians: Children

Analyses show that children and older adults are at a heightened risk of MVC involvement and of serious injury or fatality when involved in an MVC.[56,57,58,59]

Children, and especially younger children, may lack the cognitive, attentional, and perceptual skills and abilities needed to navigate the road system safely.[56] MVCs were the leading cause of death (at 29 per cent) among BC child deaths in 2009 reviewed by the BC Coroners Service Child Death Review Unit.[s,60] In 2009, the European Conference of Ministers of Transport noted that transportation systems had not been designed with child safety in mind, as children have limited concentration and ability to evaluate risk and are spontaneous and impulsive.[57] Many children, especially those under age 11, do not have the capacity to use roadways safely on their own.[56,61] Vehicle design, roadway design and driver conduct should take into account the tendency of children to misjudge the speed of oncoming traffic and a potential lack of parental supervision or inability for parents to intervene.[60]

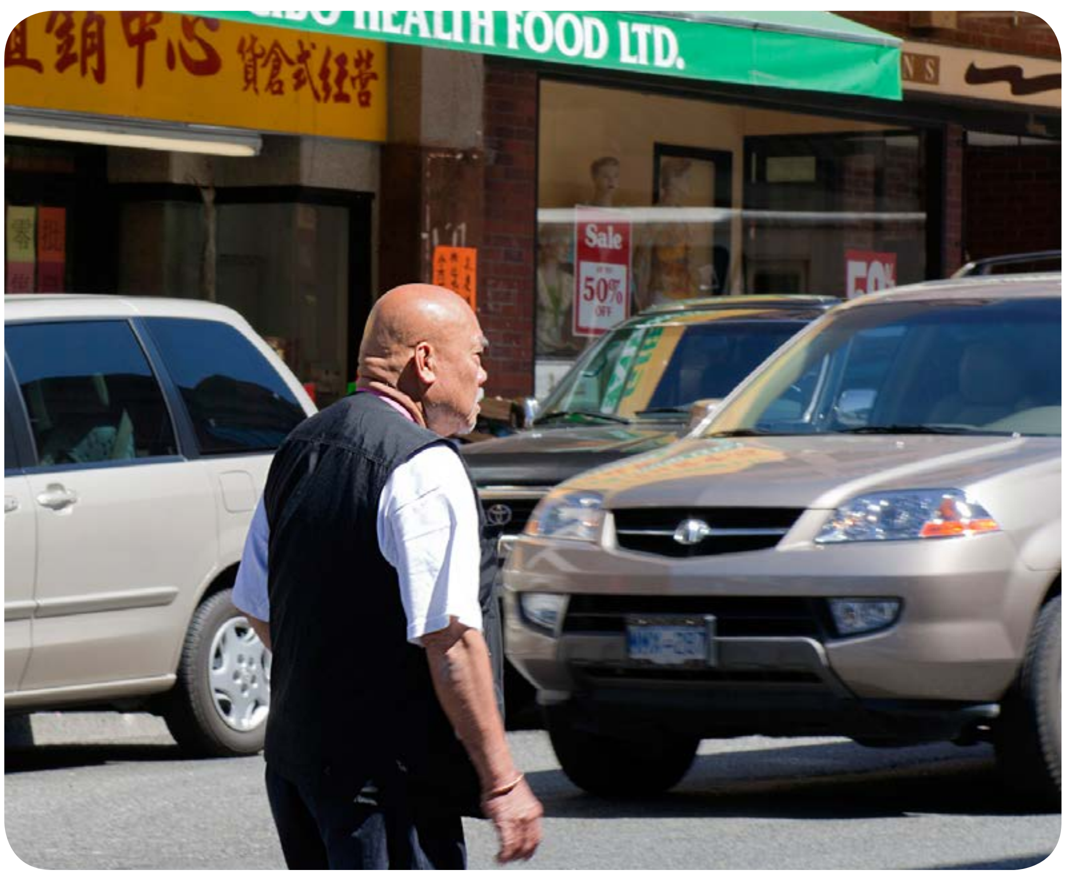
Research shows that child pedestrians are most often struck during the day during clear weather, and that most are struck midblock as opposed to at intersections.[62] Further, most children are struck while walking, not playing, and of those who were struck while playing, most were not playing in the street.[62] Younger children are particularly at

[s] The BC Coroners Service Child Death Review Unit defines children as those under age 19.

risk for "back-over" incidents, when a car backs over someone, often in a residential driveway. This is due to both their earlier stage of cognitive development and their smaller stature, which makes it more difficult for drivers to see them;[60] however, older children have also been shown to be at risk of these incidents.[63] According to one Canadian study, 3.4 per cent of severe pedestrian injuries among children under age 14 from 1994 to 2003 were the result of back-over MVCs.[63] Of these, 49 (33.1 per cent) involved a vehicle backing out of a driveway.[63] In BC, 12 per cent of child pedestrian injuries between 2003 and 2008 occurred in residential driveways; all vehicles involved were pickup trucks or sport-utility vehicles.[64] These statistics underscore the importance of roadway and vehicle design, including the need for greater anticipation and accommodation of children in residential settings and increased visibility around and behind vehicles, such as vehicles equipped with sensors and/or backup cameras.

Vulnerable Pedestrians: Older Adults

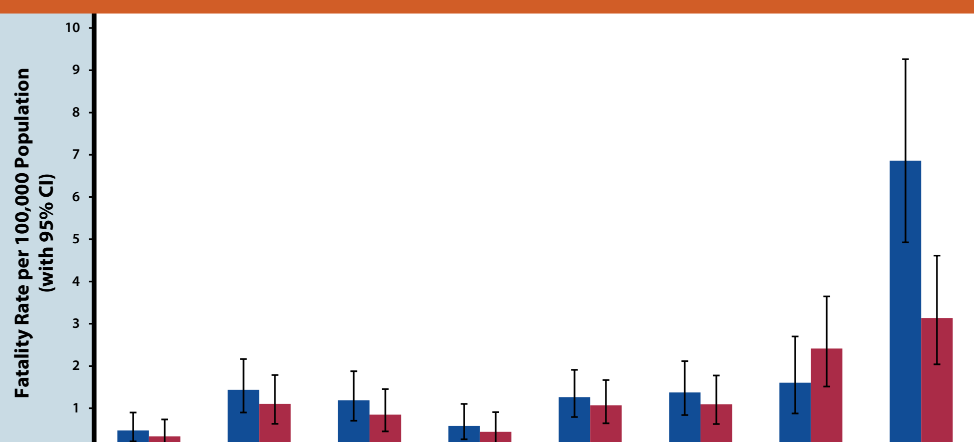
Analyses of pedestrian fatalities and serious injuries highlight the burden suffered by older adult pedestrians. Older pedestrians are among the most vulnerable and experience the highest rate of MVC fatalities in BC. The fatality rate for pedestrians aged 76 and up is more than two times the MVC fatality rate for pedestrians age 66-75.[18] Due to age-related changes, older people are more likely to have visual, cognitive, and/or physical challenges that compromise their ability to cross roadways safely or to cross them before the "walk" phase ends. Older pedestrians may also be frail and therefore less able to withstand the physical force of an MVC, resulting in more serious injuries and a greater likelihood of fatality.[59,66] According to the US Centers for Disease Control and Prevention, increased fatality among older adults is not due to increased crash rates, but rather, to increased susceptibility to injury and resulting medical complications.[65]



According to BC Stats, adults age 65 and up comprised 16.4 per cent of the BC population in 2013, and this proportion is expected to grow to 24.7 per cent by 2036. This proportion is greater than the projected proportions of children and youth combined for 2036 (those age 0-14 are projected to be 13.7 per cent of the BC population, and youth age 15-24 are projected to be 10.1 per cent of the BC population).[67] The proportion of the BC population age 80 and over is expected to almost double in the same timeframe, from 4.4 to 8.4 per cent.[67] Because of the aging BC population, there will be an increasing number of particularly vulnerable road users in the coming years.

As shown in Figure 4.15, among MVC pedestrian fatalities in BC 2009-2013, both males and females age 76 and up had the highest rate of fatalities per 100,000 population, at 6.9 and 3.1 per 100,000 population, respectively. Males had a higher fatality rate per 100,000 than females for most age groups.

Figure 4.15 **Motor Vehicle Crash Pedestrian Fatality Rate per 100,000 Population, by Sex and Age Group, BC, 2009-2013**



	0-15	16-25	26-35	36-45	46-55	56-65	66-75	76+
Male	0.5	1.4	1.2	0.6	1.3	1.4	1.6	6.9
Female	0.3	1.1	0.9	0.4	1.1	1.1	2.4	3.1
BC	0.4	1.3	1.0	0.5	1.2	1.2	2.0	4.7

Age Group

Notes: Rates are calculated using age- and sex-specific population numbers. There were nine cases where age group and/or sex was missing, and these cases are excluded from this figure. Cases with missing sex data have been included in total rates. See Appendix B for more information about these data sources.

Sources: Fatality data are from the Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia, 2009-2013; population estimates are from the BC Stats website, April 2015. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

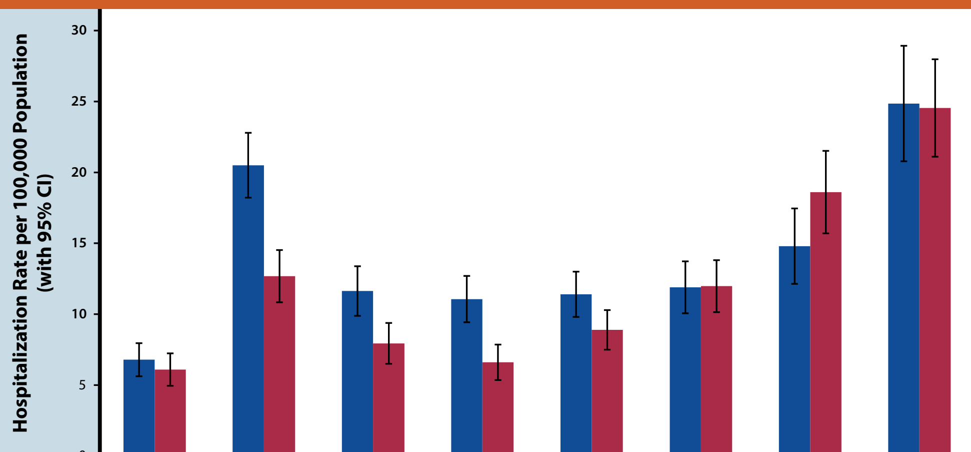
In examining pedestrian hospitalizations due to MVCs for 2007-2011, the data continue to show the vulnerability of older adults, but also a somewhat different picture than fatality rates. As shown in Figure 4.16, on average for 2007-2011, the hospitalization rate was highest among adults age 76 and up, for both males and females, at 24.9 per 100,000 population and 24.5 per 100,000, respectively. The data for both males and females show a 'U' shaped distribution between 16 and 76 years of age, with the lower rates occurring between 26 and 55 years of age. The lowest hospitalization rate for both sexes was for children and youth age 0-15 years, at 6.8 per 100,000 for males and 6.1 per 100,000 for females.

Measures to Promote Pedestrian Safety

As with cyclists, some ways to reduce the number of MVC-related pedestrian fatalities and serious injuries include modifying roadways, especially intersections, to prioritize pedestrians; ensuring speed limits are safe for all road users; encouraging vehicle adaptations to prevent MVCs with pedestrians and to protect them in the event of an MVC; and educating all road users about safe road user behaviour. Public education to improve knowledge and to help bring about changes in pedestrian behaviour (e.g., wearing bright clothing, lights, and reflectors to increase visibility to drivers; crossing at marked crosswalks; and staying alert and attentive to traffic) is an important component of pedestrian safety.[1,4] It is also crucial to educate drivers about the vulnerability of pedestrians (e.g., how to watch for pedestrians, especially at intersections; the importance of driving with lights on and obeying speed limits; and how all road users can share the roadways safely, especially in residential areas.[4,68,69]

In an attempt to improve pedestrian safety, the provincial government has worked with municipalities to install countdown signals at crosswalks and to extend pedestrian crossing times in areas that have a high proportion of elderly pedestrians.[70] However, a study

Figure 4.16 Motor Vehicle Crash Pedestrian Hospitalization Rate per 100,000 Population, by Sex and Age Group, BC, 2007-2011



	0-15	16-25	26-35	36-45	46-55	56-65	66-75	76+
Male	6.8	20.5	11.6	11.1	11.4	11.9	14.8	24.9
Female	6.1	12.7	7.9	6.6	8.9	12.0	18.6	24.5

Age Group

Notes: Rates are calculated using age- and sex-specific population numbers. There were fewer than five cases in which sex was unknown, and these cases are excluded from this figure. See Appendix B for more information about these data sources.
Sources: Hospitalization data are from the Discharge Abstract Database, Ministry of Health, 2007-2011; population estimates are from the BC Stats website, April 2015. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

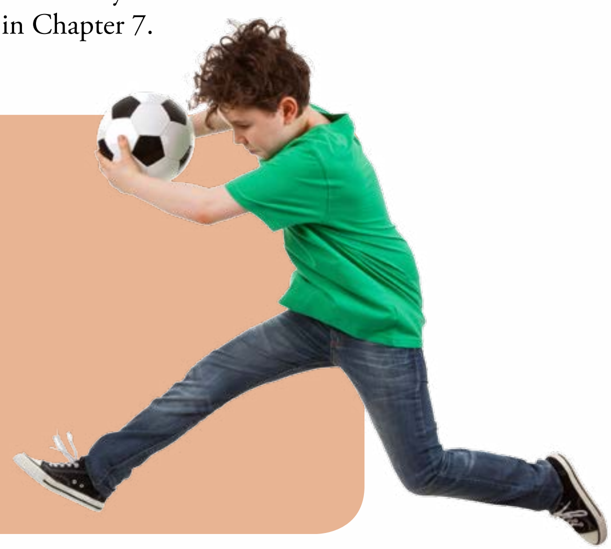
in the city of Toronto found that installing pedestrian countdown signals increased the amount of pedestrian MVCs, potentially due to drivers and pedestrians hurrying in response to the signal.[71]

Other jurisdictions are improving pedestrian safety by modifying speed and roadways. For example, New York City's Safe Streets for Seniors pedestrian safety initiative focuses on infrastructure and engineering changes to improve safety, including shortening crossing distances, increasing crossing times, restricting vehicle turns, and narrowing roadways.[72] Another example is Japan's promotion of "people-first walking spaces" and "safe walking areas," created through infrastructure improvements to sidewalks and intersections, as well as improved pedestrian lighting and the development of pedestrian overpasses.[73] In London, England, the introduction of 20 mph (about 32 km/h) speed zones was associated with a 41.9 per cent reduction in MVC-related pedestrian injuries and fatalities, with the greatest reductions found among young children.[74]

Suggested measures to specifically address child pedestrian MVCs include reducing children's exposure to vehicle traffic; increasing parental supervision; providing road safety education and training for children (from their parents as well as within the school system), parents, and drivers;[56,62] promoting enhanced vehicle safety features (e.g., backup cameras and sensors); and designing infrastructure that separates child pedestrians from vehicle traffic, and provides safe play areas for children that are away from roadsides.[57,60,75] Efforts to promote the safety of children in Japan include installing push-button traffic lights and other improvements along school walking routes.[73] The European Conference of Ministers of Transport suggests that pedestrian safety education for children begin in kindergarten and continue through primary and secondary school.[57] Here in Canada, the Royal Canadian Mounted Police (RCMP) recommend that parents teach their children safe pedestrian behaviours through role modeling.[68]

A recent report from the Child Death Review Unit of the BC Coroners Service found that the environmental risk for child pedestrian injuries is reduced in neighbourhoods with traffic calming features such as **speed humps**, traffic circles, restrictions on traffic volume, and lower speed limits. Safe speed is crucial to child pedestrian safety. Child pedestrians involved in MVCs were seven times more likely to be hospitalized when struck by vehicles traveling an average of 50 km/h compared with average vehicle speeds of 30 km/h. Indeed, research suggests that lower motor vehicle speeds (i.e., 30-40 km/h) promote pedestrian safety. MVCs may be more easily avoided at lower speeds, and where pedestrian-involved MVCs do occur at lower speeds, injury outcomes are less severe.[56]

Safe speeds will be discussed further in Chapter 6, and roadway infrastructure will be examined in Chapter 7.



> "Child pedestrians involved in MVCs were seven times more likely to be hospitalized when struck by vehicles traveling 50 km/h compared to those traveling 30 km/h."

SUMMARY

Promoting the safety of road users—including vulnerable road users—is a critical component of a safe roadway system. Unfortunately, there has not been the same decrease in MVC fatalities for vulnerable road users compared to vehicle occupants. The MVC fatality rate for motorcyclists increased between 1995 and 2005, followed by notable decreases after 2009. There has been an increase in MVC fatality and serious injury rates among cyclists over the last several years, with men being disproportionately more affected. Pedestrian MVC fatalities and serious injuries have fluctuated over the years but do not show a clear downward trend. In addition, cyclists and pedestrians in BC have higher rates of fatalities and serious injuries compared to vehicle occupants when measured on a per trip or kilometres travelled basis. Both children and older adults are especially vulnerable as pedestrians. Regional distribution among health authority areas shows that compared to the distribution of the BC population, MVC motorcycle occupant fatalities occur disproportionately in Interior and Northern Health, with proportionately fewer in Vancouver Coastal and Fraser Health. Cyclist fatalities in Interior Health and Island Health were disproportionately large compared to their population size, while Vancouver Coastal and Northern Health had disproportionally fewer cyclist fatalities. Pedestrian fatalities were distributed more in proportion to the BC population. A variety of measures to enhance road safety for each vulnerable road user type are being implemented here and abroad, such as strengthened licensing for motorcycle drivers and incorporating cyclist and pedestrian safety into roadway policy and design.

The next chapter will investigate road user behaviour and conditions in BC.

Chapter 5

Road User Behaviour and Conditions

INTRODUCTION

The holistic vision of road safety and the safe systems concepts described in Chapter 1 of this report focus on improving the entire system. One of the main tenants of a Safe System Approach (SSA) is that the road system should accommodate human error, since road user behaviour and all human behaviour by nature is unpredictable and prone to error.[2] Driver conditions and behaviour are a crucial component of an SSA, including, but not limited to, improving road safety through education, awareness, and enforcement measures. As shown in Chapter 3, the road user group with the greatest number and proportion of motor vehicle crash (MVC) fatalities and serious injuries is drivers, and, in many ways, drivers can do the most to prevent MVCs and/or to reduce their severity.

This chapter explores four main aspects of driver behaviour, including distracted driving, substance-based impairment due to alcohol and other substances, cognitive or physical impairment, and high-risk or aggressive driving, and measures that may be effective at reducing their prevalence. Speed and speeding will be discussed in Chapter 6.

To drive on public roads in BC, drivers must abide by the rules set out in the *Motor Vehicle Act*.[3,4] Driver training, testing, and licensing, along with vehicle registration and licensing, auto insurance, and the administration of driving records are all provided by the Insurance Corporation of British Columbia (ICBC).[4,5] When drivers violate the rules of the road, police can issue tickets and impose sanctions (e.g., driving prohibitions and suspensions) and/or lay criminal charges,[4] as outlined in the *Criminal Code of Canada*.[3,4] There are laws related to distracted driving, impaired driving, and high-risk or aggressive driving, and sanctions for drivers who violate these laws.

"We each use the roads within a collective public system where the risks we take can affect someone else."

– N. Arason, *No Accident: Eliminating Injury and Death on Canadian Roads*[1(p.101)]

DISTRACTED ROAD USERS

Distracted Driving

Distracted driving is when a driver's attention is diverted to an object, activity, event, or person not related to driving. The distraction can include a wide range of non-driving activities, such as eating and drinking, smoking, personal grooming, adjusting the stereo, interacting with passengers, using a vehicle navigation system, and any use of cellular phones (both handheld and hands-free) or other electronic devices.[6,7] Distracted driving results in a loss of visual and cognitive attention, decreased decision-making abilities, reduced awareness, and poorer driving performance, which then leads to an increased risk of driver error, near-crashes, and MVCs.[8] The recent proliferation of electronic devices, including cell phones and smartphones, has led to an increasing problem with distracted driving around the world.[7] New legislation introduced in 2010 in BC prohibits the use of handheld devices while driving. While distracted driving is not limited to the use of electronic devices,[9] the increasing problems related to use of electronic devices while driving will be the focus of the discussion presented here.

"… data indicate that cell-phone conversations place demands upon the driver that differ qualitatively from those of other auditory/verbal/vocal tasks commonly performed while operating a motor vehicle. Even when cell-phone drivers direct their gaze at objects in the driving environment, they often fail to 'see' them because attention has been diverted to the cell-phone conversation."

– D.L. Strayer, F.A. Drews, Cell-phone-induced driver distraction, *Current Directions in Psychological Science*[11]

Some forms of driver distraction are less problematic than others. For example, conversations with passengers can be less hazardous than phone calls when driving. This is because passengers are aware of the driving environment and can adjust their speech, tone, and conversation as appropriate. Passengers can also assist in watching for driving hazards. A person on the other end of a phone conversation is not aware of the driving environment and accordingly is unable to adjust the conversation. Compared to passengers, people calling a driver tend to speak in longer stretches with fewer pauses.[10] Cell phone conversations have been shown to divert attention from the roadway to the conversation.[11] Studies have shown that using a handheld device while driving can reduce driver ability to process as much as half of the visual information on and around the roadway.[6,12] While hands-free devices may appear to require less attention from a driver, research has found that the use of hands-free and handheld devices requires similar amounts of cognitive attention.[12,13,14] The use of any form of electronic device has been shown to increase both the risk of driver error and of MVCs.[13]

The Burden of Road User Distraction in BC

On average in recent years, one-third of all MVC fatalities in BC had distraction as a contributing factor.[15] As shown in Table 5.1, overall, from 2008 to 2012 there was an increase in the number of distraction-related MVCs recorded but a decrease in the number of related fatalities. The lower number of distraction-related MVCs shown in 2011 likely relates to the legislation introduced in 2010 that prohibits the use of handheld devices while driving.

Table 5.1

Distraction-related Motor Vehicle Crashes and Fatalities, by Year, BC, 2008 to 2012

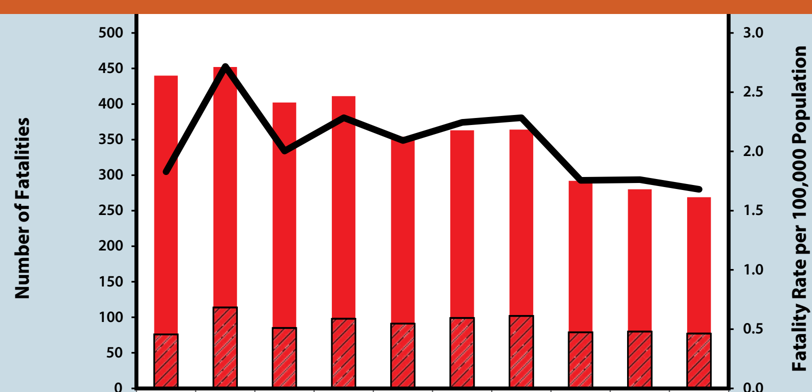
YEAR	NUMBER OF DISTRACTION-RELATED MVCs	DISTRACTION-RELATED MVC FATALITIES
2008	5,902	91
2009	5,714	99
2010	6,289	102
2011	6,038	79
2012	6,201	80

Notes: "Distraction-related" fatalities are deaths where one or more vehicles involved in the crash had any one of the contributing factors: use of communication/video equipment, driver internal/external distraction, and/or driver inattentive. Data are based on police reports from police-attended motor vehicle crashes; therefore, contributing factors reported emphasize human error rather than other systemic factors (e.g., vehicle design or roadway design). See Appendix B for more information about this data source.
Source: Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia, 2008-2012 (March 2014). Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

Figure 5.1 shows the total number, proportion, and rate of distraction-related MVC fatalities for 2004 to 2013.[t] This figure shows that the number and rate of distraction-related fatalities per year has been decreasing since 2005. Similar to Table 5.1, the steep decrease in number and rate from 2010 to 2011 may be related to the 2010 legislation prohibiting the use of handheld devices while driving.[u] Despite these improvements, the proportion of MVCs involving driver distraction that result

Figure 5.1

Distraction-related Motor Vehicle Crash Fatality Count and Rate per 100,000 Population, BC, 2004 to 2013



	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Number of MVC Fatalities	440	452	402	411	354	363	364	292	280	269
Number of Distraction-related MVC Fatalities	76	114	85	98	91	99	102	79	80	77
Distraction-related MVC Fatality Rate	1.8	2.7	2.0	2.3	2.1	2.2	2.3	1.8	1.8	1.7
Distraction-related Proportion of Fatalities	17.3	25.2	21.1	23.8	25.7	27.3	28.0	27.1	28.6	28.6

Year

Notes: "Distraction-related" fatalities are deaths where one or more vehicles involved in a crash had any one of the contributing factors: use of communication/video equipment, driver internal/external distraction, and/or driver inattention. Data are based on police reports from police-attended motor vehicle crashes; therefore, contributing factors reported emphasize human error rather than other systemic factors (e.g., vehicle design, roadway design). See Appendix B for more information about these data sources.
Sources: Fatality data are from the Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia, 2004-2013; population estimates are from the BC Stats website, April 2015. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

[t] Comparable distraction-related hospitalization data are currently unavailable.

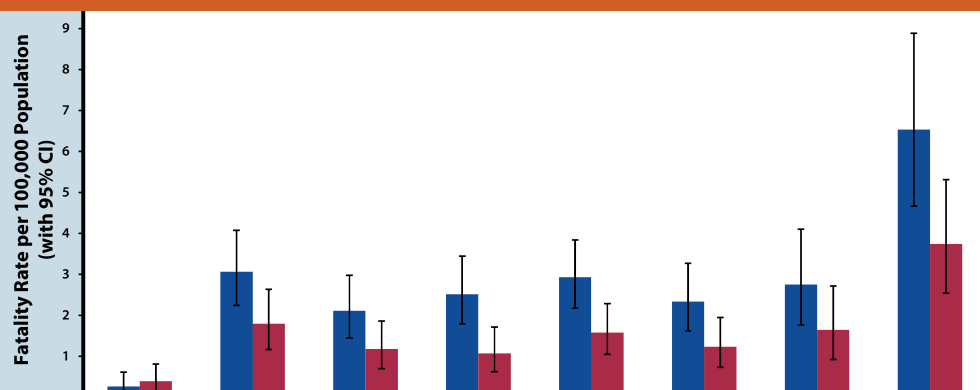
[u] These data include all types of road user distraction leading to fatal MVCs, not just handheld devices.

in a fatality has increased, growing from 17.3 per cent in 2004 to 28.6 per cent in 2013; this suggests that distracted driving remains an important area for targeted programming. In fact, ICBC reports that in 2013, distraction surpassed speed as the top contributing factor to MVC fatalities reported by police.[16]

Figure 5.2 shows distraction-related MVC fatality rates per 100,000 population in BC between 2009-2013 by age group and sex. These data show that males have a higher distraction-related fatality rate than females for all age groups except those age 0-15. This figure also shows that distraction-related MVC fatality rates were highest among those age 76 and up for both males and females (6.5 and 3.7 per 100,000 population, respectively). However, since the data presented show who suffered the fatality rather than the distracted party in the MVC, these data may reflect other factors (e.g., an older adult may have been less likely to survive the impact of the MVC).

A lack of driving experience and a greater tendency to use electronic devices may make new and/or younger drivers particularly vulnerable to distracted driving (or to being distracted as pedestrians or other road user types).[17,18] However, some studies have found that the increased risk of MVCs for people who use cell phones while driving is similar

Figure 5.2 **Distraction-related Motor Vehicle Crash Fatality Rate per 100,000 Population, by Sex and Age Group, BC, 2009-2013**



	0-15	16-25	26-35	36-45	46-55	56-65	66-75	76+
Male	0.3	3.1	2.1	2.5	2.9	2.3	2.8	6.5
Female	0.4	1.8	1.2	1.1	1.6	1.2	1.6	3.7
BC	0.3	2.4	1.6	1.8	2.2	1.8	2.2	4.9

Age Group

Notes: "Distraction-related" fatalities are deaths where one or more vehicles involved in a crash had any one of the contributing factors: use of communication/video equipment, driver internal/external distraction, and/or driver inattentive. Victim may or may not be the distracted person involved in the crash. Rates are calculated using age- and sex-specific population numbers. There were five cases where age group and/or sex was missing, and these cases are excluded from this figure. Data are based on police reports from police-attended motor vehicle crashes; therefore, contributing factors reported emphasize human error rather than other systemic factors (e.g., vehicle design, roadway design). See Appendix B for more information about these data sources.
Sources: Fatality data are from the Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia, 2009-2013; population estimates are from the BC Stats website, April 2015. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

for drivers under age 30 compared to those over age 30, and may even be higher for middle-aged drivers.[12]

Figure 5.3 presents further analysis of distraction-related MVC fatality rates in BC from 2004 to 2013, by sex. Over these 10 years, there was a notable increase in 2005 followed by a gradual reduction over time, resulting in a slight decrease in the rate of distraction-related MVC fatalities. For males there was a small increase, from 1.9 per 100,000 population in 2005 to 2.0 per 100,000 in 2013. Among females there was an overall reduction of 26.7 per cent, from 1.5 per 100,000 population in 2004 to 1.1 per 100,000 in 2013. The rate for females showed greater year-to-year fluctuation than the rate for males.

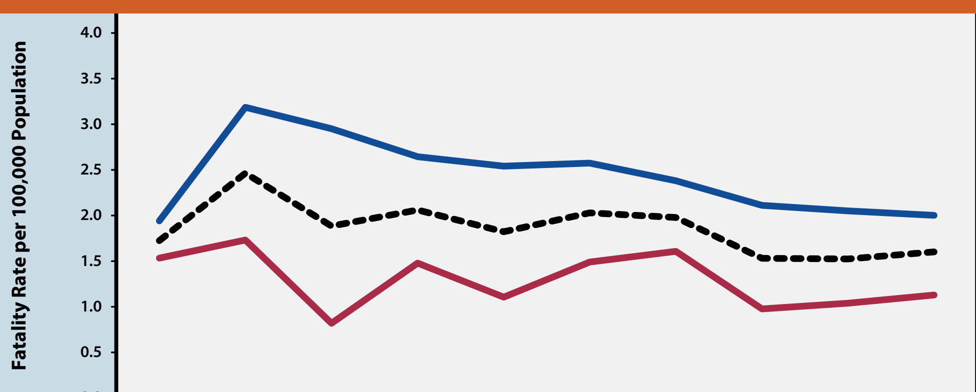
Overall, Figures 5.2, 5.3, and related literature show that distracted driving is a problem for road safety for road users of all ages and sexes.

Measures to Prevent and Reduce Distracted Driving

While there is a growing body of research that examines distracted driving, with a focus on the use of electronic devices, there is little research on what interventions are most effective in preventing and reducing distracted driving.[19] Given this, there is a variation in policies across jurisdictions. Some countries have banned use of all electronic devices, whereas others have focussed legislation on handheld devices, while allowing hands-free devices. Other countries (e.g., Sweden) focus their efforts on public education about the risks of distracted driving, recognizing that prohibiting the behaviour will not eliminate cell phone use.[19]

As of January 2012, every Canadian jurisdiction except Nunavut had introduced some form of distracted driving legislation banning the use of handheld electronic and/or communication devices. BC, Saskatchewan, and the Yukon have also

Figure 5.3 **Age-standardized Distraction-related Motor Vehicle Crash Fatality Rate per 100,000 Population, by Sex, BC, 2004 to 2013**



	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Male	1.9	3.2	3.0	2.6	2.5	2.6	2.4	2.1	2.1	2.0
Female	1.5	1.7	0.8	1.5	1.1	1.5	1.6	1.0	1.0	1.1
BC	1.7	2.5	1.9	2.1	1.8	2.0	2.0	1.5	1.5	1.6

Year

Notes: "Distraction-related" fatalities are deaths where one or more vehicles involved in a crash had any one of the contributing factors: use of communication/video equipment, driver internal/external distraction, and/or driver inattentive. Victim may or may not be the distracted person involved in the crash. Age-standardized rates are calculated using Canada 1991 Census population. There were 14 cases where age group and/or sex was missing, and these cases are excluded from this figure. Data are based on police reports from police-attended motor vehicle crashes; therefore, contributing factors reported emphasize human error rather than other systemic factors (e.g., vehicle design, roadway design). See Appendix B for more information about these data sources.
Sources: Fatality data are from the Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia, 2004-2013; population estimates are from the BC Stats website, April 2015. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

banned the use of hands-free devices for drivers in graduated licensing programs (GLPs).[20] Distracted driving penalties assessed by individual jurisdictions range from fines of $0-1000 and 0-4 demerit points.[20]

BC's distracted driving legislation, *Use of Electronic Devices while Driving* (Part 3.1 of the *Motor Vehicle Act*), came into force on January 1, 2010.[21] Violators of this legislation are subject to a fine of $167 for talking, texting, or emailing, and a penalty of three points on their driver's licence.[18,22] The legislation was accompanied by a public awareness campaign that included 10 fixed signs at international border crossings and travel routes near international airports; messages on 45 variable message signs on highways throughout the province; and television, movie, newspaper, and billboard ads, among other promotional efforts.[21] (See Figure 5.4 for an example of the related signage.)

In the first 11 months after BC's distracted driving law took effect, police reported more than 32,000 distraction-related infringements. Further to this, police served 37,393 tickets for distracted driving in 2011, which increased to 44,875 in 2012.[23] An observational study comparing cell phone use in Victoria, BC, before and after the legislation was passed, suggested that the use of electronic communication devices did decline after the legislation came into effect, although there were limitations to this study.[v,21]

In 2014, the Canadian Council of Motor Transport Administrators conducted an observational study of electronic handheld device use in Canada by counting use at intersections when vehicles were stopped. The study revealed that 5.5 per cent of drivers in BC used a handheld device while driving, which was above the overall national average of 4.4 per cent. This included 5.4 per cent of urban drivers and 6.2 per cent of rural drivers using handheld devices while driving, both above the national averages of 4.6 and 3.5 per cent, respectively.[24]

In 2013, the BC Association of Chiefs of Police called for tougher penalties for distracted drivers, such as doubling the $167 fine to $334 and confiscating cell phones from repeat offenders.[25] A BC public opinion poll published in March 2013 found that 70 per cent of those surveyed support these measures.[25]

Figure 5.4 **Electronic Device Warning Signage**

Notes: These roadway signs were introduced in BC in 2010 with the new distracted driving legislation. Reproduced with permission.
Source: BC Ministry of Transportation and Infrastructure, CC BY-NC-ND 2.0 (see: https://creativecommons.org/licenses/by-nc-nd/2.0/).

[v] Two limitations to this study were that the sample was not representative, and it only counted cell phone use if the device was being held up to the driver's ear.

Overall, despite new legislation, distracted driving is still contributing to a sizeable portion of MVC serious injuries and fatalities, and will continue to be a key topic for improving road safety. Research evaluating the efficacy of various approaches to preventing distracted driving would benefit BC and other jurisdictions in achieving further progress on this issue.

SUBSTANCE-BASED IMPAIRMENT

Substance-based impairment includes both alcohol impairment and **drug impairment** (both legal and illegal drugs). Even in small amounts, alcohol and other psychoactive substances can impair driving performance.[26,27] The risk of an MVC increases with the amount of alcohol and other drugs consumed and from combining alcohol and other drugs.[28,29,30] These substances include alcohol, prescription medication, over-the-counter medications (whether their use is legal or illicit), and illegal drugs.

Effects of Impairment

The effects of medications on driving ability vary by medication, and effects can include sleepiness, impaired vision, dizziness, decreased reaction time, fainting, and/or difficulty concentrating.[31,32] Prescription and over-the-counter medications such as benzodiazepines,[33] opioids, antihistamines, and cough and cold remedies may impair cognitive function and/or driving performance.[31,34,35] Any symptoms or effects may also be worsened when multiple medications are taken concurrently or are taken in conjunction with alcohol or other drugs.[36,37]

Alcohol and other drugs also have an array of effects. Depressants and barbiturates can reduce motor coordination and reaction times, cause blurred or double vision, and impair depth perception.[36] Stimulants such as amphetamines and cocaine may lead to overconfidence and aggressive, high-risk driving.[36] Hallucinogens (e.g., ecstasy, LSD,[w] psilocybin mushrooms) may distract drivers by distorting their perceptions or causing hallucinations.[36] Cannabis is currently the most commonly used illegal drug in Canada and in BC,[38] although with the legalization of medical marijuana it may also be used legally by some people for medical purposes. Evidence shows that cannabis causes impairment of the psychomotor skills needed to drive safely,[39] and reduces a driver's attention span and ability to concentrate. Observational studies estimate that drivers impaired by cannabis have a two- to three-fold higher risk of being involved in an MVC.[36,40] Cannabis used in combination with alcohol may lead to greater impairment compared to using either of these substances alone.[41,42]

Alcohol Impairment

Alcohol is a depressant and affects judgment, which can lead to poor decision-making and reckless driving. Research has found that alcohol consumption increases both the probability of an MVC occurring and the probability that an MVC will result in a fatality or serious injury.[43] The risk associated with driving while impaired has clearly been shown to increase as **blood alcohol content (BAC)**[x] (also known as blood alcohol concentration) increases.

In BC, drivers are considered impaired by alcohol and can face administrative sanctions if they have a 0.05 BAC or higher (50 mg of alcohol per 100 mL of blood).[44,45] Canada's *Criminal Code* sets the legal limit for drivers at 0.08 BAC, meaning that drivers who have a BAC over 0.08 are committing a punishable criminal offence.[46] BAC is typically determined through breath testing, because the amount of alcohol in a person's breath has been shown to directly correlate with the amount of alcohol in a person's blood, and alcohol breath testing is readily available for roadside use by enforcement officers.

[w] LSD is lysergic acid diethylamide and is also known as acid.

[x] Blood alcohol content measures the amount of alcohol in a person's body in milligrams of alcohol per 100 millilitres of blood.

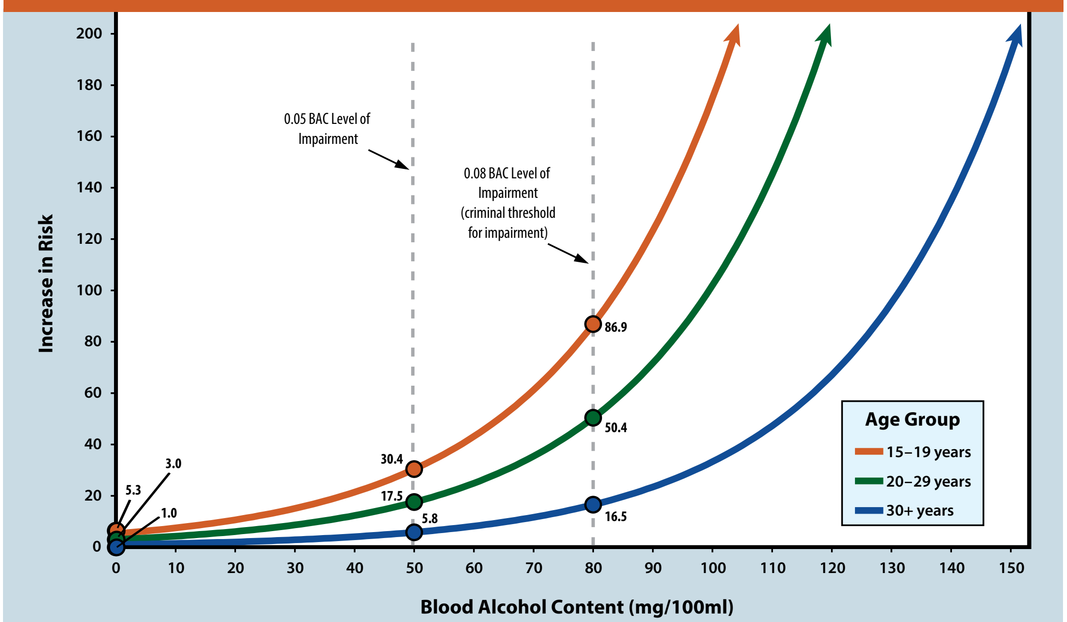
Figure 5.5 illustrates the relative risk of a driver-fatal MVC based on a driver's BAC. While this graph provides a general guide, it is important to note that alcohol impacts and impairs people differently. Many factors (e.g., sex, weight, genetics, food consumption) can influence the effect alcohol has on a person. This figure illustrates that the risk of an MVC resulting in a driver fatality is increased among younger people even without impairment. Drivers age 15-19 have a 5.3 times greater risk and those age 20-29 have a 3.0 times greater risk of dying in an MVC compared to those age 30 and up. For all age groups, the relative risk of a driver-fatal MVC is much higher when a driver is impaired by alcohol. A driver age 30 and up has 5.8 times the risk of being killed in an MVC at a level of 0.05 BAC and 16.5 times the risk at a level of 0.08 BAC compared to having a 0.00 BAC. Compared to drivers age 30 and up with a 0.00 BAC, drivers age 20-29 have a 17.5 times greater risk of a driver-fatal MVC at 0.05 BAC and 50.4 times greater risk at 0.08 BAC, while those age 15-19 are at 30.4 times the risk at 0.05 BAC and 86.9 times the risk at 0.08 BAC.

Drug Impairment

Other than alcohol, most drugs are only measurable through a blood sample. Urine or saliva samples may also be used, but such tests may not always reflect the amount or concentration of drugs in the blood, so blood samples are considered the "gold standard" for drug impairment testing.[1] "Zero-limit" laws that make it illegal for people to drive with any measurable level of illegal drugs in their bodies may be problematic because it penalizes someone for having a detectable level of drugs in their blood (not always a sign of impairment) rather than for impaired driving. For example, in the case of cannabis, cannabinoids may be detected in the body beyond when the driver would be impaired.[48]

Another approach is to make it illegal to drive solely based on evidence of drug impairment, as determined by police-administered sobriety tests. A sobriety test may be used by police officers in Canada if the officer suspects impairment.[1] A field sobriety test includes specific tests or tasks to

Figure 5.5 **Relative Risk of Fatal Motor Vehicle Crash, by Blood Alcohol Content Level and Age Group**



Source: Reproduced with permission and based on data from Keall MD, Frith W, Patterson TL. 2004. *The Influence of Alcohol, Age and Number of Passengers on the Night-time Risk of Driver Fatal Injury in New Zealand*.[47] Prepared by Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

determine impairment, including the "walk and turn test," the "one leg stand test," and the "horizontal gaze test."[1] Two drawbacks to sobriety tests are that they are subjective, and can be insensitive to moderate impairment.[50,51,52]

In summary, there are multiple challenges with assessment and enforcement of drug-impaired driving. Identifying effective roadside drug testing mechanisms[53] and determining appropriate, evidence-based limits for driving (such as for Tetrahydrocannabinol [THC] in the bloodstream) would simplify and clarify drug-related traffic laws and related enforcement.

"…studies show that there are significant percentages of young people of driving age who are confused or unaware that driving while under the influence of prescription or illegal drugs like cannabis can also seriously affect their driving capabilities. Among young drivers, the high driving problem is rapidly becoming comparable to the drunk-driving problem and it needs to be addressed with as much urgency.

Relaxed attitudes towards drugged driving are part of the problem. It's just not considered as dangerous as drunk driving, neither by teenagers nor their parents."

– Partnership for a Drug-Free Canada, *Drugs and Driving*[49]

The Burden of Road User Impairment in BC

The Canadian Council of Motor Transport Administrators reports that other than alcohol, the substances most commonly detected among Canadian drivers are cannabis, cocaine, amphetamines, and antidepressants.[54] In 2012, a random survey of 2,513 vehicles was used to gather information on the prevalence of alcohol and drug use (illegal drugs and commonly abused legal drugs) among drivers in BC.[55] This survey found that 6.5 per cent of surveyed drivers had been drinking, down from 9.9 per cent in the 2010 version of the survey. Further, only 0.9 per cent of drivers had a BAC over the 0.08 criminal limit, down from 2.2 per cent in 2010.[55] This same survey showed that 10.1 per cent of drivers tested positive for drug use, up from the 7.2 per cent reported in 2010.[56] The most common drugs reported were cannabis and cocaine.[55] A researcher reviewed two recent Canadian studies, including one in BC, and estimated that 11 to 12 per cent of drivers admitted to hospital following an MVC had been using cannabis. This research further estimated that 4 to12 per cent of MVC fatalities and/or injuries in Canada involve cannabis-impaired driving.[40]

Figure 5.6 shows the number of impaired-related MVC fatalities in BC from 1996 to 2013. It shows that although there has been variation from year to year, the number and rate of impaired-related MVC fatalities has generally decreased from 1996 to 2013, with the rate in 2013 being just over one-third of the rate in 1996. The lowest count and rate was in 2012, at 57 and 1.3 fatalities per 100,000 population, respectively. This improvement likely reflects both a culture change in attitude towards impaired driving and the **Immediate Roadside Prohibition** (IRP) program introduced in 2010 (see next section for further detail). These improvements are successes for BC; however, this figure also shows that impairment is still a factor in nearly one-quarter of MVC fatalities in BC in recent years.

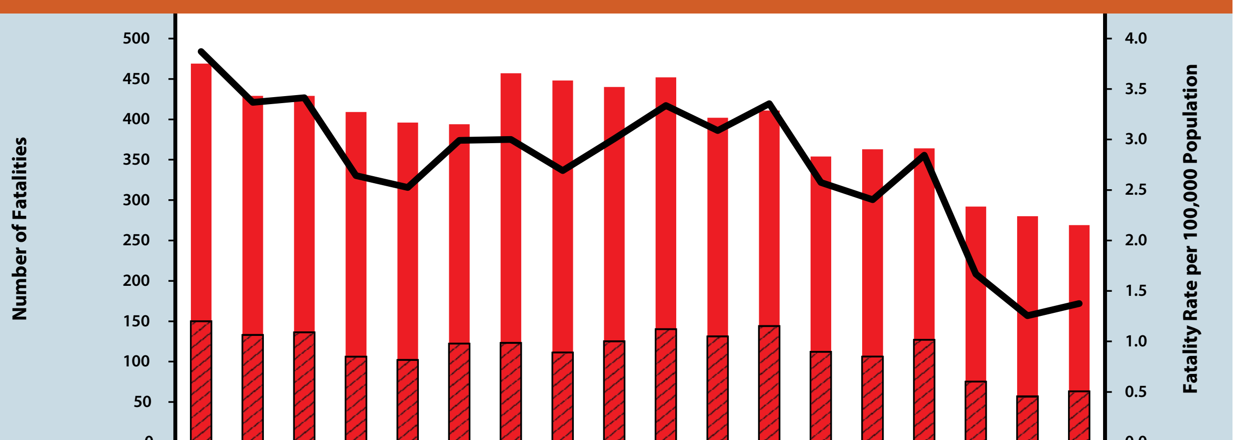
Further analyses of impaired-related MVC fatalities are presented in Figure 5.7, which shows the age-standardized rate per 100,000 population from 1996 to 2013 by sex. This figure shows that the impaired-related MVC fatality rate for both males and females decreased over these 18 years, from 5.8 to 2.3 per 100,000 population for males, and from 2.1 to 0.4 per 100,000 for females. The relative decrease shown is greatest among females; the female rate declined by 81.0 per cent, while the male rate declined by 60.3 per cent.

Figure 5.8 shows the impaired-related MVC fatality rates by sex and age group for 2009-2013. Much like other analyses by sex presented in this report, across almost every age group males have at least double the fatality rate of females. The highest impaired-related MVC fatality rates identified for both sexes are in the 16-25 age group, at 6.3 fatalities per 100,000 population for males and 2.4 per 100,000 for females.

The larger proportion of fatalities in the 16-25 age group may in part be associated with a greater tendency of this age group toward risk-taking behaviour and experimentation with alcohol and other

Figure 5.6

Impaired-related Motor Vehicle Crash Fatality Count and Rate per 100,000 Population, BC, 1996 to 2013



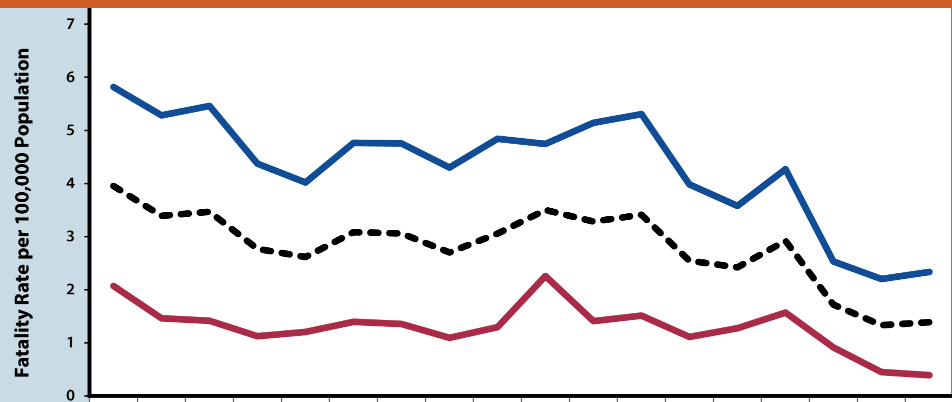
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Number of MVC Fatalities	469	429	429	409	396	394	457	448	440	452	402	411	354	363	364	292	280	269
Number of Impaired-related Fatalities	150	133	136	106	102	122	123	111	125	140	131	144	112	106	127	75	57	63
Impaired-related Fatality Rate	3.9	3.4	3.4	2.6	2.5	3.0	3.0	2.7	3.0	3.3	3.1	3.4	2.6	2.4	2.8	1.7	1.3	1.4
Impaired-related Proportion of Fatalities	32.0	31.0	31.7	25.9	25.8	31.0	26.9	24.8	28.4	31.0	32.6	35.0	31.6	29.2	34.9	25.7	20.4	23.4

Year

Notes: "Impaired-related" fatalities are deaths where one or more vehicles involved in a crash had any one of the contributing factors: alcohol involvement, prescribed medication, and/or drug involvement listed. Victim may or may not be the impaired person involved in the crash. Data are based on police reports from police-attended motor vehicle crashes; therefore, contributing factors reported emphasize human error rather than other systemic factors (e.g., vehicle design, roadway design). See Appendix B for more information about these data sources.
Sources: Fatality data are from the Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia, 1996-2013; population estimates are from the BC Stats website, April 2015. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

Figure 5.7

Age-standardized Impaired-related Motor Vehicle Crash Fatality Rate per 100,000 Population, by Sex, BC, 1996 to 2013



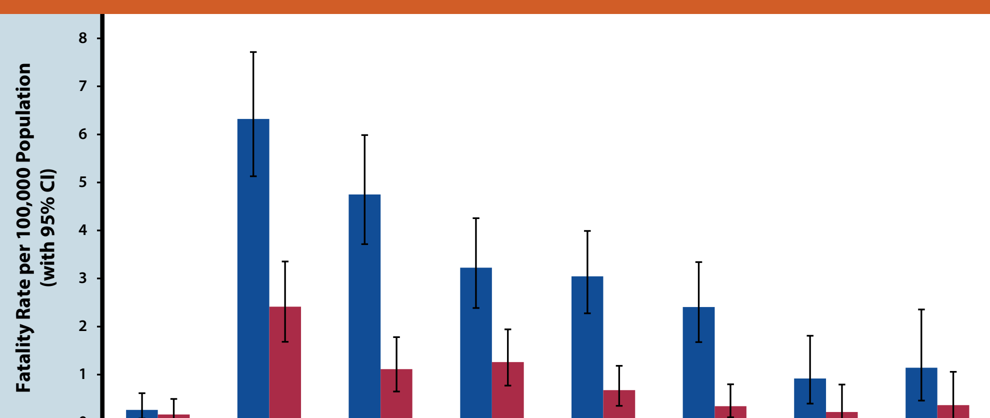
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Male	5.8	5.3	5.5	4.4	4.0	4.8	4.8	4.3	4.8	4.7	5.1	5.3	4.0	3.6	4.3	2.5	2.2	2.3
Female	2.1	1.5	1.4	1.1	1.2	1.4	1.4	1.1	1.3	2.3	1.4	1.5	1.1	1.3	1.6	0.9	0.4	0.4
BC	4.0	3.4	3.5	2.8	2.6	3.1	3.1	2.7	3.1	3.5	3.3	3.4	2.5	2.4	2.9	1.7	1.3	1.4

Year

Notes: "Impaired-related" fatalities are deaths where one or more vehicles involved in a crash had any one of the contributing factors: alcohol involvement, prescribed medication, and/or drug involvement listed. Victim may or may not be the impaired person involved in the crash. Age-standardized rates are calculated using Canada 1991 Census population. There were 28 cases where age group and/or sex was missing, and these cases are excluded from this figure. Data are based on police reports from police-attended motor vehicle crashes; therefore, contributing factors reported emphasize human error rather than other systemic factors (e.g., vehicle design, roadway design). See Appendix B for more information about these data sources.
Sources: Fatality data are from the Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia, 1996-2013; population estimates are from the BC Stats website, April 2015. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

Figure 5.8

Impaired-related Motor Vehicle Crash Fatality Rate per 100,000 Population, by Sex and Age Group, BC, 2009-2013



	0-15	16-25	26-35	36-45	46-55	56-65	66-75	76+
Male	0.3	6.3	4.8	3.2	3.0	2.4	0.9	1.1
Female	0.2	2.4	1.1	1.3	0.7	0.3	0.2	0.4

Age Group

Notes: "Impaired-related" fatalities are deaths where one or more vehicles involved in a crash had any one of the contributing factors: alcohol involvement, prescribed medication, and/or drug involvement listed. Victim may or may not be the impaired person involved in the crash. Rates are calculated using age- and sex-specific population numbers. There were fewer than five cases where age group and/or sex was missing, and these cases are excluded from this figure. Data are based on police reports from police-attended motor vehicle crashes; therefore, contributing factors reported emphasize human error rather than other systemic factors (e.g., vehicle design, roadway design). See Appendix B for more information about these data sources.
Sources: Fatality data are from the Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia, 2009-2013; population estimates are from the BC Stats website, April 2015. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

drugs (including binge drinking), and a lack of awareness of the effects these substances can have on driving ability and decision-making.[57,58,59] Younger drivers are involved in a disproportionate number of alcohol-related MVCs, even with low BAC,[60] as shown in Figure 5.5. Gender-related factors may include the greater propensity for men to drink alcohol than women,[61] in conjunction with their tendency to drive more miles, engage in riskier behaviour, and overestimate their ability to drive while impaired.[57]

These analyses have shown that alcohol impairment currently forms the largest proportion of known impairment-related MVC fatalities. Further, they have shown that males and younger individuals have the most of these fatalities. These observations are important considerations to keep in mind when developing strategically targeted actions to prevent and reduce impaired driving and related fatalities and serious injuries.

Measures to Prevent and Reduce Substance-based Impaired Driving

Jurisdictions have used a variety of measures to curb the use of alcohol and other drugs among drivers. While the majority of these initiatives focus on alcohol, many of the principles apply to preventing impairment due to other substances as well. The following are six leading strategies to prevent impaired driving and to reduce its impact.

1. Increase Public Education and Awareness

Programs designed to prevent and reduce impaired driving have been shown to be effective at reducing alcohol-related MVCs and associated costs when they combine multiple components, including public awareness and education, legislation, and enforcement.[62,63] Research shows that "high-quality, high-intensity" public education advertising campaigns on drinking and driving, especially when conducted in conjunction with high-profile enforcement efforts, have contributed to reductions in alcohol-related MVC fatalities and injuries, and that the public benefits of such campaigns outweigh the costs.[63]

One example of a public education campaign is BC's CounterAttack program. CounterAttack is a partnership between the provincial government, ICBC, and police agencies that began in 1977 with the goal of reducing the number of alcohol-impaired drivers on the road.[64] Education and enforcement have been key components in CounterAttack, which, along with other road safety improvements and safety initiatives introduced over time, has contributed to a significant reduction in the number of alcohol-related MVC fatalities and injuries throughout the province.[64] Recently there has been an increased focus on public education against drug-impaired driving, especially among youth groups like Partnership for a Drug-Free Canada.[49]

2. Limit Access

Some interventions that limit access to alcohol have been shown to be effective in reducing the likelihood that people will drive while impaired by alcohol. Measures can include raising the cost of alcohol (e.g., higher alcohol taxes) to create economic barriers;[65] prohibiting and/or limiting the sale of alcoholic drinks in restaurants, shops, and service stations along roadways, which creates logistical barriers;[66] and requiring training programs for servers of alcoholic beverages to limit access to alcohol by intoxicated people.[67] Studies have shown decreased alcohol-impaired MVC fatalities associated with increased economic barriers to accessing alcohol[65] and training servers to limit access to intoxicated people.[67]

3. Lower Legal Limits for Alcohol

Evidence demonstrates that legal limits of 0.08 BAC or lower have been effective at reducing alcohol-related MVC fatalities and injuries, and that lowering the limit to 0.05 BAC can achieve further harm reduction.[43,67,68] Countries around the world have implemented legal limits on BAC for motor vehicle drivers: legal BAC limits in Europe range from 0.00–0.08, with many European countries having limits of 0.00 or 0.02, and the most common legal limit being 0.05 BAC.[66] Studies show that even BAC levels below 0.05 increase the risk of having an MVC[161] and of a fatal MVC.[47]

Graduated licensing programs (GLPs) that include requirements for 0.00 BAC at all times for new drivers have proven to be an effective measure to reduce the risk of alcohol-related MVCs and MVC fatalities in Canada, the United States, and worldwide.[43,69,70,71,72,73] In BC[74] and most other Canadian jurisdictions,[75] drivers in a GLP must maintain a 0.00 BAC while driving. Currently in BC, this requirement for new drivers is lifted upon completion of the GLP program,[76] which typically occurs at about the same time as young drivers reach the provincial legal drinking age (19 years).[77]

According to recent Canadian data, upon reaching legal drinking age, young drivers have an immediate increase in alcohol-related MVCs[78,79] and criminal alcohol-impaired driving (BAC over 0.08 or refusal to provide a sample),[79] with increases being seen in MVC-related serious injuries[80] and fatalities[81] among males. One study showed that the high number of MVC fatalities in Canada does not meaningfully decline until after the age of 25 years.[82] Data presented in this chapter show that in BC, the impaired-related MVC fatality rates are highest among those age 16-25. One strategy to address this is to extend BAC restrictions for new drivers beyond the provincial legal drinking age.[83] This approach has been implemented in Ontario, New Brunswick, and Quebec until a driver is 21 or 22 years of age;[84,85,86] in Nova Scotia for the first two years after graduating the GLP; and in Manitoba for the first five years of driving, including the time spent within the GLP.[87,88]

4. Increase Enforcement Checkpoints and Testing

Sobriety checkpoints, where drivers are stopped and checked for impairment, have been found to be very effective in deterring impaired driving and reducing alcohol-related MVC fatalities and injuries.[67,89] High-visibility checkpoints and public awareness of both the checkpoints and the consequences of being caught can heighten drivers' perception of risk.[67,89] In general, sobriety checkpoints can be either random, where all drivers stopped are given breath tests, or selective, where police must have reason to suspect the driver has been drinking before a breath test can be requested.[67] Under Canadian law, police must have reasonable suspicion to believe that a driver is affected by alcohol before they can request a sample for an approved screening device, such as a breath test.[90] A 2002 research review found that both random and selective breath testing at sobriety checkpoints resulted in decreases in alcohol-related MVCs.[89] Indeed, evidence suggests that random checkpoints may be more effective at identifying and deterring drivers from drinking.[91,92] Other countries have introduced further measures. For example, police in Australia conduct alcohol blood testing for drivers admitted to hospital for injuries incurred in MVCs.[93] In the Netherlands, it is also common policy for police to test drivers involved in MVCs for alcohol.[89,94]

Although driving while impaired by psychoactive substances is a criminal offence in Canada,[95] detecting the use of many kinds of drugs among drivers is considerably more difficult than detecting the use of alcohol. Some research suggests that saliva or oral fluid-testing may become a viable option for detecting drivers under the influence of cannabis, but there are currently challenges with this method.[53]

5. Increase Penalties

The United Nations recommends penalties be part of a comprehensive strategy to deter people from driving while impaired.[66] In BC, when police determine that a driver is impaired by alcohol (based on blood or breath test to determine BAC) or drugs (based on a roadside sobriety test or a drug recognition evaluation), they may seize the person's driver's licence, issue a driving prohibition to remove driving privileges for up to 90 days, and impound the driver's vehicle for up to 30 days.[96] BC implemented Immediate Roadside Prohibitions (IRP) for alcohol impaired driving in 2010.[y] Based on a sampling of drivers in June 2012, it was determined that the IRP program was associated with a 44 per cent decrease in drivers with a BAC over 0.05, and a 59 per cent decrease in drivers with a BAC over 0.08.[97] Several studies have provided compelling evidence that this new IRP approach to dealing with drinking and driving in BC has been successful.[98,99] Failing or refusing a breath test can also lead to criminal charges; a conviction may result in longer-term driving prohibitions and other penalties.[96] Administrative licence suspension or revocation for alcohol-impaired drivers has been shown to reduce MVC injuries and deaths.[100] A US study showed that immediate penalties are more effective than delayed penalties at reducing fatal MVC involvement.[101] There is also evidence that licence suspension can reduce repeat offences,[102] although studies show that some offenders continue to drive without a licence.[103,104,105]

6. Deter Repeat Offenders

A 1995 research review from the Canadian Traffic Injury Research Foundation estimated that approximately 35-40 per cent of drivers killed in impaired-related MVCs have previously been arrested for driving while impaired.[106] In BC, drivers with alcohol- or drug-related driving prohibitions or convictions may also be referred to the Responsible Driver Program (see sidebar: *Responsible Driver Program*). An **ignition interlock** may also be used to deter repeat offenders. An ignition interlock is a breath-testing device connected to a vehicle's ignition system that is intended to prevent an alcohol-impaired person from driving the vehicle. An ignition interlock requires a breath test from the driver before the vehicle will start and randomly when the vehicle is in operation; if a breath sample tests positive for alcohol, the interlock prevents the vehicle's engine from starting, or, if the vehicle is in operation, the device

The Responsible Driver Program

The Responsible Driver Program (RDP) is a remedial program for drivers with alcohol- or other drug-related driving prohibitions or convictions. Program participants are referred to either classroom education or group counselling sessions where they learn about the effects of alcohol and other drugs on driving ability. Such programs, which have been implemented in numerous Canadian and international jurisdictions, have been shown to reduce the risk of repeat alcohol- and other drug-related driving offences and motor vehicle crashes.[110] RoadSafetyBC refers BC drivers to the RDP based on their driving records, and program participants are assessed to determine their fitness to drive.[111,112]

[y] IRPs for impaired drivers were temporarily suspended in 2011 after a BC Supreme Court judge ruled that the program in part violated constitutional rights. Related legislation was amended and the suspension was lifted in May 2012.

repeatedly instructs the driver to turn off the vehicle.[107]If instructions are ignored, an alarm on the device will sound.[107] In 2009 in BC, the Ignition Interlock Program became mandatory for those caught driving while impaired by alcohol and those with certain alcohol-related driving prohibitions. The use of ignition interlocks has been associated with reduced recidivism as long as the interlock is installed, but evidence reviews published in 2004 and 2011 found no long-term benefit after the device was removed.[108,109]

PHYSICAL OR COGNITIVE IMPAIRMENT

Safe operation of a motor vehicle requires reliable sensory, cognitive, and motor functions. In addition to impairment from substance use, drivers can also be subject to **physical impairment** or **cognitive impairment**, as is the case with medically-at-risk drivers and drivers impaired by drowsiness or fatigue. Individuals whose mental or physiological conditions may compromise their ability to drive safely are at increased risk of MVC involvement and resulting serious injury or fatality.[113] Detecting these forms of impairment may be difficult and relies heavily upon self-awareness; self-detection; and/or feedback from a driver's friends, family, and medical professionals.

Medically-At-Risk Drivers

Medically-at-risk drivers are drivers who may be impaired due to medical conditions that impede their ability to drive a vehicle safely. Driving is a complex task that requires a combination of vision, cognitive, and motor functions.[114] Individuals with impaired vision may lack the ability to perceive visual details necessary for safe driving. For example, visual field impairments, loss of contrast sensitivity, loss of depth perception, double vision, and visual perceptual difficulties, all impair a driver's ability to identify risks on the road and operate a motor vehicle safely on roadways.[114,115] Cognitive function includes executive decision-making, memory, attention, language, problem-solving, and judgment.[114] Cognitive impairments may reduce a driver's ability to react appropriately to situations on the road, to recognize risky situations, and to make quick decisions, as well as to recognize problems with his or her own driving ability. A driver's cognitive function may decline for a variety of reasons; for example, because of medical conditions such as stroke, traumatic brain injury, degenerative diseases (e.g., dementia), or effects of past substance use.[114,116] A driver must also have sufficient physical motor function to perform many complex movements quickly and precisely in order to safely operate a vehicle. Physical impairment that impedes muscular movements and/or sensory functions (e.g., medical conditions) lowers a driver's level of control and/or ability to react and adapt to the roadway.[114,117]

Older adults are a growing portion of the BC population and are more likely than younger adults to be medically at risk. While many older adults may be skilled and experienced drivers, changes related to aging can make driving more challenging.[118] Some changes can include slower reaction times; reduced range of motion; sensory impairments (e.g., loss of peripheral vision, blind spots, contrast sensitivity problems); and cognitive declines (e.g., reduced ability to divide attention between two concurrent driving tasks).[6,119,120,121,122] The likelihood of dementia and chronic conditions increase with age,[121,123,124] which may then lead to a combination of cognitive impairment and substance-based impairment from medications. For example, in 2004 about 75 per cent of seniors were taking medication regularly,[125] including those that may adversely affect driving performance (such as antidepressants and benzodiazepines).[119] Even given this, the Organisation for Economic Co-operation and Development (OECD) reports that, based on data from Britain, the Netherlands, and Spain, the number of crashes per 1,000 drivers actually decreases with age, to age 75.[126] The reason for this is unclear, and aggregate data may not account for older drivers who still have a registered vehicle and/or a driver's licence but no longer drive. Importantly, age-related frailty makes older adults more susceptible to injuries and fatalities if they are involved in an MVC.[126,127,128] One challenge experienced by older drivers in BC is that individuals who might otherwise choose to retire from driving may lack affordable, accessible, and suitable forms of alternative transportation, particularly in more rural and remote communities.[129]

Sleep-Related Driver Impairment

Driving ability is negatively affected by fatigue, drowsiness, and other forms of sleep-related impairment.[z] Fatigue can set in because of the repetitiveness or monotony of driving or during long periods of driving without a break.[130] Driver fatigue is a recognized issue worldwide.[43] Sleep-related impairment may also result from lack of sleep due to lifestyle factors, hours of employment, sleep disorders,[131,132] or the use of alcohol or medications with sedative effects.[130,133] Australian research has found that after 17 to 19 hours of being awake, a driver's performance was comparable to the performance of alcohol-impaired drivers with 0.05 per cent BAC.[134]

Sleep-related impairment can lead to dangerous driver behaviours, such as straying from the correct lane,[135] speeding or driving at inconsistent speeds, making frequent lane changes, failing to abide

[z] Although fatigue, drowsiness, and other forms of sleep-related impairment may be defined separately, they are also sometimes used interchangeably; hereafter, "fatigue" will be used as a catch-all term for forms of sleep-related impairment, unless otherwise specified in the literature cited.

by road signs and traffic lights, and braking suddenly.[130] Fatigued drivers may also "nod off" or experience periods of microsleep; although these may last only a few seconds, a driver's ability to control the vehicle is compromised.[132] Ultimately, driver fatigue can lead to sleeping unexpectedly, resulting in complete loss of control of the vehicle with potentially fatal consequences.

In a 2011 poll, 18.5 per cent of Canadians surveyed reported having "fallen asleep or nodded off even for a moment" while driving in the previous 12 months. Of these respondents, 40.3 per cent had done so once, 29.2 per cent had done so twice, and 30.5 per cent reported having done so three or more times.[136] Table 5.2 shows the number of fatalities with sleep-related impairments as contributing factors for MVC fatalities for 2008-2012. The most common contributing factor was falling sleep, which accounted for 53 fatalities and 3.2 per cent of all MVC fatalities over those five years. The second most common contributing factor was extreme fatigue, accounting for 29 fatalities and 1.8 per cent of MVC fatalities during that period.[57,132,137] Fatigue is difficult to measure, and it is likely that its role in MVCs is underreported since it relies on a driver's disclosure of fatigue to police attending the MVC.

Due to the small number of MVC fatalities attributable to physical and cognitive impairment in BC, it is not possible to analyze age- and sex-specific sleep-related impairment data. However, research suggests that drivers under age 25 and males (especially young males) are particularly prone to fatigue-related MVCs.[57,137] Commercial vehicle drivers are also at increased risk of fatigue-related MVC involvement.[130] In fact, a 2009 road safety survey in Canada of heavy commercial vehicles found that 8 per cent of drivers self-reported driving when tired or fatigued, and about 31 per cent had fallen asleep or nodded off when driving at least once in the last year.[aa,138]

Table 5.2 **Number and Proportion of Sleep and Medication Impaired-related Motor Vehicle Crash Fatalities, by Impairment Type, BC, 2008-2012**

SLEEP IMPAIRMENT TYPE	NUMBER OF FATALITIES	PROPORTION OF FATALITIES
Extreme Fatigue	29	1.8%
Fell Asleep	53	3.2%
Extreme Fatigue & Fell Asleep	9	0.5%

Note: Fatigue and falling asleep are self-reported. Victim may or may not be the impaired person involved in the crash. Data are based on police reports from police-attended motor vehicle crashes; therefore, contributing factors reported emphasize human error rather than other systemic factors (e.g., vehicle design, roadway design). See Appendix B for more information about this data source.
Source: Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia, 2008-2012; prepared by BC Injury Research and Prevention Unit, 2014.

[aa] This was a random sample, but it captured a very small sample size of commercial truck drivers (N=67). Therefore, these data should be interpreted with caution.

Measures to Prevent and Reduce Physical or Cognitive Impairment

Preventing Medically At-Risk Driving

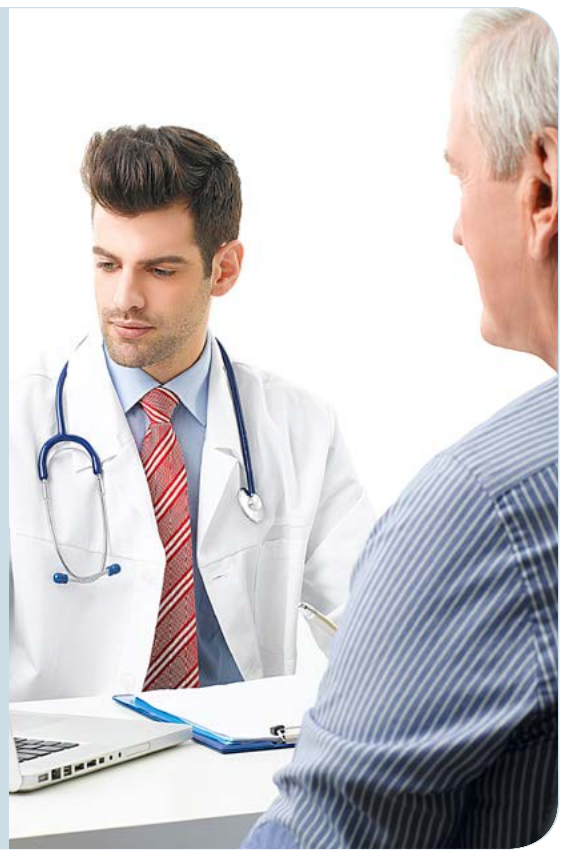
Determining whether an individual is unfit to drive is a complex process that requires collaboration between individuals, medical professionals, and licensing agencies. In Canada, each province and territory has its own laws and policies to determine whether a driver is fit to drive—some require doctors to report unfit drivers to licensing bodies, some have mandatory medical exams, while others do not have such mechanisms in place.[1] Due to the potential for declining cognitive functioning (e.g., Alzheimer's or other types of dementia), many jurisdictions have policies regarding testing of fitness to drive specific to age. For example, many countries in Europe require mandatory medical fitness testing at age 70.[141]

In BC, drivers who have a known or possible medical condition relevant to their driving ability, commercial drivers, and drivers 80 years and up are required to complete a Driver Medical Examination Report.[115,142] If this exam results in the identification of potential physical or cognitive impairment that may affect driving ability, drivers are referred by RoadSafetyBC for further assessments. Each year, RoadSafetyBC assesses the medical fitness to drive of nearly 150,000 BC drivers[143] using a variety of assessment tools. For example, an assessment may include a vision test, a driving evaluation, and/or a DriveABLE cognitive assessment (see sidebar: *DriveABLE Assessments in BC*).

DriveABLE Assessments in BC

RoadSafetyBC is responsible for making driver's licensing decisions based on the effect(s) of a medical condition on a person's ability to drive. When RoadSafetyBC receives a report of a driver with cognitive impairment from a physician, family member, police officer, or other individual, that driver may be referred for further assessments. For some, further assessments may entail a DriveABLE cognitive assessment to measure driving ability.[139] About 1,500 BC drivers are referred for a DriveABLE assessment each year.[142]

The DriveABLE in-office computerized assessment evaluates a driver's attention, judgment, decision-making, motor skills, and memory.[ab,140] If they fail, they have an opportunity to take an on-road evaluation. Results are submitted to RoadSafetyBC, where an adjudicator or nurse case manager reviews all of the information and makes a licensing decision.[139]



[ab] The DriveABLE assessment is a computerized program and it has been criticized by some seniors advocates as being unfair for older drivers who may not be comfortable using computers.

Each year, these assessments result in the cancellation or denial of driving privileges for about 4,000 drivers (2.7 per cent of cases assessed), and the restriction or reduction of about 2,500 drivers (1.7 per cent of cases).[143]

In BC, under the *Motor Vehicle Act*, a variety of medical professionals (e.g., physicians, registered psychologists, optometrists, ophthalmologists, and nurse practitioners) are required to report an individual whose driving ability may be impaired by a medical condition to the Superintendent of Motor Vehicles, if they have already told the individual to stop driving and he/she fails to do so.[114,144,145,146] The reporting role is a challenge for many health professionals. Of Canadian physicians surveyed in 2003, more than 45 per cent reported that they did not feel confident assessing their patients' fitness to drive, nor did they consider themselves the most qualified people to do so.[147] About three-quarters felt that the requirement for them to report a patient as an unsafe driver was a conflict of interest and also damaging to the physician-patient relationship.[147] However, the majority of physicians also felt that it was important to report unsafe drivers in order to protect public health, and that they would benefit from training on how to talk to patients about the need to stop driving.[147]

Preventing Sleep-Impaired Driving

When determining how to address issues regarding sleep-related impairment, the OECD and European Conference of Ministers of Transport consider night-time driving restrictions an effective means of preventing fatigue-related MVCs among young drivers.[57] Evidence suggests that teaching drivers to recognize the signs of sleep-related impairment may be more effective at reducing fatigue-impaired driving than recommending that drivers rest after a given number of hours behind the wheel.[148] However, as many drivers continue to drive fatigued even when they know the risks, UK researchers have suggested that public awareness campaigns challenge the belief that a journey is "important enough to risk driving in a severely fatigued state," as well as focus on changing attitudes among high-risk populations and pre-driving-aged youth.[133] Although sleep is the only real antidote to fatigued driving, road infrastructure that alerts drivers when they cross a highway line (e.g., shoulder and/or centre line rumble strips) and secure highway rest areas (to encourage breaks) may also be effective at reducing fatigue-related MVCs.[149] Rumble strips and other road safety infrastructure are discussed further in Chapter 7.

HIGH-RISK DRIVING

High-risk driving is driving a vehicle aggressively or in a way that may harm property or another person. "High-risk drivers" also refer to individuals who incur more driving violations than average drivers.[1] High-risk driving may include risk-taking behaviour or outright hostile behaviour toward another individual.[150] Drivers with previous licence suspensions and multiple at-fault crashes are more likely to cause future crashes and have a much higher crash risk compared to other drivers.[1]

The Royal Canadian Mounted Police (RCMP) identify high-risk driving as one of the top three road safety concerns in BC, along with seat belt use and impaired driving.[150] High-risk driving includes driving behaviours such as failing to yield, ignoring traffic-control devices, following too closely, speeding, and improper passing.[151] Table 5.3 shows the proportion and number of MVC fatalities with high-risk driving behaviours as contributing factors. Speeding is the most common high-risk driving behaviour, and was a factor in 34.9 per cent of MVC fatalities. The next highest contributing factor was failing to yield the right-of-way (8.5 per cent) followed by ignoring a traffic-control device (5.2 per cent), improper passing (3.4 per cent), and following too closely (0.8 per cent). Speed will be discussed in more detail in Chapter 6.

Road rage is an extreme form of driver aggression that typically results from high levels of driver frustration, stress, anger, and hostility.[152,153] It has been defined as an over-reaction of aggressive thoughts, behaviours, and emotions of a driver targeted at a victim in response to a road related incident.[154] A study of a sample of Ontario residents found that just under half of respondents reported having experienced road rage directed at them, most commonly shouting, cursing, and/or gesturing at other drivers, and more than 7 per cent reported being threatened with personal injury or damage to their vehicle. About one-third of respondents admitted to shouting, cursing, and/or gesturing at other road users, and 2 per cent admitted to threatening to hurt someone or to damage their vehicle. This study found that males, younger respondents, higher income earners, Toronto residents, and never married

Table 5.3 Number and Proportion of High-risk Driving-related Motor Vehicle Crash Fatalities, by Behaviour Type, BC, 2008-2012

HIGH-RISK DRIVING BEHAVIOUR TYPE	NUMBER OF FATALITIES	PROPORTION OF FATALITIES
Following too Closely	14	0.8%
Improper Passing	56	3.4%
Ignoring a Traffic-control Device	86	5.2%
Failing to Yield Right-of-Way	141	8.5%
Speeding	577	34.9%

Notes: Victim may or may not be the high-risk driver involved in the crash. See Appendix B for more information about this data source.
Source: Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia, 2008-2012; prepared by BC Injury Research and Prevention Unit, 2014.

respondents were most likely to admit to shouting, cursing, and making rude gestures.[155] High-risk driving behaviours are frequently associated with youth,[150] male youth in particular,[57,58,154,156,157] and research from Canada and other jurisdictions has also found road rage to be a behaviour predominantly exhibited by younger males.[154] According to a study of road rage incidents reported in Canadian newspapers between 1998 and 2000, 96.6 per cent of perpetrators were male, with an average age of 33.[158]

The primary mechanism by which many jurisdictions deter and penalize high-risk driving behaviour is the demerit point system.[1] In this system, points are assigned based on traffic violations with increasingly severe financial penalties with increasing points.[1] The majority of European Union countries, the US, and Canada use this system.[1] In BC, there may also be penalty points imposed when police issue a ticket to a driver for committing a traffic offence. Each year, fees are assessed and billed to drivers, who pay premiums based on the number of points they were assigned in the assessment period.[159] However, there is currently a lack of research supporting the sustained success of demerit point programs.[1]

In addition to penalty points in BC, ICBC penalizes "high-risk" drivers with the Driver Risk Premium if they have one or more driving-related *Criminal Code* convictions; one or more *Motor Vehicle Act* convictions of 10 points or more; one or more excessive speeding convictions; or two or more roadside suspensions/prohibitions.[160] Another way to keep high-risk drivers off the road is to restrict the sale of vehicle insurance.[1] For optimal effect, programs must be implemented in conjunction with consistent police enforcement and public education.[1]

SUMMARY

Road user behaviours and impairment have a significant impact on road safety. Impairment includes road user distraction; substance-based impairment (alcohol and other drugs, including prescription and over-the-counter medications); physical or cognitive impairment (this includes medically at-risk drivers, age-related cognitive or sensory impairments, and driving while fatigued), and high-risk driving. As discussed in this chapter, males are at increased risk for motor vehicle crash (MVC) fatalities related to some of these behaviours and conditions, particularly distracted driving, substance-impaired driving, and high-risk driving. Further, impairment-related MVC fatalities are overwhelmingly experienced by youth age 16-25, especially males. Recognizing and addressing problematic driver behaviours and impairment can help to improve the health and safety of all road users. Strategies that combine public education and awareness, legislation and enforcement, and penalties for unsafe behaviours can help to reduce the burden of MVCs and related injuries and fatalities on BC roads. For maximum effectiveness, such strategies should focus on higher-risk populations, such as young and new drivers, male drivers, commercial drivers, and those who are medically at-risk.

The next chapter will investigate the role of safe speeds in promoting road safety in BC.

Chapter 6

Safe Speeds

INTRODUCTION

Speed is the top road safety problem in many countries.[1] Globally, it is an aggravating factor in the severity of all motor vehicle crashes (MVCs) and the causal factor in about one-third of fatal MVCs.[1] Safe speed is one of the four pillars of a Safe System Approach (SSA) and is closely linked with the other pillars. Interventions to prevent speeding or reduce the severity of speed-related MVCs focus on road user behaviour, roadway engineering, and vehicle modifications. This chapter provides an overview of speed in BC, including relevant laws, enforcement, and trends. It examines the burden of speed-related MVCs in BC in relation to serious injuries and fatalities. The chapter concludes with a discussion about options for speed management in BC.

Speeding in BC includes driving faster than the designated speed limit and driving too fast for the conditions (which may be lower than a posted limit). Excessive speeding is defined in the BC *Motor Vehicle Act* as driving more than 40 km/h over the speed limit.[3] Default speed limits in BC are designated in the Act as 50 km/h in municipalities and 80 km/h outside of municipalities.[3] The speed limit near schools and playgrounds is 30 km/h when signs are present and within specified hours. While these speed limits are static and applicable on all roads in BC, both municipalities and the Minister of Transportation and Infrastructure have legislated power to modify speed limits.[4] For example, some highways in BC have speed limits as high as 120 km/h, while some municipalities have sections of road with a 30 or 40 km/h speed limit.[7]

Speed impacts MVCs in two main ways. First, when a vehicle travels at a higher speed, the time for a driver to react decreases but the distance required to stop increases, which results in more MVCs occurring.[1,5] In fact, the risk of an MVC involving a serious injury increases exponentially with the speed of the vehicle, doubling with each five kilometres per hour in travel speeds above 60 km/h.[6] Second, when MVCs do occur, higher speeds mean greater kinetic energy[5] and result in greater physical force of impact and increased severity of crashes,[1,7] resulting in an exponentially increased risk of a serious injury or fatality.[8] Research underscores the susceptibility of vulnerable road users to injuries and death that is directly attributable to vehicle speeds: 90 per cent of pedestrians

> **"…speed is the number one contributing factor to fatalities in car accidents in the province. The faster you go, the less likely you'll walk away from a crash. Anything we can do to reduce speed in turn reduces the number of needless tragedies on our roads and highways."**
>
> – Cpl. Jamie Chung, Langley RCMP E Division Traffic Services, as quoted in BC Ministry of Public Safety and Solicitor General, *Government Set to Target B.C.'s Worst Speeders*[2]

survive when struck by a vehicle travelling 30 km/h, but only 20 per cent survive when struck at 50 km/h.[1]

In addition to its negative impact on road safety, speeding impedes traffic flow and increases fuel consumption, emissions, and traffic noise. It also impacts on quality of life in related areas—for example, residents may fear speeding vehicles and not feel safe walking or cycling in their communities.[1] Despite these potential consequences, people continue to drive fast, speed limits are sometimes set above the survivable speed for the related roadway type, and roadways do not always encourage drivers to travel at a safe speed.[1]

One of the main reasons people speed is because driving faster is perceived to result in shorter travel times;[1] however, few studies have examined how much time is actually saved by speeding. Preliminary findings from one study found that time saved was negligible—an average of only 26 seconds per day, based on 106 drivers over 3,049 driving hours.[9] Others may speed because it gives them a sense of freedom or excitement.[1] Drivers may also not fully understand the physics and relative risks of speed rates.

SPEED BEHAVIOUR IN CANADA AND BC

Evidence suggests that Canadians do recognize that speeding is dangerous and that they associate speed with risk of collision, injury, and death.[10] Despite this awareness, a 2005 national survey found that 71 per cent of Canadians reported speeding "on occasion" or "frequently," a trend mirrored in other Organisation for Economic Co-operation and Development (OECD) countries.[1] Additionally, 61 per cent of Canadians reported receiving at least one speeding ticket in their lives, and indicated that the top reasons for speeding were to avoid being late, because they thought the speed limits were too low, or because they were not paying attention to how fast they were travelling.[10] This survey found that speeding tickets were correlated to self-reported speeding, and that British Columbians reported that they have received more speeding tickets per capita than other Canadians.[10]

In BC, the Royal Canadian Mounted Police (RCMP) and municipal police both enforce traffic laws, including speed limits. For traffic violations involving speeding, police issue tickets ranging from $138 to $483. In addition to the immediate fine, drivers incur penalty points that may result in further financial costs. Excessive speeding carries the consequence of vehicle impoundment, as well as the driver incurring the Driver Risk Premium (for more information visit the Insurance Corporation of BC [ICBC] website at www.ICBC.com).[11] Integrated Road Safety Units (IRSUs) are groups of police officers from multiple jurisdictions who work across municipal borders to address specific dangerous driving behaviours, including speeding. IRSUs concentrate on traffic enforcement to prevent serious MVCs, rather than responding to MVCs that have already occurred.[12]

According to RoadSafetyBC, police issue approximately 10,000 tickets per year for excessive speeding in BC.[13] Results from the 2011 BC Drivers' Public Attitude Survey showed substantial increases in public perceptions of both police commitment to traffic enforcement and the likelihood of being caught while speeding, from 2010 to 2011. In 2011, 41 per cent of respondents felt that police were "very committed" to enforcing traffic laws, (compared to 18 per cent in 2010), and the percentage who reported that it was "very likely" to be caught if driving more than 20 km/h over the speed limit increased by 97 per cent between 2010 and 2011.[14]

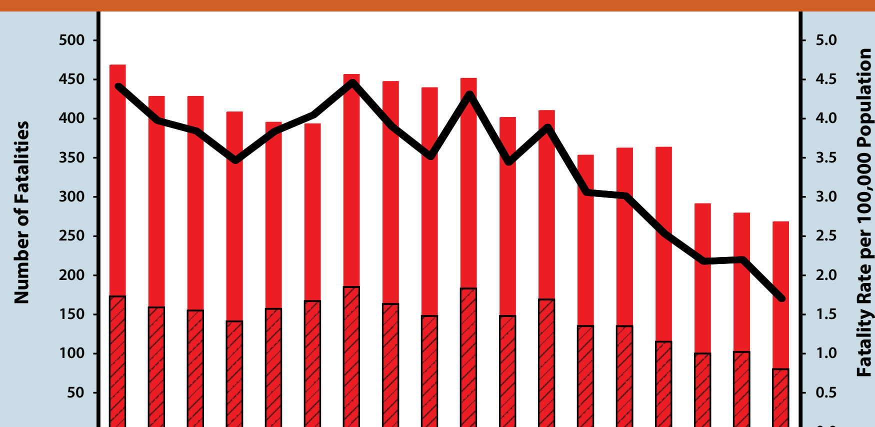
BURDEN OF SPEED-RELATED MVCS IN BC

In BC from 2006 to 2013, speed was the top contributing factor cited in police reports for police-attended MVCs in which there was a fatality. Only in 2013 was this factor surpassed by driver distraction.[ac,15]

As shown in Figure 6.1, over the last 18 years the number of MVC fatalities overall has decreased substantially, from 469 in 1996 to 269 in 2013. The number of speed-related fatalities was highest in 2002 and 2005 (at 183 and 181, respectively) and has been generally decreasing since 2005, down to 78 in 2013. Similarly, the speed-related proportion of MVC fatalities has been decreasing in recent years and reached its lowest proportion in 2013, at 29.0 per cent.

Since 1996, a number of road safety programs and initiatives have been developed in BC that have likely impacted the trends shown here. For example, a photo radar program was introduced in BC in 1996, and likely accounts in part for the reduced the number of speed-related fatalities over the three years following its implementation (1997 to 1999). However, in 2001, the program was cancelled, and this cancellation likely accounts in part for the subsequent increase in speed-related fatalities

Figure 6.1 **Speed-related Motor Vehicle Crash Fatality Count and Rate per 100,000 Population, BC, 1996 to 2013**



	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Number of MVC Fatalities	469	429	429	409	396	394	457	448	440	452	402	411	354	363	364	292	280	269
Number of Speed-related MVC Fatalities	171	157	153	139	155	165	183	161	146	181	146	167	133	133	113	98	100	78
Speed-related MVC Fatality Rate	4.4	4.0	3.8	3.5	3.8	4.0	4.5	3.9	3.5	4.3	3.4	3.9	3.1	3.0	2.5	2.2	2.2	1.7
Speed-related Proportion of Fatalities	36.5	36.6	35.7	34.0	39.1	41.9	40.0	35.9	33.2	40.0	36.3	40.6	37.6	36.6	31.0	33.6	35.7	29.0

Year

Notes: "Speed-related" fatalities are deaths where one or more vehicles involved in a crash had any one of the contributing factors: unsafe speed, exceeding speed limit, excessive speed over 40 km/h, and/or driving too fast for conditions. Data are based on police reports from police-attended motor vehicle crashes; therefore, contributing factors reported emphasize human error rather than other systemic factors (e.g., vehicle design, roadway design). See Appendix B for more information about these data sources.
Source: Fatality data are from the Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia, 1996-2013; population estimates are from the BC Stats website, April 2015. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

[ac] As noted in earlier chapters of this report, these contributing factors are based on police reports from police-attended MVCs, so they emphasize human factors rather than other systemic factors.

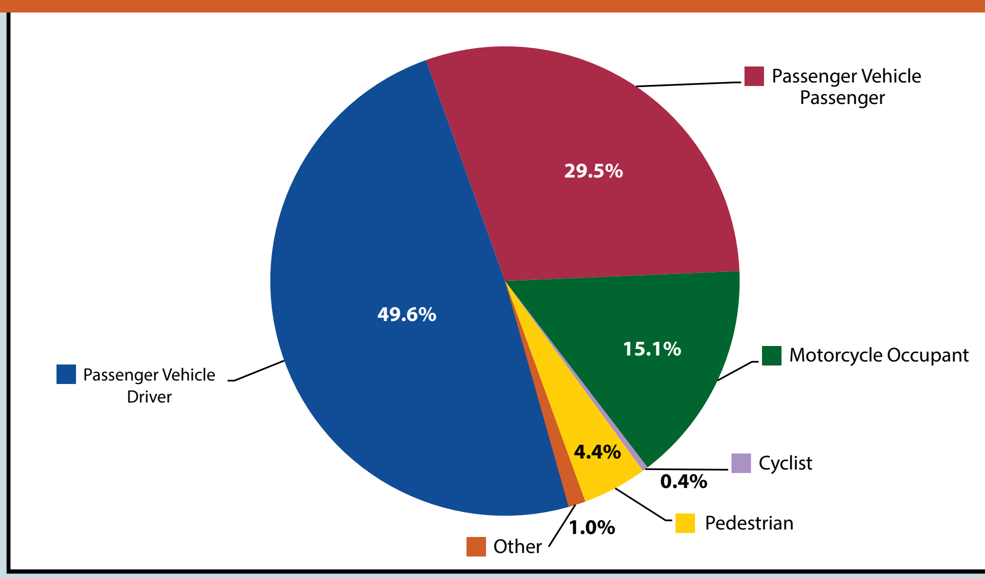
(this program will be further discussed later in this chapter). Impoundment rules and penalties for excessive speeding violations that came into effect in September 2010[16] may explain at least part of the reduction in speed-related fatalities from 2010 onward.

Figure 6.2 shows the distribution of speed-related MVC fatalities by road user type on average for 2009-2013. While these data do not indicate who was at fault (i.e., whether the driver fatalities were those who were speeding), they do show that drivers represented the largest proportion of speed-related fatalities at 49.6 per cent. This figure shows that vulnerable road users are heavily impacted by speed as well, with motorcyclists, pedestrians, and cyclists making up a total of 19.9 per cent of speed-related fatalities.

Figure 6.3 displays the average speed-related fatality rates per 100,000 population by sex and age group for 2009-2013. These numbers show that individuals age 16-25 had the highest speed-related fatality rates among the age groups, and that the rates decrease until age 65 for females and until age 75 for males. Research indicates that young drivers are likely overrepresented in MVCs due to a variety of factors, many of which may contribute directly or indirectly to speed-related fatalities, such as lack of driving experience, lack of maturity, status-seeking and risky behaviour, increased likelihood of driving while impaired, and not wearing a seat belt.[17,18,19] This figure also shows that males had higher speed-related fatality rates than females across all age groups.

Figure 6.4 shows age-standardized speed-related fatality rates by sex from 1996 to 2013. This figure shows that males have had a consistently higher speed-related fatality rate than females across these 18 years—often double or triple the female rate. The male rate shows increases in 2002, 2005, and 2007, which are not seen in the female rate for those years; in fact, in comparison to males, the rate for females has remained relatively stable across the 18-year period

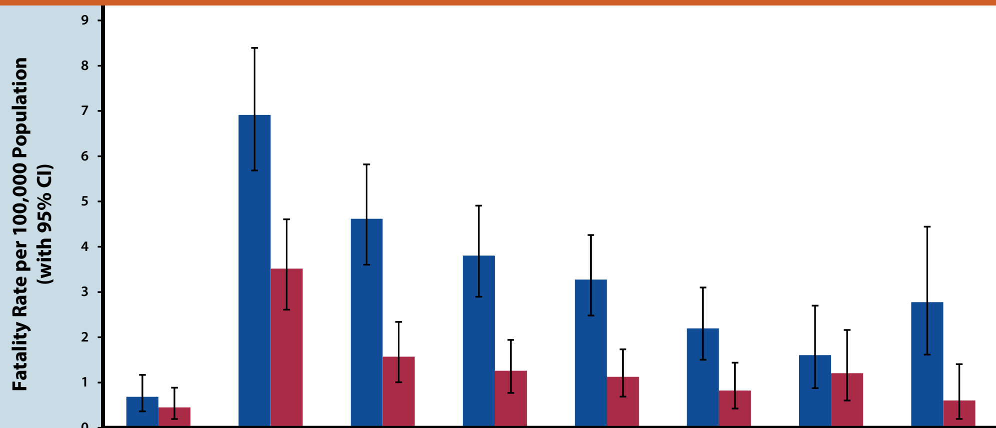
Figure 6.2 **Proportion of Speed-related Motor Vehicle Crash Fatalities, by Road User Type, BC, 2009-2013**



Notes: "Passenger vehicle" includes cars, trucks, sport-utility vehicles, commercial vehicles and heavy trucks, and excludes motorcycles. "Motorcycle occupant" includes motorcycle drivers and passengers. "Speed-related" fatalities are deaths where one or more vehicles involved in a crash had any one of the contributing factors: unsafe speed, exceeding speed limit, excessive speed over 40 km/h, and/or driving too fast for conditions. Data are based on police reports from police-attended motor vehicle crashes; therefore, contributing factors reported emphasize human error rather than other systemic factors (e.g., vehicle design, roadway design). See Appendix B for more information about this data source.
Source: Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia, 2009-2013. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

Figure 6.3

Speed-related Motor Vehicle Crash Fatality Rate per 100,000 Population, by Sex and Age Group, BC, 2009-2013



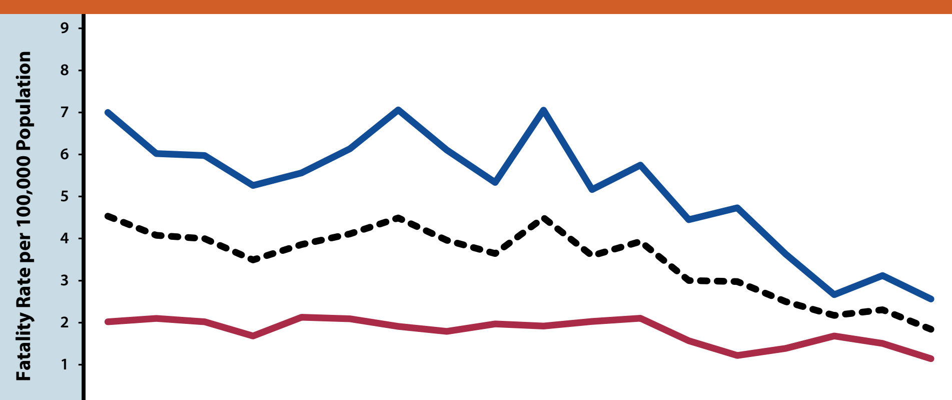
	0-15	16-25	26-35	36-45	46-55	56-65	66-75	76+
Male	0.7	6.9	4.6	3.8	3.3	2.2	1.6	2.8
Female	0.4	3.5	1.6	1.3	1.1	0.8	1.2	0.6

Age Group

Notes: "Speed-related" fatalities are deaths where one or more vehicles involved in a crash had any one of the contributing factors: unsafe speed, exceeding speed limit, excessive speed over 40 km/h, and/or driving too fast for conditions. Rates are calculated using age- and sex-specific population numbers. There were fewer than five cases where the age group was missing, and these cases are excluded from this figure. Data are based on police reports from police-attended motor vehicle crashes; therefore, contributing factors reported emphasize human error rather than other systemic factors (e.g., vehicle design, roadway design). See Appendix B for more information about these data sources.
Sources: Fatality data are from the Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia, 2009-2013; population estimates are from the BC Stats website, April 2015. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

Figure 6.4

Age-standardized Speed-related Fatality Rate per 100,000 Population, by Sex, BC, 1996 to 2013



	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Male	7.0	6.0	6.0	5.3	5.6	6.1	7.1	6.1	5.3	7.1	5.2	5.7	4.4	4.7	3.6	2.7	3.1	2.6
Female	2.0	2.1	2.0	1.7	2.1	2.1	1.9	1.8	2.0	1.9	2.0	2.1	1.6	1.2	1.4	1.7	1.5	1.1
BC	4.5	4.1	4.0	3.5	3.9	4.1	4.5	4.0	3.6	4.5	3.6	3.9	3.0	3.0	2.5	2.2	2.3	1.8

Year

Notes: "Speed-related" fatalities are deaths where one or more vehicles involved in a crash had any one of the contributing factors: unsafe speed, exceeding speed limit, excessive speed over 40 km/h, and/or driving too fast for conditions. Age-standardized rates are calculated using Canada 1991 Census population. There were 33 cases where the age group and/or sex was missing, and these cases are excluded from this figure. Data are based on police reports from police-attended motor vehicle crashes; therefore, contributing factors reported emphasize human error rather than other systemic factors (e.g., vehicle design, roadway design). See Appendix B for more information about these data sources.
Sources: Fatality data are from the Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia, 1996-2013; population estimates are from the BC Stats website, April 2015. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

shown, with only a minor decline since 2007. This has resulted in the gap between males and females narrowing over time. Both sexes reached their lowest rate in 2013, at 2.6 per 100,000 population for males and 1.1 per 100,000 for females. Programming targeted at males may help to further lower the related rate.

According to a Canadian survey about speeding, male drivers reported receiving twice as many tickets during their life as female drivers (4.6 tickets compared to 2.3 tickets).[10] Female drivers were found to be most often classified as "cautious drivers," meaning they speed less often and have a negative opinion of speeding, while 58 per cent of male drivers reported that they drive over the speed limit frequently. The same survey found that females may feel pressured to drive at a higher speed than they prefer in order to avoid aggressive drivers and to keep up with traffic.[10]

Speed and Impairment

Table 6.1 shows the number of speed- and impairment-related fatalities for 2009-2013 in BC. In this five-year period there were 326 MVC fatalities in which speed (and not impairment) was the contributing factor identified in police reports, and another 196 fatalities in which speed and impairment were both contributing factors.[20] This demonstrates that speed and impairment are key factors in road safety and that related interventions may be most efficient if they focus on both factors.

Table 6.1 **Number and Proportion of Speed- and Impairment-related Motor Vehicle Crash Fatalities, BC, 2009-2013**

CONTRIBUTING FACTOR	NUMBER OF FATALITIES	PROPORTION OF MVC FATALITIES
Impairment-related (speed not a factor)	232	14.8%
Speed-related (impairment not a factor)	326	20.8%
Both impairment- and speed-related	196	12.5%
Total (impairment- and/or speed-related)	**754**	**48.1%**

Notes: "Impaired-related" fatalities are deaths where one or more vehicles involved in a crash had any one of the contributing factors: alcohol involvement, prescribed medication and/or drug involvement. Victim may or may not be the impaired person involved in the crash. "Speed-related" fatalities are deaths where one or more vehicles involved in a crash had any one of the contributing factors: unsafe speed, exceeding speed limit, excessive speed more than 40 km/h above speed limit, and/or driving too fast for conditions. Data are based on police reports from police-attended motor vehicle crashes; therefore, contributing factors reported emphasize human error rather than other systemic factors (e.g., vehicle design, roadway design). See Appendix B for more information about this data source.
Source: Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia, 1996-2013; prepared by BC Injury Research and Prevention Unit, 2014.

MANAGING SPEED LIMITS

Education, speed limits, enforcement, legislation, roadway design, and vehicle design all help to manage speed, but it also requires active awareness and responsibility of drivers. Speed limits are an important mechanism to achieve appropriate speeds on roadways and to enable appropriate interventions for drivers who drive at unsafe speeds.[1] Road safety requires that speed limits be appropriate for the roadway design and for the types of crashes that may occur, including the types of road users that are likely to be involved in those crashes; that drivers abide by posted limits and account for road and weather conditions in their driving; and that vehicle design assists drivers in maintaining safe speeds. Research shows that when speed is reduced, the number of crashes and the severity of injuries are both lowered and overall road safety is improved.[8] This section reviews the importance of speed for road safety, how speed limits are set, and mechanisms used to control and/or monitor speed.

Speed Limits and Road Safety

Speed limits are designed to limit vehicle speeds for road user safety. There is an existing and expanding body of research showing a clear relationship between safe speeds and road safety. Vehicle safety features that are designed to protect vehicle occupants in the event of an MVC (e.g., vehicle crumple zones, air bags, and seat belts) work best at low or moderate speeds and cannot completely offset the physics at play in high-speed MVCs.[1] Vulnerable road users are even more susceptible to death and serious injury in high-speed MVCs. Research shows that pedestrians have a 10 per cent risk of dying when hit at 30 km/h, but an 80 per cent risk of dying when hit at 50 km/h.[1] Evidence shows that to reduce serious injuries and fatalities among pedestrians, vehicle speed in urban areas and other areas with pedestrian activity should be 30 km/h or below.[1]

Evidence has shown that reducing the average speed of traffic reduces the number of MVCs, as well as the number and severity of MVC-related injuries that occur over the road length where the speed was reduced.[21] For example, the Nilsson Power Model, validated with Swedish and international data, provides estimates for the changes in MVCs resulting in injury, serious injury, or fatality associated with changes in speed. Overall, this model shows that when the mean speed of traffic is reduced, the number of crashes and the severity of injuries decrease. Conversely, when the mean speed of traffic increases, the number of crashes and the severity of injuries will increase.[22,23] The model has been adapted to recognize the greater safety gains from decreasing higher speeds compared to low speeds.[24,25] Additionally, a recent 20-year time series study in London, England demonstrated that introducing 20 mph zones (32 km/h) reduced MVCs and associated injuries and fatalities. In this study, introduction of these lower speed zones was associated with a 42 per cent reduction in road fatalities.[26]

Studies have shown that raising speed limits increases the number of MVCs that involve injuries and fatalities.[27] In the 1980s, several US and European jurisdictions increased their speed limits; a review of 18 studies showed that almost every one of these increases were paralleled by increases in MVC fatalities.[28] Reviews of the results of

> **"If government wants to develop a road transport system in which nobody is killed or permanently injured, speed is the most important factor to regulate."**
>
> – R. Elvik, P. Christensen, A. Amundsen, *Speed and Road Accidents: An Evaluation of the Power Model* [22]

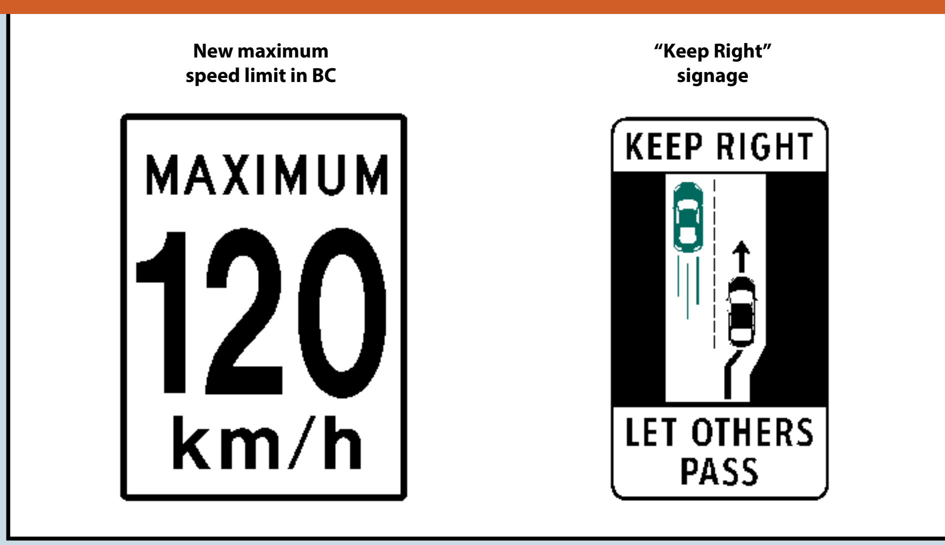
the 1995 repeal of US federal speed limit controls found an overall rise of 3.2 per cent in fatal MVCs attributable to increased speed limits[29] and a 36 to 37 per cent increase in fatalities on rural interstate highways.[30] Similarly, research from Australia found that raising the speed limit from 100 to 110 km/h resulted in a 24.6 per cent increase in MVCs with injuries.[31] In addition, research shows speed limit increases have a broader impact on the roadway system in a speed spillover effect, whereby vehicle speeds increase on nearby roadways where limits were not increased. This is demonstrated by increased fatalities on adjacent roadways after speed limit increase.[32,33,34]

In July 2014, the Ministry of Transportation and Infrastructure (MoTI) increased speed limits on 1,300 kilometres of rural highways in BC, and created a new maximum speed in BC of 120 km/hour (see Figure 6.5).[35] This took place despite widespread concern from related experts, including medical professionals, various health authorities, the Provincial Health Officer, police chiefs, the RCMP, the BC Trucking Association, the BC Cycling Coalition, RoadSafetyBC in the BC Ministry of Justice, and a selection of university researchers.[36] In a study of ambulance calls for road trauma, researchers found an 11.1 per cent increase in road trauma calls in the six months following the increased limits.[37] The study was not able to determine whether increases were isolated to roads where speed limits increased or if it was a rise across all roads in the province; therefore, the researchers suggest that this issue continue to be monitored and be more comprehensively evaluated.[37]

In June, 2015, the MoTI introduced changes to the *Motor Vehicle Act*, supported by new highway signage throughout the province requiring drivers to move into the right lane to let drivers travelling at higher speeds pass (see Figure 6.5). The focus of this initiative is to provide legal provisions and public messaging to prevent vehicles travelling at lower speeds from impeding other, faster drivers, and to clarify language in legislation to allow police to enforce this provision among slower drivers.[35]

While evidence clearly supports the road safety benefits of lower speed limits, lowering speed limits is not enough to change driver behaviour. Research shows that when a speed limit is lowered by 10 km/h, the actual average speed on the road decreases by only

Figure 6.5 **Sample of Signage in BC**



Notes: These roadway signs were introduced in BC in 2014 and 2015. Reproduced with permission.
Source: BC Ministry of Transportation and Infrastructure, CC BY-NC-ND 2.0 (see: https://creativecommons.org/licenses/by-nc-nd/2.0/).

3 to 4 km/h.[1(p.100),8] Therefore, to achieve the optimal outcomes, lowered speed limits need to be accompanied by education, changes to infrastructure, and enforcement.[1]

Setting Speed Limits

Around the world, most countries set speed limits according to the classification of roads. Most speed limits are representative of the fastest speed at which drivers of **light vehicles** can travel safely with ideal road conditions.[1] They typically range from 30 to 50 km/h on urban roads and from 70 to 110 km/h on rural roads and main highways, depending on roadway design.[1]

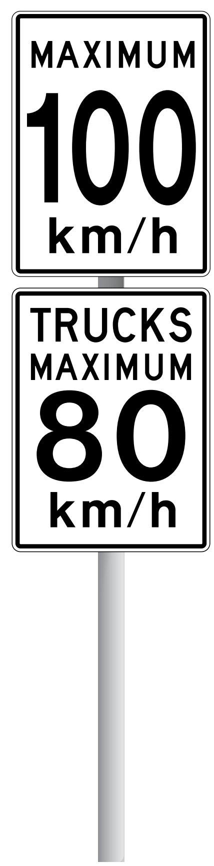
A number of international jurisdictions allow higher speeds (e.g., Bulgaria, US states such as Montana and Texas) or unlimited speed (e.g., Germany's autobahn) on sections of their highway systems.[38] Notably, Germany has a comparatively low MVC fatality rate of 4.4 per 100,000 population[ad,39] despite their unlimited autobahn speeds. The autobahn has been specially designed for fast-moving vehicles (e.g., there are no opportunities for head-on or right-angle MVCs, and pedestrians and cyclists are not permitted).[38,40] Germany also has comprehensive road safety policies,[39] including an aggressive goal to reduce MVC fatalities by 40 percent under the motto "each traffic death is one too many."[41] Further, licensing processes in Germany are more extensive than in BC, requiring attendance at mandatory classes,[42] success in both theoretical and practical exams,[43] and additional licensing requirements for different licence classification levels.[43] They also have national speed limits on other roads;[39] and very strict autobahn driving rules enforced by the specialized autobahn police force, who are trained and equipped with specialized vehicles.[38]

Types of Speed Limits

Most speed limits are static and unchanging; however, speed limits can also be subject to advisories, be variable, or be dynamic.

Advisory speeds are used by some jurisdictions (including BC) on sections of road that suggest a lower speed limit due to conditions or design (e.g., corners). These advisory speeds are often recommended speeds that are not enforced, as is the case in BC.[44] Enforcement can often be difficult due to the challenges inherent in the locations where advisory speeds are posted.[1]

Variable speed limits are speed limits that are different from the overall speed limit for an area, based on considerations of the roadway, driver, and/or vehicle. Sections of road might be set at lower speed limits depending on the season (e.g., winter), time of day (e.g., nighttime), weather conditions



[ad] This is a crude rate, calculated based on 3,648 MVC fatalities in a population of 82,302,468 in 2010.

(e.g., fog), the environment around the roadway (e.g., school zones, parks), the type of driver (e.g., young or novice), or type of vehicle (e.g., heavy vehicles, commercial vehicles). While variable limits are set based on a specific factor or condition, they are consistent in their application. In BC, variable speed limits are used in park and school zones, on some highways at night, and where MVCs involving wildlife are common. Other jurisdictions also use variable speed limits.[45] Many countries have different speed limits for heavy trucks and buses on rural roads, with some countries preventing these vehicles from exceeding those limits through the use of mandatory **speed limiters**[1] (for more information, see Chapter 8).

Dynamic speed limits are speed limits activated based on specific conditions as they happen.[1] For example, when traffic volume is heavy or the weather conditions are poor, a dynamic speed limit will be activated and displayed on a digital sign. Germany uses dynamic speeds on highways to reduce speed limits when weather is poor.[1]

Determining Speed Limits

Speed limits are set using various methodologies. In BC, the *Motor Vehicle Act* establishes a 50 km/h speed limit within municipalities and 80 km/h outside of municipalities. The 85th percentile method is used to determine a highway's regulatory speed limits, which range from 50 to 120 km/h. The 85th percentile method sets the speed limit as the speed under which 85 per cent of drivers travel.[44] This method does not reflect the more advanced understanding of the risks associated with higher speeds or the mix of road users, and does not consider the full roadway system.[1(p.94)] Speed limits can also be set based on the survivable speed, type of road (e.g., windy roads with many private access roads or driveways would have a lower speed limit).[8] In practice, jurisdictions around the world use a mixture of these methods.[8]

Speed is a key determining factor in the potential to survive an MVC. Table 6.2 outlines the maximum speeds that humans can survive given a particular scenario and road type. For example, 30 km/hr is the survivable speed for vulnerable road users such as pedestrians and cyclists, and so speed limits of 30 km/hr would be safest for local neighbourhood roads and other mixed use roads where vulnerable road users are not protected via infrastructure.

In addition to these established methods for setting speed limits, two additional approaches are emerging. The first is to use an SSA, which focuses on setting speed limits in conjunction with modifications to infrastructure to reduce the severity of MVCs.[1] This technique emphasizes changing both speed limits and the environment instead of just relying on one part of the

Table 6.2 **Survivable Speed and Road Type, by Road User and Motor Vehicle Crash Type**

ROAD USER AND MVC TYPE	SURVIVABLE SPEED	TYPICAL ROAD TYPE WHERE SURVIVABLE SPEED LIMIT LIKELY TO APPLY
Vulnerable road user (pedestrian or cyclist) involved MVC	30 km/hr	Local and other mixed use roads where vulnerable road users are not protected
Vehicle occupant in a side-impact MVC	50 km/hr	Minor and major roads where side-impact MVCs are possible, especially with intersections
Vehicle occupant in a front-impact MVC	70 km/hr	Minor and major roads where front-impact MVCs are possible
Vehicle occupants in MVC with no frontal or side impact	100 km/hr	Major roads that are designed so that neither front- nor side-impact MVCs are possible

Sources: Adapted from: Arason N. 2014. *No Accident: Eliminating Injury and Death on Canadian Roads;*[62] and Tingval C, Haworth N. 1999. *Vision Zero-An Ethical Approach to Safety and Mobility.*[63]

larger road system to create safe roads. The second approach includes setting a speed limit that poses lower risk to road users, based on assessment of the combined risk of traffic speed, traffic volume, the different types of vehicles, road user types on the road, and the relevant infrastructure.[1]

SPEED CONTROL AND ENFORCEMENT

Some methods of speed control discourage speeding among drivers (such as increasing driver awareness and enhancing or expanding driver education), while some can actually prevent them from speeding. Others integrate speeding deterrence and enforcement. The conventional method for speed limit enforcement in BC is roadside ticketing by enforcement officers. As technology has advanced, alternatives to this conventional speed control method have been developed, and some of them are used in BC. Some alternatives include speed reader boards (or radar speed signs), **speed cameras**, section control, vehicle design, and roadway design.

Speed Reader Boards

Speed reader boards (or radar speed signs) are signs on the side of the road that display the speed of passing cars, calculated using radar, and they are used around the province.[46] A study in Fredericton, New Brunswick revealed that up to four years after installation in school zones, these signs were effective at reducing average speeds.[47] In a Canadian driver attitude survey, 72 per cent of Canadians were supportive of the wider use of these roadside signs.[10]

Roadside Speed Violation Tickets

Speed limits are most often enforced in BC through conventional speed control, which usually includes one law enforcement officer who measures the speed of a vehicle using a radar or laser speed measurement device and another who stops the vehicle to issue a ticket. This method removes the positive reinforcement of speeding (by preventing the driver from getting to their destination more quickly), provides immediate feedback for the driver, and allows the enforcement officer to explain to the driver what they have done wrong. Further, vehicles that have different speed limits (e.g., trucks that have lower limits) can be identified.

Speed Cameras

Speed cameras, also known as photo radar, detect when a vehicle is speeding using laser or radar technology and photograph the speeding vehicle. Tickets are then issued to the owner of the vehicle based on registration information obtained from the photographed licence plate. Speed cameras are used all over the world (e.g., the Netherlands, New Zealand, Australia, France, and the UK).[1] There are many ways that speed cameras can be deployed. They can be fixed at one location or be mobile (which makes enforcement unpredictable and broadens deterrence); they can be operated by trained personnel or have automated functionality; they can be used on different types of roadways; they can be visible or hidden; and they can have different speed enforcement thresholds.[48] The effectiveness of speed cameras has been widely studied[1] since they were first introduced in Norway in 1988.[49] According to a 2009 Cochrane Review,

speed camera technology consistently resulted in speed reductions, although the studies reviewed had some methodological weaknesses, leading to less conclusive findings for reducing MVC injuries and fatalities. The review recommended that speed camera programs consistently collect and report on data for follow-up periods after implementation.[50]

In March 1996, the BC provincial government implemented a speed camera (photo radar) program that included 30 mobile units, each consisting of a law enforcement officer and camera inside an unmarked vehicle on the roadside. The program initially followed established guidelines regarding placement of the units, which were deployed in areas that had high MVC rates or where complaints regarding speed were common. Enforcement thresholds were set at the 85th percentile, which was typically 11 km over the posted limit. Vehicle owners were mailed violation tickets beginning in August 1996. Fines ranged from $115 to $173, with the higher amounts for speeding in school and construction zones. Public support for the program was fairly high when first implemented, and a review of the BC photo radar program showed it did demonstrate successful outcomes—in seven months, speeding vehicles in deployment sites decreased by 50 per cent. Within the first year of the program, daytime speed-related MVCs were reduced by 25 per cent, and there was a 17 per cent reduction in daytime speed-related MVC fatalities.[49] However, after some time, location restrictions were relaxed, and in November 1997, fines were increased to a range of $115 to $460. Public opinion changed as the program developed a reputation as a revenue generator for government rather than as a road safety initiative, and the program became a platform issue in the next provincial election. In June 2001, the program was cancelled by the newly elected government, after just five years.[51] The implementation and subsequent cancellation of the program likely account for a component of the MVC-related fatality trends shown in Figure 6.1, in which the number and rate of speed-related MVC fatalities decreased from 1996 to 1999 but increased to the highest recorded number and rate in 2002.

Section Control

Section control, also known as point-to-point speed enforcement, average speed enforcement, and time-over-distance cameras, has been used in some countries since the late 1990s and works by measuring the average speed of a vehicle on a section of road. The average speed is calculated based on the length of the section of road and the time it takes the vehicle to travel through that section, as determined by time-stamped photographs taken of the vehicle as it enters and leaves the section.[52] Section control is designed to facilitate reduction of speed across a whole section of road, rather than just one spot (as with speed cameras).[53] It is usually implemented across a section of road measuring 2 to 5 km. It can be operated 24 hours a day, resulting in a greater likelihood of speeders being caught,[54] and enforcement can be set for any given threshold to allow for small or large variations in speed.[55]

In 2008, the OECD reported that section control was in use in the Netherlands, Switzerland, Australia, the UK, Austria, and the Czech Republic.[1] A 2012 review of international literature on section control found that this method of speed control resulted in increased compliance with posted speed limits, reduced speeds, reduced levels of excessive speeding, and decreased speed variability among vehicles. The comprehensive review included consultations with Australian, New Zealand and international stakeholders. This work resulted in 34 best practice recommendations to guide implementation efforts, including operational technology, legislation, public education, evaluation, and privacy recommendations.[56] Another international literature review in 2012 associated this technology with decreased rates of MVCs, as well as reduced related fatalities and serious injuries. Other positive impacts included improvements in traffic flow and decreased emissions. The researchers also found that section control had high public acceptability. While the review reported that the technology is expensive, its high reliability led the researchers to conclude that the reduction in social and economic costs from MVCs meant a positive cost-benefit ratio.[57]

"Most automobiles are capable of going two to three times faster than the highest speed limits in Canada."

– N. Arason, *No Accident: Eliminating Injury and Death on Canadian Roads*[62(p.179)]

Controlling Speed with Vehicle Design

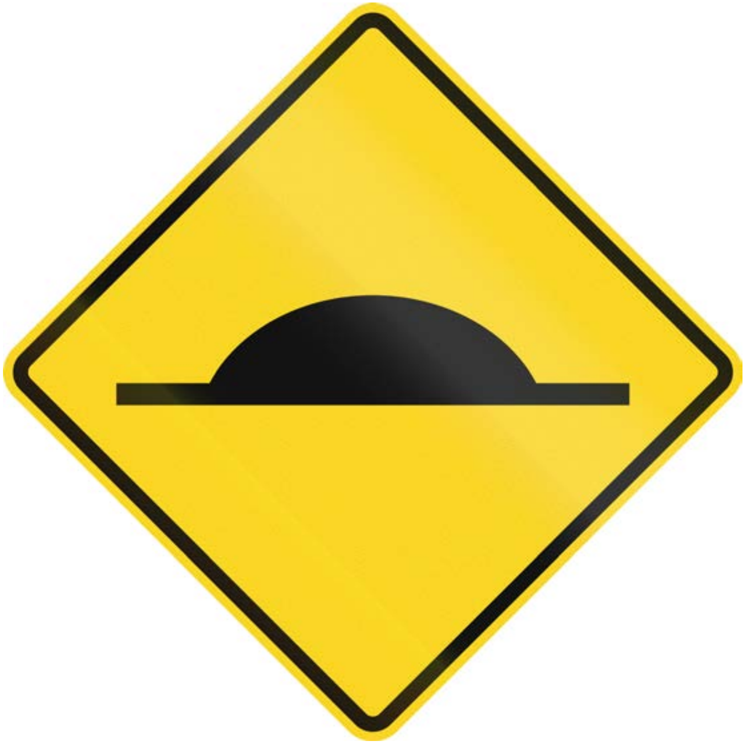
Intelligent speed adaptation (ISA) is a vehicle technology where speed limits are communicated to the vehicle either via electrical signals from a beacon/transmitter attached to roadside infrastructure or via GPS (global positioning system) technology, and then the technology intervenes if the driver is speeding.[58] There are two main types of ISA. The first variation is "informative," which alerts the driver that they are exceeding the speed limit through a visual, auditory, or physical cue (e.g., vibration or upward pressure on gas pedal). The second type of ISA is a speed limiting variation in which the driver is prevented from driving faster than the limit through the use of engine and braking systems in the vehicle. Both alerting and speed limiting ISA systems have override functions in place for situations that require a faster speed.[58] Both types of ISA can be voluntary, in which the driver would elect to use the device, or mandatory, where the ISA would be activated at all times based on the discretion and policies of government or private companies.[1]

The European Transport Safety Council is a strong advocate for ISA technology, stating that it will result in safer roads, and is cost-effective and reliable.[1,59] The speed limiting type of ISA has been found to be more effective at reducing speeds, but the informative type has been found to be more acceptable to drivers.[58] Countries around the world have trialed ISA with a variety of results, including the UK, Sweden, the Netherlands, Belgium, Spain, Hungary, France, and Australia.[1,58] In a review of international research, researchers found that the benefits of ISA include a reduction of 5 km/h or more in average speeds, and reductions in speed violations.[58] Results of simulation research in the UK estimate that if speed-limiting ISA fittings were mandatory on all vehicles, and were supplied basic speed limit information, an estimated 20 per cent of injury MVCs and 37 per cent of fatal MVCs could be prevented in the UK.[60] ISA trials in Sweden (using informative ISA) project reductions in serious MVCs by 20 per cent.[1] A 2010 review identified some challenges with this technology, including driver frustration, closer vehicle following, increased travel time, uncertainty of compliance/use of the system, and uncertainty of consumer acceptability.[61]

Controlling Speed with Roadway Design

Overall, the majority of drivers will drive at a speed that they consider reasonable and safe. Evidence suggests that if a set speed limit is higher or lower than the speed a driver perceives as appropriate for the road, most drivers will ignore the posted limit.[7] This reinforces the need to design roadway features that communicate the appropriate and safe speed.

There are a number of road features used in BC and other jurisdictions, especially in areas with high pedestrian and cyclist activity, to reduce speeds and speed-related MVCs. Intentional elevations in a roadway—speed humps and raised pedestrian crosswalks—are effective roadway features.[8] Speed humps



are elevations that are usually the height of the pedestrian curb and span a residential roadway,[8] and the shape and width can vary. Evidence shows that speed humps reduce speed where they are installed, reduce MVCs with injuries by an estimated 41 per cent, and reduce traffic volume where installed without increasing MVCs on neighbouring roads without speed humps.[8] Raised pedestrian crossings are similar to speed humps because the driver must slow down to transverse the elevated plane. They have been estimated to reduce injury MVCs by 42 and 65 per cent, compared to regular marked crosswalks and no crosswalks, respectively.[8] Another way to modify the roadway is to make it narrower; for example, by widening the sidewalk pavement at intersections, which encourages cars to slow down.[27] Rumble strips installed across the stretch of roadway approaching an intersection can also be used to warn drivers to slow down, and they have been shown to reduce injury MVCs by 33 per cent in a review of international studies.[27]

Improving road safety through roadway design and vehicle design will be discussed further in Chapters 7 and 8, respectively.

SUMMARY

Speed is one of the Safe System Approach pillars, and driving at unsafe speeds is a leading concern for road safety in BC. The number and rate of speed-related motor vehicle crash (MVC) fatalities have been decreasing in recent years, but speed remains a top police-reported contributing factor to MVC fatalities and serious injuries. Males of all ages and youth age 16-25 are at greatest risk for speed-related MVC fatalities. Speed limits are one key strategy to manage roadway speed; as the mean speed of traffic is reduced, the number of crashes and the severity of injuries decline, but when the mean speed of traffic increases, the number of crashes and the severity of injuries usually increases. Ongoing monitoring and evaluation of impact on MVCs and associated serious injuries is needed to ensure speed increases in 2014 in BC do not have adverse effects on road safety and health. It is essential that speed limits are appropriate for the road type and condition; safe for all road users, especially vulnerable road users; and enforced, so that drivers are more likely to follow them. Enforcement of speed limits is a key element of maintaining safe speeds. Conventional roadside ticketing is effective at reducing speeds and provides immediate feedback to the offender. Other promising speed control mechanisms are speed cameras and section control, which automatically issue penalties for speeding. Technology such as speed reader boards, as well as vehicle design mechanisms (e.g., intelligent speed adaptation, which alerts drivers when they are above the speed limit), and roadway designs (e.g., rumble strips, speed humps) can help control driver speed by providing information about a driver's travelling speed relative to the speed zone and road type. Fundamentally, there is a need to ensure that the road system—including vehicle and roadway features—reflects survivable speeds for road users, and encourages driving at safe speeds.

The next chapter will investigate the role of safe roadways in promoting road safety in BC.

Chapter 7

Safe Roadways

INTRODUCTION

In addition to safe road user behaviour and safe speeds, safe roadways are a crucial component of road safety. In fact, some evidence indicates that the most effective way to reduce trauma to road users is through better designed roads and vehicles.[1] Roadway design includes highway lane separation, guard rails, paved shoulders, rumble strips, **roundabouts**, roadway lighting, and more.[2] Within a Safe System Approach (SSA), safe roadways are roads and related infrastructure that are designed around road users, encourage safe driving behaviour, and anticipate road user error.[3] In addition to reducing roadway traumas, safe roadways are important for public health and healthy living. Urban planning, transportation infrastructure, neighbourhood density, and the development of safe environments for schools, parks, and other amenities influence how people behave, including their choice of transportation, their opportunities to exercise, and their access to healthy food and clean air and water.[4] Safe roadways are an integral part of safe, active communities.

This chapter examines roadways in BC and how they are developed and governed. It explores roadway locations, including urban roads, highways, and rural and remote areas, and then looks at the environmental factors that affect road safety, including infrastructure, road type and location, and roadway conditions. The chapter concludes with a presentation of road safety measures in BC and international best practices that have been shown to reduce motor vehicle crash (MVC) fatalities and serious injuries. The terms "road" and "roadway" are used interchangeably and refer to the open way for vehicles and people to travel, and may include only the strip used for travel (usually paved or gravel) or may encompass related features such as the shoulder and sidewalk.

RESPONSIBILITY FOR ROADWAYS IN BC

In 2013, BC had approximately 71,100 km of public road, 67.8 per cent of which was paved (48,200 km), and 32.2 per cent unpaved (22,900 km).[5] Responsibility for roadways in BC is complex and lies with multiple bodies, including municipal, provincial, and federal governments.

Municipalities are responsible for roadway and traffic pattern design, and maintaining streets and roads within their boundaries.[8] Highways fall within provincial jurisdiction,[9] and some projects are supported by a cost-sharing agreement with Transport Canada.[10] The Ministry of Transportation and Infrastructure (MoTI) is responsible for developing transportation networks, providing transportation infrastructure and services, administering related acts and regulations, and developing and applying transportation policies.[11] MoTI contracts out road maintenance—service providers are hired to remove snow, mow roadside grass, remove brush, and repair pavement, among other tasks. MoTI retains responsibility for marking road lines and managing avalanches.[12] The Ministry of Forests, Lands and Natural Resource Operations (MFLNRO) is primarily responsible for Forest Service Roads in BC.[13] Parks Canada manages roads in national parks, and Public Works and Government Services Canada manages a portion of the Alaska Highway in Northern BC.[9] **First Nations** communities manage roads on **reserves**.

ROADWAY TYPES AND LOCATIONS IN BC

BC has a highly complex system of roadways, ranging in scale from small roadway systems to large multi-lane highways. The evolution of roadways and modern roadway infrastructure in Canada favours vehicles over other, more vulnerable, road users,[1,14] even though most roadways in BC are frequented by multiple types of road users. MVC injuries and fatalities are influenced by the type or design of roadways, and there are different best practice safety measures for different types of roadways. Types of roadways explored in this section include small roadway systems, highways, and intersections.

Small Roadway Systems

In both urban and rural communities in BC, small roadway systems are designed for local traffic. They are composed of sometimes complex networks of **local roads** (roads giving access to individual land use such as residences[15]), minor roads (roads that connect residential and service areas[15]), and **major roads** (roads that connect activity centres, residential areas, and service areas[15]). These roadways typically have lower speed limits than larger roadways such as highways, but they also have a high density of intersections and private access driveways, which can be problem sites for MVC injuries and fatalities.[16,17,18,19] These systems are the ones most heavily used by multiple road users, especially vulnerable

The BC Healthy Built Environment Alliance

The BC Healthy Built Environment Alliance (the Alliance) was formed in 2008 and is supported by the Provincial Health Services Authority. The Alliance brings together public health and design professionals to aid in learning and development for the emerging field of healthy built environments. It includes municipal governments, the provincial government, health organizations, related professional associations (e.g., planning and landscape architecture), non-government organizations, researchers, and community champions.[6] The Alliance aims to understand the health impacts of the built environment, increase communication and collaboration between involved professional groups, and develop supporting tools and resources.[7]

road users such as pedestrians and cyclists, as well as children and seniors.

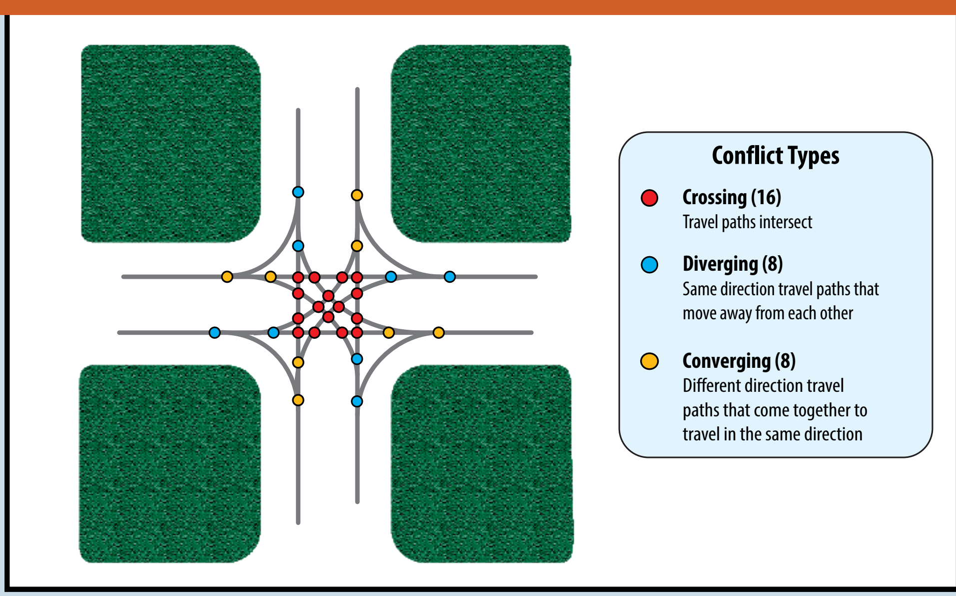
Intersections

An intersection is an area where two or more roads cross each other.[20] Types of intersections range from single stop sign intersections to urban signal-light-controlled intersections, to complex freeway interchanges. Intersections represent one of the most complex traffic situations that road users encounter, because they require all road users to pay attention and respond to the movements of vehicles and other road users, as well as adherence to traffic signals.[21]

MVCs commonly occur at intersections because there are many potential points of conflict between vehicles, in addition to those between vehicles and pedestrians and other road users (see Figure 7.1).[21] In addition, these MVCs are potentially more severe because they often involve a side impact, for which vehicles typically offer less protection than a head-on collision,[22] and because some vehicles may speed up in order to reach or cross the intersection before the traffic light turns red.[21]

According to the Insurance Corporation of British Columbia (ICBC), for 2009-2013, there was an average of 83,000 MVCs at intersections each year, making up 31.9 per cent of MVCs in BC during that time. These intersection MVCs resulted in an average of 53,000 injuries (67.1 per cent of the provincial total) and 74 fatalities (26.2 per cent of the provincial total) per year.[16] Intersections are a particular concern for pedestrians; for 2008-2012, an average of 40 per cent of all pedestrian fatalities occurred at intersections.[17]

Figure 7.1 **Potential Conflict Points at Intersections**



Notes: "Intersection" includes both common roadway intersections and junctions of intersecting highways.
Source: Adapted from City of Chilliwack. Roundabouts – FAQ's.[23]

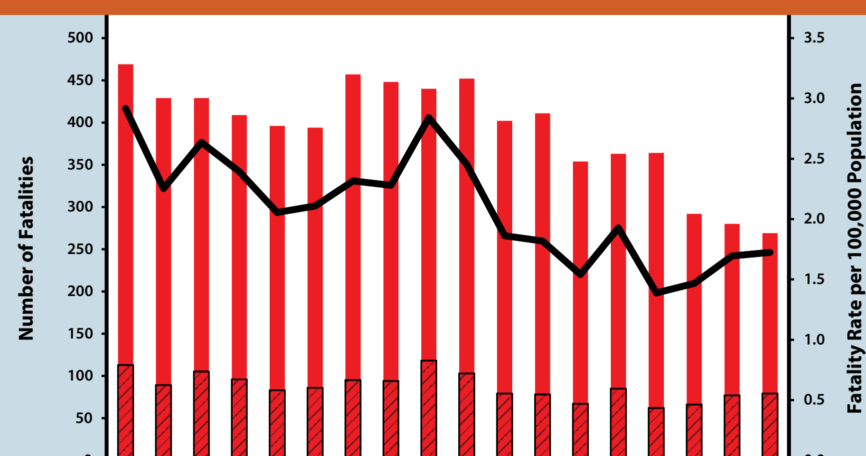
Figure 7.2 shows the number and rate of MVC fatalities at intersections from 1996 to 2013. This figure shows an overall declining trend over these 18 years, with some fluctuations in both rates and counts. Notably, there were increases in MVC fatality rates at intersections from 2000 to 2004, in 2009, and from 2010 to 2013, but considerable decreases in the interim years. The latest increase is particularly concerning since improvements and innovations in intersection infrastructure and vehicle design, and successes in other areas of road safety, have occurred during these years.[1]

Figure 7.3 shows the proportion of MVC fatalities at intersections by road user victim category for 2009-2013. As shown here, 31.4 per cent of MVC fatalities at intersections were pedestrians, and 30.6 per cent were drivers. These two groups were followed by motorcycle occupants (15.4 per cent) and passengers (14.6 per cent). Together, vulnerable road users (pedestrians, cyclists, and motorcyclists) accounted for more than half (53.3 per cent) of all fatalities at intersections.

Figure 7.4 shows the fatality rates for MVCs at intersections involving pedestrians, broken down by age group and sex. As shown, older adults are much more likely than other age groups to be fatal victims of MVCs at intersections as pedestrians. The higher rates for older males and females is likely due to age-related difficulties at intersections, such as longer crossing times due to slower walking speeds,[24] as well as age-related frailty,[25] making impacts more likely to cause death.

Going forward, BC's 10-year transportation plan, *BC on the Move*, released in 2015, pledges $30 million over the next three years to improve intersection safety throughout the province and has identified three priority projects in Kelowna, Terrace, and Vernon.[26]

Figure 7.2 **Motor Vehicle Crash Fatalities at Intersections, Count and Rate per 100,000 Population, BC, 1996 to 2013**

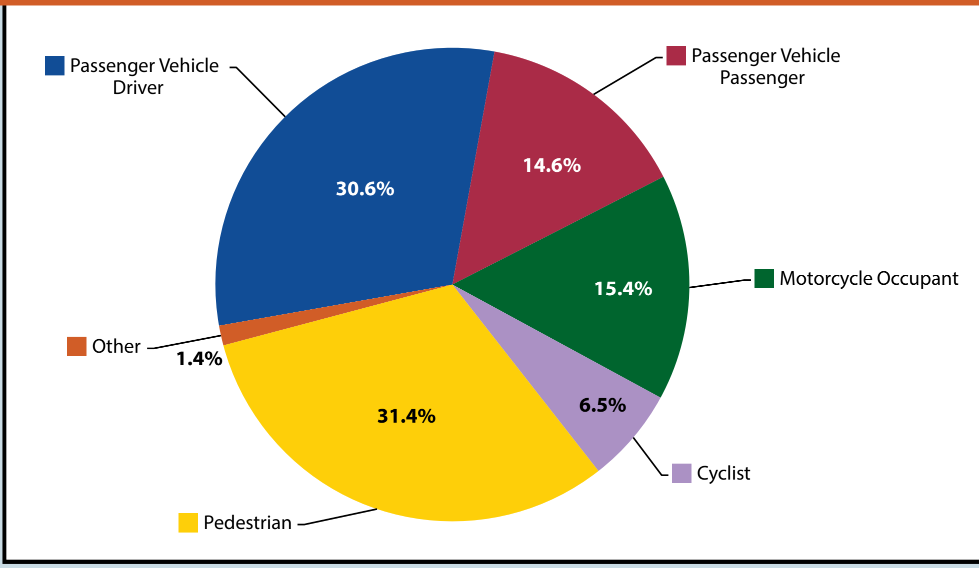


	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Number of MVC Fatalities	469	429	429	409	396	394	457	448	440	452	402	411	354	363	364	292	280	269
Number of MVC Fatalities at Intersections	113	89	105	96	83	86	95	94	118	103	79	78	67	85	62	66	77	79
Intersection Fatality Rate	2.9	2.3	2.6	2.4	2.1	2.1	2.3	2.3	2.8	2.5	1.9	1.8	1.5	1.9	1.4	1.5	1.7	1.7
Intersection Proportion of Fatalities	24.1	20.7	24.5	23.5	21.0	21.8	20.8	21.0	26.8	22.8	19.7	19.0	18.9	23.4	17.0	22.6	27.5	29.4

Year

Notes: "Intersection" includes junctions of intersecting highways. See Appendix B for more information about these data sources.
Sources: Fatality data are from the Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia, 1996-2013; population estimates are from the BC Stats website, April 2015. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

Figure 7.3 **Proportion of Motor Vehicle Crash Fatalities at Intersections, by Road User Type, BC, 2009-2013**



Notes: "Passenger vehicle" includes cars, trucks, sport-utility vehicles, commercial vehicles and heavy trucks, and excludes motorcycles. "Motorcycle occupant" includes motorcycle drivers and passengers. "Intersection" includes junctions of intersecting highways. See Appendix B for more information about this data source.
Source: Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia, 2009-2013. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

Figure 7.4 **Pedestrian Fatality Rate per 100,000 Population for Motor Vehicle Crashes at Intersections, by Sex and Age Group, BC, 2009-2013**

	0-15	16-25	26-35	36-45	46-55	56-65	66-75	76+
Male	0.1	0.5	0.3	0.1	0.2	0.3	0.3	3.6
Female	0.2	0.4	0.2	0.2	0.6	0.7	1.5	1.7
BC	0.1	0.5	0.2	0.2	0.4	0.5	1.0	2.5

Age Group

Notes: "Intersection" includes junctions of intersecting highways. Rates are calculated using age- and sex-specific population numbers. There were fewer than five cases where age group and/or sex was missing, and these cases are excluded from this figure. See Appendix B for more information about these data sources.
Sources: Fatality data are from the Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia, 2009-2013; population estimates are from the BC Stats website, April 2015. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

Highways

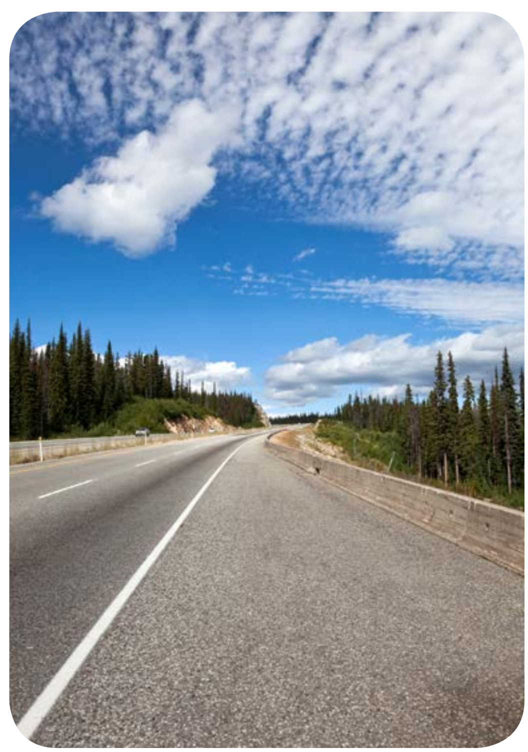
Highways are major roadways that are designed for large volumes of traffic, including commercial transport vehicles, moving intra-provincially, inter-provincially, and/or internationally. Larger highways are often called freeways or expressways because speed limits are typically higher than on local roads.[27] In 2013, over 7,000 km of BC's 71,000 km of public roads were part of the National Highway System (nationally identified inter-provincial and international routes that support trade and travel).[5] In BC for 2008-2012, 32.9 per cent of MVC fatalities, where the posted speed limit was known, occurred on highways with a posted speed of 90 km/hr or above.[17] Since vehicles travel at higher speeds on highways, they are associated with greater forces of impact during an MVC, and therefore a greater potential for serious injury and death. Many highways in BC are in rural and remote areas, especially in northern regions of the province. MVCs in these areas have unique issues related to their remote locations (this will be explored further in the following section) and concerns such as contact with wildlife, which will also be discussed later in this chapter.

Rural and Remote Areas

Rural roads span large and geographically diverse areas, and present a road safety challenge for many road users in BC. They are not as frequently travelled, are not as close to maintenance infrastructure as urban roads,[15] allow vehicles to travel at higher speeds, and are farther from emergency services and hospitals. Resource roads, which are one- or two-lane, gravel roads in remote areas built for commercial access to natural resources (e.g., forests, petroleum, minerals), also pose challenges because of the mixed use and variable road safety enforcement.[28]

A report by Transport Canada found that while more injuries resulting from MVCs occurred in urban areas compared to rural areas, more MVC fatalities occurred in rural areas.[2,29] MVCs are more commonly fatal in rural areas because of relatively high travel speeds, increased interaction between non-commercial and commercial vehicles, longer emergency response times, and further distances to hospitals.[29] The Organisation for Economic Co-operation and Development recommends that rural roads have their own road safety strategy because of their unique risk.[30]

Research that examined MVC-related serious injuries and fatalities in rural and urban areas in BC found that there is a disparity between rural and urban areas, with rural populations having two to three times the risk of death after an MVC and a similar increased risk for hospitalization following an MVC.[31] This disparity was even greater when taking into account socio-economic status (SES). In this research, those with the lowest SES were also living in rural areas, resulting in a complex relationship between geography, SES, and MVC fatalities.[31] Research about rural MVCs in Alberta revealed that rural and urban fatality rates also vary by age, with children being more vulnerable; rates were five times higher for rural children and three times higher for rural youth compared to their urban counterparts.[32]

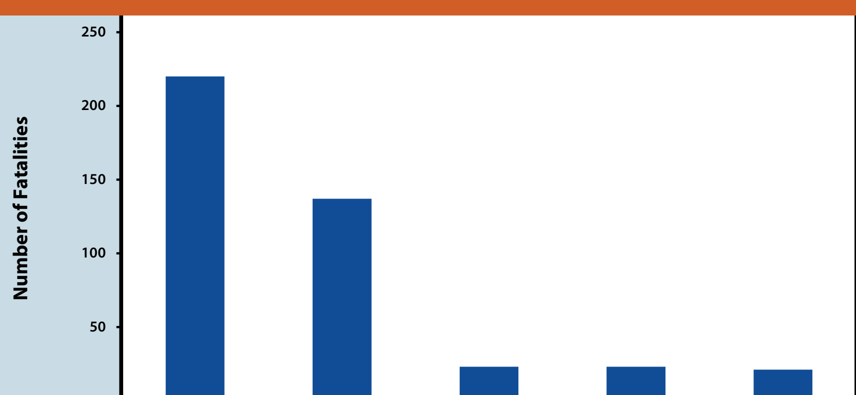


ROADWAY ENVIRONMENTAL CONTRIBUTING FACTORS TO MVCS IN BC

Environmental conditions affect the ability of road users to safely navigate the roadway. Roadway design can also be a contributing factor, such as sharp or blind corners. Changes in conditions can quickly reduce the safety of a roadway, so it is important for roadways to be designed and maintained with the surrounding landscape in mind, including potential weather conditions and the presence of wildlife.

For the five-year period of 2008-2012, police reports noted one or more environmental contributing factors to MVCs in 23.7 per cent of MVC fatalities in BC.[33] Figure 7.5 presents fatal crashes with at least one environmental condition identified in police reports as a contributing factor to the MVC. It shows that road condition (e.g., ice, snow, slush, or water on the road) contributed to 56.3 per cent of these and weather (e.g., fog, sleet, rain, and snow) contributed to 35.0 per cent; these were the top two contributing factors[ae] reported by police among these MVCs.

Figure 7.5 **Top Five Environmental Contributing Factors in Fatal Motor Vehicle Crashes, BC, 2008-2012**



	Road Condition	Weather	Sunlight Glare	Animal	Road/ Intersection Design
Number of MVC Fatalities	220	137	23	23	21
Percentage among Environment-related MVC Fatalities	56.3	35.0	5.9	5.9	5.4

Environmental Factor

Notes: "Road condition" includes ice, snow, slush, and/or water on the road. "Weather" includes fog, sleet, rain, and snow. "Animal" includes both domestic and wild animals. "Road/intersection design" includes locations an attending police officer believes consistently present a problem, such as roadway curves, limited sign distance, inadequate lanes or lane width, sight distance obstruction, or traffic control issues. Data are based on police reports from police-attended motor vehicle crashes (MVCs); therefore, contributing factors reported emphasize human error rather than other systemic factors (e.g., vehicle design, roadway design). Percentages will not add to 100 as less common factors are not shown, and MVCs can have more than one contributing factor assigned. See Appendix B for more information about this data source.
Source: Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia, 2008-2012. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

[ae] In many cases these factors are related, but they are documented as separate contributing factors. For example, during snowfall, "snow" may be a weather condition (due to reduced visibility) and/or a road condition (due to snow on the road); once snow stops falling but has accumulated on the ground it would be a road condition only.

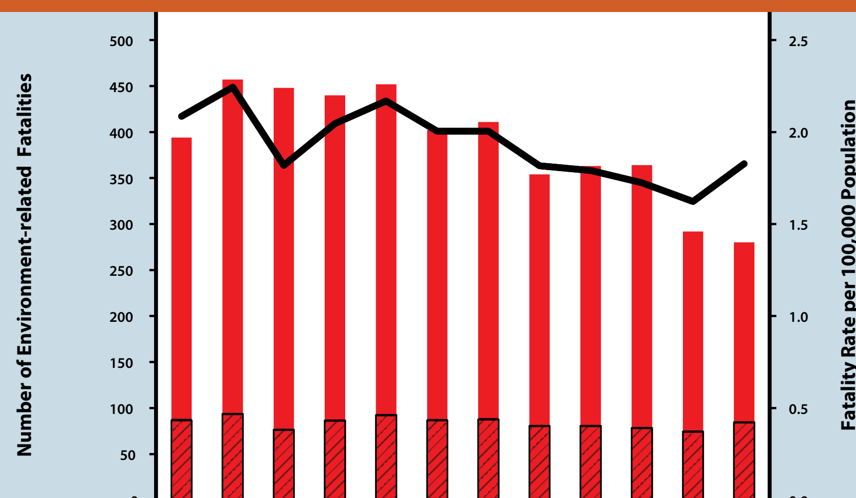
Figure 7.6 depicts the number and rate of MVC fatalities with one or more environmental contributing factors cited in police reports from 2001 to 2012. Overall, the rate of environment-related MVC fatalities decreased slightly over this period; however, the number of environment-related MVC fatalities did not decrease during this time. Therefore, environment-related MVC fatalities have not kept pace with decreases in MVC fatalities overall in BC, and as a result, MVC fatalities with environmental contributing factors are an increasing proportion of total MVC fatalities. The figure shows that the number of environment-related MVC fatalities has fluctuated during this time, which may reflect year-to-year variation in weather conditions (this will be explored further in the next section).

Road and Weather Conditions

A variety of events such as weather, MVCs, or natural disasters such as forest fires can make road conditions less safe or unsafe for driving. Weather affects road safety in multiple ways. Among other things, it influences people's travel decisions, the kind of transportation they will use, the visibility of roadways, the types and scale of potential road hazards, and the quality of the contact the vehicle has with the road.

In BC, rain and snow are common, annual occurrences that have important impacts on road safety. Rain may cause hydroplaning and can reduce driver visibility because of the rain falling on the windshield, rainwater being sprayed from or splashed by trucks and other vehicles, and the related humidity

Figure 7.6 **Number of Environment-related Motor Vehicle Crash Fatalities, BC, 2001 to 2012**



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Number of MVC Fatalities	394	457	448	440	452	402	411	354	363	364	292	280
Number of Environment-related MVC Fatalities	85	92	75	85	91	85	86	79	79	77	73	83
Environment-related Fatality Rate	2.1	2.2	1.8	2.0	2.2	2.0	2.0	1.8	1.8	1.7	1.6	1.8
Environment-related Proportion of Fatalities	21.6	20.1	16.7	19.3	20.1	21.1	20.9	22.3	21.8	21.2	25.0	29.6

Year

Notes: "Environment-related" fatalities are deaths where one or more vehicles involved in the crash had any of the contributing factors: obstruction/debris on the road, roadway surface defects, artificial glare, previous traffic accident, roadside hazard, site line obstruction, road/intersection design, sunlight glare, animal, weather, road condition, visibility impaired, road maintenance/construction, sign obstruction, domestic and wild animal, insufficient traffic controls, and defective/inoperable traffic control device. Data are based on police reports from police-attended motor vehicle crashes, so contributing factors reported emphasize human error rather than other systemic factors (e.g., vehicle design, roadway design). See Appendix B for more information about this data source.
Source: Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia, 2001-2012. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

that fogs windows. Water on the road can also freeze, resulting in "black ice" that can cause tires to lose traction entirely but is very difficult for drivers to detect. In general, drivers behave more cautiously when it rains, but MVC rates still increase, which indicates that changes in driver behaviour in response to the rain are not sufficient to maintain the same level of road safety in wet weather as in dry conditions.[34]

Research in the US examining the effect of snow on MVCs in the US between 1975 and 2000 found that while MVCs causing property damage and/or injuries increased when it snowed, the number of fatal MVCs actually decreased.[35] This is likely because there are fewer drivers on the road, and because drivers may lower their speed compared to dry conditions but not enough to completely prevent a crash. At the same time, research indicates that the first snow of the season results in an increase in MVC fatalities, while subsequent snows do not have the same impact.[35] In addition to rain and snow, low sun positioning, wind, and fog may also impact road conditions and reduce visibility, increasing the potential for MVCs.[36]

Wildlife

Highways in BC cut though many wildlife habitats. In BC, wildlife are involved in one out of every 25 MVCs,[16] and there is an average of 9,900 MVCs involving animals, both wild and domestic, each year.[16] According to the Wildlife Accident Reporting System (WARS), a system administered by MoTI that tracks MVCs involving wildlife on numbered highways, more than 109,000 wildlife MVCs have been reported on BC highways since 1978, over 90 per cent of which involved elk, moose, bears, and deer. Some wildlife, such as deer, prefer to travel along open areas close to cover—qualities of many BC highways.[37] In addition, some animals might be attracted to highways to access "salt licks," mineral deposits that accumulate on roadsides, through natural occurrence or through the use of de-icing compounds.[38] While there are some measures in place to prevent vehicle-wildlife interactions, BC roadways would benefit from further preventive initiatives related to roadway design. (See discussion in next section for further details.)

ROAD SAFETY MEASURES FOR ROADWAYS IN BC

There are currently a number of road safety initiatives in BC that focus on roadway design and infrastructure improvements, each targeting the challenges associated with specific types of roads.[af] Infrastructure has a crucial role in public health, not only in ensuring the safe interaction of roadway users, but also in promoting safe, active transportation options. This includes non-motorized transportation, such as walking and cycling, as well as mass transit, such as buses and trains. Some cities—sometimes called "smart growth" cities—are being designed or improved with these modes

"Planners and engineers in many cities talk increasingly about the road diet, which involves improving the safety of pedestrians and cyclists by eliminating lanes of traffic and providing more space for people... The road diet, and the many road design features that can accompany it, communicates that travel space is for all types of road users."

– N. Arason, *No Accident: Eliminating Injury and Death on Canadian Roads*[1(p.123)]

New York City is *"Making Safer Streets"*

The New York City Department of Transportation has been *Making Safer Streets*, the title of their 2013 publication, by implementing innovative road design solutions to make roadways safer for all road users, focusing on vulnerable road users. The underlying design principle for their successful initiatives is creating clarity of traffic flow for all road users and reducing the potential of unexpected movements of road users.

They report that their most successful initiatives do the following:

- "Make the street easy to use" by accommodating road users' desired travel paths and simplifying their movements.
- "Create safety in numbers" to increase the visibility of vulnerable road users.
- "Make the invisible, visible" by assuring different types of road users can see each other.
- "Choose quality over quantity" by prioritizing and designating road space according to use.

Overall, the work to adapt the city's existing road infrastructure has reduced traffic fatalities in the city by 29.5 per cent and combined fatalities and serious injuries by 28.7 per cent between 2001 and 2012.[42]

"By addressing issues of complexity, confusion, lack of visibility of vulnerable street users, and excessive vehicular speeds which are most likely to cause death or severe injury, the projects highlighted in this [report] reduce the risk of crashes."

– New York City Department of Transportation, *Making Safer Streets*[42]

[af] For more information about specific road infrastructure initiatives underway, see http://www2.gov.bc.ca/assets/gov/driving-and-transportation/driving/publications/road-safety-strategy.pdf.

of transport in mind, resulting in people tending to drive less, own fewer vehicles, and walk more.[39,40,41] Alternative modes of transport offer health benefits to individuals as well as the larger population: fewer vehicles on the road means reduced MVCs, traffic noise, and air pollution; and active transportation offers health benefits from increased physical activity.

This section explores road safety initiatives for mixed use roadways, intersections, and highways, as well as initiatives to address road and weather conditions, wildlife, and resource roads. Some road safety initiatives are presented that focus on cyclists or pedestrians, but many are applicable to both of these vulnerable road user groups.

Road Safety Initiatives for Mixed Use Roadways

Public Transportation

The World Health Organization highlights the importance of giving priority to high-occupancy public transit, such as city buses, light rail, or trains, in order to reduce overall vehicle distance travelled per capita and thus reduce MVC risk.[43] These public transit options are also safer compared to personal transportation (see Chapter 3 for further discussion). In BC's Lower Mainland, the Sky Train (light rail) system operates 2.6 million trips per year with more than 11,000 riders daily, and is being expanded to serve more outlying areas.[44] Another public transportation option is the high-occupancy bus system. These have been implemented in cities in North America, Australia, Europe, and South America. A study of 26 cities with varying bus rapid transit systems identified key lessons for successful systems (indicated in part by ridership and travel time savings), including priority right-of-way for buses; service to high traffic areas; accommodation of multiple modes of active transportation; rapid service, and more.[45] Another review demonstrated that well-designed and communicated systems with busways (lanes reserved for buses) lead to reductions in MVC fatalities and injuries, depending on the system's design and implementation.[46]

Traffic Calming

According to Transport Canada, traffic calming is the modification of a roadway and its design in a way that is intended to reduce traffic and/or decrease speed. Safety can also be increased by implementing changes that aim to minimize the negative impacts of vehicle use, reduce traffic volume, change drivers' behaviours, lower speeds, and reduce conflict between road users with improved conditions for pedestrians and cyclists.[48] Traffic calming can be focused on fixing isolated parts of a roadway (e.g., an intersection with a high volume of complaints or high incidence of MVCs), or implemented across a broader area. Examples of traffic calming include the creation of one-way, one-lane streets; the addition of roundabouts designed to protect pedestrians and cyclists; and the addition of speed humps, rumble strips, low speed limits, and more.[49,50]

"Ensuring implementation of a number of safety measures when road infrastructure projects are designed—and facilitating their implementation during construction with earmarked funding—can produce important safety gains for all road users. This is particularly true when road design, construction and maintenance are underpinned by a Safe System approach, i.e., where allowances are made that can help compensate for human error, and roads and roadsides are built in such a way that their physical characteristics minimize potential harmful consequences to all."

– World Health Organization, *Global Status Report on Road Safety 2013: Supporting a Decade of Action*[ag,47]

[ag] The World Health Organization has sourced this information from a 2008 Organisation for Economic Co-operation and Development document entitled *Towards Zero: Ambitious Road Safety Targets and the Safe System Approach.*

There are several specific types of traffic-calmed roads. For example, **environmental streets** use a variety of built elements, usually aesthetically rendered, to calm and slow traffic, and encourage driver attention (such as planter boxes, pedestrian refuges on road crossings, and raised pedestrian crosswalks). **Urban play streets** are residential streets designed for play rather than vehicles and only residential vehicles are permitted to drive (at very low speeds) on them.[50] Two analyses of studies in a variety of European countries show these two traffic-calming techniques reduced injury MVCs by 35 per cent (studies in Denmark, Norway, Germany, Sweden, France, and Great Britain) and 25 per cent (studies in Norway, Germany, The Netherlands, and Denmark), respectively.[50] Another traffic-calming approach most commonly used in commercial centres is the inclusion of **pedestrian streets**, which are roads for pedestrian use (and often bicycles) that are closed to motor vehicle traffic.[50] A collection of European studies (Sweden, Norway, Finland, Denmark, and Great Britain) together have shown an estimated 60 per cent reduction in MVCs resulting from the introduction of pedestrian streets.[50]

Most traffic calming is on minor streets in residential areas.[48] Traffic-calmed areas in North America can be more accommodating of the other activities that take place on the road including playing, walking, and socializing. Traffic calming also helps to address public health issues associated with traffic noise, and low rates of walking, cycling, and transit use.[48] Encouraging active transportation (e.g., walking or cycling to work or school) and making it a safe, viable option works both to improve health and to reduce the number of vehicles on the road, which then has further road safety and environmental benefits.

Cycling Infrastructure

Infrastructure that is designed with cycling in mind offers considerable safety benefits to this group of vulnerable road users; indeed, countries with more extensive infrastructure for bicycles have lower cyclist fatality rates than those with less cyclist-related infrastructure.[51]

Because concerns about safety deter many people from cycling,[52,53,54] the introduction of safer infrastructure can make a population feel more comfortable making at least some of their travel by bicycle. This is important because cycling has many benefits if those trips would otherwise be made by motor vehicle: increased physical activity for the individual; reduced traffic congestion, noise, air pollution, and greenhouse gas emissions; and fewer vehicles on the road at risk of being involved in an MVC.[55,56,57] Some examples of cycling infrastructure that have been associated with reduced injury risk were discussed in Chapter 4 (e.g., protected cycling paths,[58,59,60] painted cycling lanes,[61,62] and bike routes that do not require bicyclists to ride between parked and moving motor vehicles[58,63,64]).

Changes in infrastructure to increase the safety and comfort of cyclists have been implemented around the world. For example, the comprehensive networks of cycling routes in Germany and the Netherlands have helped to protect riders from exposure to vehicles.[65] A series of European studies shows that protected cycling paths and painted cycling lanes may decrease all injury MVCs and cycle-involved injury MVCs. They also showed that intersections continue to stand out as a risky section of road.[50] Protected cycling paths are considered safer than cycling lanes, more inclusive of all cyclists despite their skill level, and better at attracting cyclists.[66] New York City has focused on improvements to their cycling infrastructure, building over 470 miles of cycling lanes with parking-protected paths, improvements to increase visibility in mixed use road spaces, and bicycle signals. Between 2000 and 2012, the city measured a 72.4 per cent overall decrease in the risk of serious injury for cyclists and a 288 per cent increase in cycling trips for the same period.[42] Oregon has a law that requires one per cent

of their highway fund to be spent on bicycle and pedestrian infrastructure,[67] and the state government has developed a long-term plan and has inventoried roads to measure progress towards all roads accommodating cyclists and pedestrians.[68]

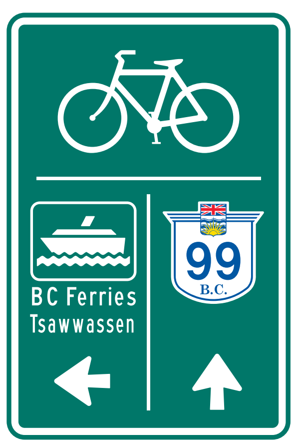
In BC, some work underway by MoTI has potential benefits for cyclists, such as the identification of provincial highway cycling routes through the use of signs and pavement markings (for example, see Figure 7.7), and a cycling policy that requires new and upgraded provincial highways to be adapted for cyclists.[69] Some work includes initiatives with partners such as municipal governments to construct new cycling infrastructure through the BikeBC program,[70] including separated bike lanes introduced by the City of Vancouver in the downtown area in 2010.[71]

Road Safety Initiatives for Intersections

Roundabouts

Roundabouts are circular intersections that do not have electronic signals or stop signs,[72] and they are becoming more popular in North America.[72] BC has had a policy in place since 2007 that requires roundabouts to be the first option for new intersections,[73] and municipalities across the province are contributing to the growing number of roundabouts in BC. In a roundabout, traffic moves counter-clockwise around an island in the centre,[72] and entering vehicles must yield to those already in the roundabout.[74] Roundabouts force drivers to reduce their speed when they move through the intersection, improving road safety for all users.[72] They also improve safety by enhancing driver alertness; since traffic lights do not provide timing instructions, drivers must actively make choices about proceeding into the roundabout.[1] Further, they improve traffic flow, reduce idling, and lower the number of side-impact collisions.[75] In addition, roundabouts reduce the severity of MVCs and related injuries when they occur because they almost completely

Figure 7.7 **Example of Provincial Highway Cycling Routes Signage**



Note: Reproduced with permission.
Source: BC Ministry of Transportation and Infrastructure, CC BY-NC-ND 2.0 (see: https://creativecommons.org/licenses/by-nc-nd/2.0/).

eliminate head-on collisions.[74] Based on a pre/post evaluation of the installation of 24 roundabouts in eight states in both urban and rural settings with both single lane and multilane models and replacing both stop sign and signaled intersections, the Insurance Institute for Highway Safety in the US estimated that the roundabouts reduced MVCs by 39 per cent overall, injury MVCs by 76 per cent, and fatal MVCs by 90 per cent.[76] Another study that observed the number of MVCs before and after installation of roundabouts on high-speed rural roads found that the average injury MVC rate was reduced by 89 per cent, and fatal MVCs were reduced by 100 per cent (for the duration of post-installation data collection, which averaged 5.5 years).[77] However, research from Belgium suggests that roundabouts may result in more injury crashes and more severe crashes for cyclists compared to signaled intersections.[78] Similarly, emerging research from Denmark suggests that roundabouts may not benefit cyclists and may even increase injury but that some variations may be safer; for example, roundabouts that are larger (20-40 m centre island diameter), have a high central island (2 m or more), or have a separate cycle path where cyclists yield to cars.[79]

Red Light Cameras

If a traffic light is red when a driver enters the intersection, he or she has "run" the red light. Driving through red lights is dangerous because it often leads to side-impact collisions, which are frequently more severe than other types of MVCs at intersections,[80] and because it can often lead to pedestrians and cyclists being hit. **Red light cameras** are one option that helps to improve road safety by deterring drivers from driving through red lights. Red light cameras photograph vehicles that travel through an intersection when the light is red and issue a ticket to the registered vehicle owner or driver.

A red light camera program, called the Intersection Safety Camera Program, was introduced in BC in 1999. It began with 30 operational cameras rotating through 120 sites throughout BC, and was expanded in 2011 to 140 sites all with digital cameras in place at all times. Tickets from this program are issued to the registered vehicle owner. Revenue from the program is distributed to all municipalities in BC, regardless of whether they have cameras installed.[81] This program reduced the number of red light runs at those intersections by 38 per cent after six months.[82]

International reviews of the effectiveness of red light cameras in reducing MVCs and related injuries and fatalities have varied. A Cochrane review of the topic found that while red light cameras are effective in reducing the number of MVCs resulting in fatalities or any level of injury, evidence is less conclusive as to whether the total number of MVCs is reduced or if specific types of collisions are reduced.[83] A study of 99 US cities looked at the per-capita rate of red light running and MVC fatalities and found that cities with red light cameras had an overall 24 per cent lower rate of red light running and a 17 per cent lower rate of MVC fatalities.[84]

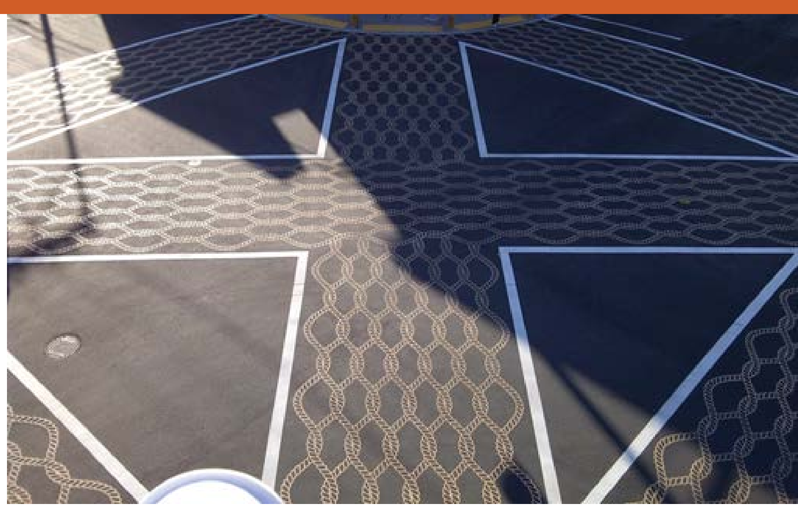
Research also suggests that other types of preventive measures could be used to reduce red light running and to encourage drivers to follow the rules of the road, rather than penalizing behaviour after it happens. Preventive measures include increasing signal visibility, addressing intentional violations, and eliminating the need to stop (where appropriate). Examples of specific measures are signal warning signs, choosing appropriate signal cycle lengths including all-red clearance intervals, and using roundabouts instead of signaled intersections.[85]

Intersection Design for Pedestrians

Many measures can be introduced to enhance the safety of existing intersections. Additionally, the safety of new intersections would be improved by prioritizing vulnerable road users in their design. A number of measures have been shown to be effective at reducing the number of vehicles striking pedestrians at intersections and other pedestrian crossings. Some include modifying the physical attributes of the crossing to protect pedestrians, such as installing sidewalks, adding refuge islands, raised medians, and pedestrian overpasses. Some are aimed at speed reduction (as discussed in Chapter 6), such as rumble strips in front of intersections, speed humps, and raised pedestrian crossings.[50] Other measures control road user behaviours in intersections and are also effective at reducing MVCs, such as prohibiting vehicle right turns on a red light and improving lighting.[86]

Another effective measure is the **pedestrian scramble** or scramble intersection, which has a period of exclusive pedestrian crossing at signaled intersections during which pedestrians can cross in any direction, including diagonally. They are most effective in busy pedestrian crossings and at intersections that have many conflicts involving turning vehicles. Scramble crossings have been shown to be effective at reducing pedestrian and vehicle conflicts at intersections and generally receive positive support.[86] In a review of international studies, protected crossing signal phases that prohibit other traffic movements during pedestrian crossing phases have been shown to reduce pedestrian injury MVCs by 30 per cent.[50] A pedestrian scramble was implemented at an intersection in Richmond, BC, in 2011 (see Figure 7.8).[h,87] Another measure to improve pedestrian safety at intersections includes **leading pedestrian intervals**, which are signals that allow pedestrians to begin crossing the street three to seven seconds before vehicles, increasing their visibility for drivers and reducing pedestrian MVCs.[88,89] Another example is signal-controlled pedestrian crossings, which are activated by pedestrians. A review including European and Australian studies found that both full signals and flashing light crosswalks reduced pedestrian-involved injury MVCs by 20 to 49 per cent compared to not having crosswalks.[50]

Figure 7.8 **Example of a Pedestrian Scramble**



Notes: Photo credit – The City of Richmond, BC. Reproduced with permission.
Source: The City of Richmond, BC.

[ah] The City of Richmond received mostly positive feedback about the scramble in the first year. Notably, in the first year after installation, the city adjusted the signalling at the intersection to resolve concerns over the safety of visually impaired pedestrians using the crosswalk, and concerns over traffic delays due to the initial no-right-turn-on-red signalling.

Other basic measures, such as installing four-way stop signs, have been shown to reduce MVCs by 45 per cent in a review of international research.[50] A review of studies from eight North American, European, and Middle Eastern countries found that modifying intersection signals to adapt their signal length to traffic volume instead of a pre-set time interval led to reduced MVCs by 15 to 33 per cent, depending on the type of intersection.[50] Further, a review of international studies determined that allowing right turns on a red light increased injury MVCs in right-turn accidents by around 60 per cent.[50]

Road Safety Initiatives for Highways

While some road safety initiatives can apply both to highways and other roads, highways have unique characteristics that result in different MVC trends and a need for relevant MVC countermeasures; therefore, building safe highways and assessing their safety requires specific tools and initiatives. MoTI oversees highway planning and considers highway safety performance throughout the process.[90] In March 2015, MoTI launched a 10-year transportation plan titled *BC on the Move*. The plan includes commitments to repair and improve the condition of highways, bridges and side roads, and to improve highway safety through a variety of initiatives, such as funding the Road Safety Improvement Program, improving intersection safety, and improving roadside worker safety.[26]

Barriers

Roadway barriers have the potential to reduce the number of single-car and head-on MVCs. Barriers can be installed either on the centre of the road (median barriers), or on the side of the road (guardrails). Median barriers are intended to separate lanes of traffic travelling in different directions and are designed to reduce head-on collisions.[92] Barriers come in three general categories: rigid, semi-rigid, and flexible. The type used depends on the types of vehicles that use the road, the potential severity of the MVCs, and the roadway geometry.[92] Rigid barriers are often made of concrete, are effective, and are easy to maintain. However, they are costly to install and have the potential to cause more severe injuries on impact due to their rigidity.[92] More flexible barriers (e.g., steel or wire) are also available, and some areas of BC have cable barriers. They reduce the number of injuries related to MVCs,[50] absorb more

Case Study: Road Health

RoadHealth is a road safety campaign in Northern Health that was developed in 2005 and is designed to raise awareness that motor vehicle crashes (MVCs) are a public health issue. It was propelled by the 2000 commitment to Canada's *Vision 2010*, which had a goal of reducing MVCs by 30 per cent by 2010.[29] It includes a coalition of partners: WorkSafe BC, Insurance Corporation of British Columbia, Royal Canadian Mounted Police, Northern Health, BC Coroners Service, Ministry of Transportation and Infrastructure, BC Forest Safety Council, the Ministry of Forests, Lands and Natural Resource Operations, and Commercial Vehicle Safety.[91]

RoadHealth was developed because the MVC-related serious injury and fatality rates in Northern Health are more than twice the provincial average. These higher rates result in a huge cost to the health care and insurance systems and have negative consequences for individuals, families, and communities.[91] RoadHealth includes $120,000 in community road safety grants, road safety campaigns, the report *Crossroads: Report on Motor Vehicle Crashes in Northern BC*, and a strategic plan for improved road safety in northern BC.[91]

energy than rigid barriers, and reduce impact force.[92] In BC, concrete median barriers are most common, and there are approximately 2,100 km of barriers currently installed.[93] Research shows that median barriers on divided highways reduce fatalities from MVCs by about 40 per cent and injuries by 30 per cent.[50]

Guardrails impact the number of injuries and fatalities in MVCs that involve driving off the road. Installation of some types of guardrails reduces damage to vehicles and injury severity, especially when they are installed in places where the vehicle would otherwise hit a tree or rock face, or drive off a steep slope. However, researchers suggest a smaller reduction in injury severity when the guardrails are installed to prevent a vehicle from hitting a signpost or ditch.[50]

Rumble Strips

Rumble strips are used to prevent **roadway departure**, commonly referred to as driving off the road.[93,94] Rumble strips are a series of ridges and grooves in the pavement usually located at the centreline or outside edge of a lane or series of lanes, which cause distinct noise and vibrations that warn a driver when their car leaves the designated boundaries of their lane.[94] They help to direct the driver's attention to safely recovering the drifting car before leaving the roadway or moving into oncoming traffic.[94] They can also provide drivers with cues as to the location of road lines when visibility is reduced by rain, fog, or snow.[94] Rumble strips installed on the centreline help to prevent head-on MVCs, and side-swipes caused when drivers cross over the centrelines in their vehicle.[94] BC uses grooved rumble strips on the shoulders and centrelines of many highways (see Figure 7.9).[95] MoTI began using shoulder rumble strips in 1996 and has installed over 5,000 km of them in BC. MoTI also installs centreline rumble strips on rural two-lane, three-lane, or four-lane highways in no-passing zones.[95]

Rumble strips are low cost, require little maintenance, and do not damage or significantly alter the structure of the roadway surface. ICBC estimates that centreline rumble strips could reduce the number of MVCs by 29.3 per cent when

Figure 7.9 Selection of Rumble Strips

Notes: These photos are cropped to feature the rumble strips. Reproduced with permission.
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installed on undivided rural highways.[96] A 2009 study of the impact of rumble strips on MVCs in BC showed that shoulder and centerline rumble strips significantly reduced serious MVCs; MVCs resulting in injuries were reduced by 18.0 per cent, and on undivided rural highways with both centerline and shoulder rumble strips, MVCs were reduced by 21.4 per cent (for off-road right, off-road left, and head-on collisions).[96]

For cyclists, rumble strips can have safety benefits (e.g., deterring vehicles from driving into cyclists from behind; however, where cyclist infrastructure is not separated, rumble strips can be dangerous and an annoyance).[97,98] Gaps in rumble strips appear on BC highways to allow cyclists to avoid obstacles on the shoulder, and rumble strips are often not installed at intersections and driveways to allow cyclists to turn safely.[99]

Road Safety Initiatives Related to Road and Weather Conditions

Salting, sanding, and snow clearance can improve road safety.[50] Winter tires are specifically designed for cold weather and slippery conditions and work to improve traction.[100] The BC *Motor Vehicle Act* provides definitions and explanations pertaining to the use of winter tires. In 2014, MoTI updated winter tire requirements and expanded their winter driving awareness campaign[101] (see Chapter 8 for further discussion of winter tires). Regulatory and warning signs are also posted on roads that inform drivers when it is required to drive a vehicle with winter tires or chains on indicated roadways (see Figure 7.10).[102]

MoTI has an environmental sensing network with 167 stations throughout the province in areas where winter weather has the most potential to create problems for road safety. These stations collect weather, avalanche, and frost data to help forecast avalanches and assist in decision-making regarding highway maintenance.[103] MoTI also hosts a website, DriveBC, which contains up-to-date weather information and live web-camera feeds from these stations. It also provides weather information from Environment Canada about local conditions and forecasts,[103] and provides weather-related driving tips.[104]

Figure 7.10 Regulatory Signs for Winter Tires

Note: Reproduced with permission.
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Road Safety Initiatives Related to Wildlife

A number of different methods are used in BC to mitigate vehicle crashes with wildlife, including fencing, wildlife warning signage and wildlife passage structures.[106]

BC has more than 450 km of wildlife fencing, which is among the most of any North American transportation agency.[107] Wildlife fencing installed on both sides of the highway has been shown to be 97 to 99 per cent effective in reducing MVCs involving wildlife in BC.[107] International research is varied regarding the effectiveness of wildlife fences in reducing MVCs. Wildlife fences can disrupt animal migration patterns and access to food and often move animal crossings to the end of the fenced roadway. Installing tunnels that pass under the highway along with game fencing is one way to allow animal migration, while better protecting animals and reducing MVCs.[50]

Since 1987, MoTI has constructed over 30 wildlife passage structures to provide safe passage for wildlife across highways. Wildlife passages can be incorporated into other structures such as stream crossings. To date the majority of these structures are underpasses. Studies have shown that these corridors are well-used by wildlife.[37]

Wildlife warning signs are used to alert drivers to animals in the area, such as deer, moose, bison, wild horses, and badgers. Signs are the most commonly used safety method in this instance because they are easy to install and maintain and are an inexpensive option.[107]

MoTI also uses a seed mix to reseed roadsides after construction that includes plants that are less attractive to wildlife.[37] Research from Sweden shows that clearing brush and other plants from the side of the road reduced wildlife MVCs by 20 per cent.[50]

The Wildlife Collision Prevention Program

The Wildlife Collision Prevention Program (WCPP) was formed in 2001 in response to the increasing number of motor vehicle crashes (MVCs) involving wildlife in BC. The WCPP was formed as a partnership between the Insurance Corporation of BC and the BC Conservation Foundation. It promotes awareness of wildlife MVCs, driver education, and research and implementation of collision mitigation techniques.[105]

Road Safety Initiatives for Resource Roads

Resource roads are currently governed by multiple acts, making it difficult for road users to easily be aware of and understand the rules governing these roads, as well as creating difficulties for managing these roads. MFLNRO is working to bring resource roads under one new piece of legislation, the *Natural Resource Road Act*.[108]

This project aims to eliminate inconsistencies in how resource roads are managed, with rules similar to those on public roads, and to recognize and reflect that people use the same roads for different activities. (Chapter 9 will discuss the use of resource roads to access some First Nations communities.) Under the new act, the province and WorkSafe BC will support driver education on the use of resource roads, monitor driver behaviour, and carry out enforcement (when necessary).[28]

SUMMARY

Safe roadways are a critical component of road safety and form one of the four pillars of a Safe System Approach (SSA). Evidence shows that roadway design is one of the most effective ways to prevent motor vehicle crash (MVC) fatalities and serious injuries. Roadway planning, design, and maintenance are shared municipal, provincial and federal responsibilities, and have wide-reaching effects on human and environmental health. In BC, intersections are especially dangerous for vulnerable road users, such as pedestrians and cyclists, while highways are especially hazardous in rural and remote areas, where speeds are higher and the emergency response times are longer. Other major roadway concerns are weather such as rain and snow, and—especially in rural areas—wildlife interactions on highways. Important interventions that address both intersection and highway design to support safer driving practices include roundabouts, red light cameras, highway barriers, rumble strips, cycling infrastructure, and wildlife fencing and corridors.

The next chapter will investigate the role of safe vehicles in promoting road safety in BC.

Chapter 8

Safe Vehicles

INTRODUCTION

Safe vehicles form another of the four pillars of the Safe System Approach (SSA) to road safety. A safe vehicle is designed to prevent motor vehicle crashes (MVCs) and reduce the severity of an MVC if one does occur.[1] Three key components of vehicle safety are vehicle design standards, vehicle technologies, and vehicle maintenance. These components reflect the SSA principle that road safety is a shared responsibility among manufacturers, regulators, and road users, among others.[2] Consumer demand and industry regulation have led to vehicle safety improvements over the past century.[3] Safety improvements have generally included enhancements to vehicle design and materials, the introduction of technologies that help drivers avoid MVCs, and in the event of an MVC, greater protection to vehicle occupants from serious injuries and fatalities through better safety features.

This chapter provides an overview of the role that vehicles play in MVCs in BC, a discussion of vehicle safety standards in Canada and BC, a review of developments in vehicle safety technologies and design, and then briefly explores vehicle maintenance and modifications.

MOTOR VEHICLE SAFETY STANDARDS IN CANADA AND BC

In Canada, the federal government regulates the safety of new and imported motor vehicles, while provinces and territories regulate and enforce vehicle licensing, operation, after-market modifications, and maintenance within their jurisdictions.[4]

In BC, the *Motor Vehicle Act* and related regulations set out safety and equipment requirements for personal and commercial vehicles, including “vehicles of unusual size, weight or operating characteristics.”[5,6] Among other things, these requirements include specifications related to headlights, brakes, emissions, seat belts, child restraint systems, and vehicle maintenance and inspection.[5,6]

Vehicle safety in Canada (including child passenger safety and commercial vehicle safety) falls primarily under the jurisdiction of Transport Canada’s Road Safety and Motor Vehicle Regulation Directorate (the Directorate).[7] The Directorate is governed by the *Motor Vehicle Safety Act*—legislation that regulates both manufacturing and importation of vehicles and vehicle

> An estimated 16,000 to 17,000 vehicles are being imported into Canada every year that may not meet current safety standards, because they are 15 years of age or older, and so the Canada Motor Vehicle Safety Standards do not apply.

equipment.[8] The Directorate is also governed by the *Motor Vehicle Transport Act*, which regulates safety and operating standards for extra-provincial motor carrier activities.[7,9] Transport Canada's other vehicle safety responsibilities include vehicle manufacturing, vehicle safety features and technologies, vehicle importation, and vehicle recalls.[10] Transport Canada also regulates the manufacturing and importation of child car seats, and promotes public awareness and education about their use.[11]

The Canada Motor Vehicle Safety Standards (CMVSS) are set out in the Motor Vehicle Safety Regulations. These standards include more than 60 performance-based safety standards that address vehicle crash avoidance, **crashworthiness**, and occupant protection.[12,13] These include elements such as seat belts,[14] side and front impact protection, and child seat safety requirements.[13]

However, the CMVSS only apply to vehicles up to 14 years of age; those 15 years of age or older can be imported into Canada without meeting motor vehicle safety standards. This is resulting in an estimated 16,000 to 17,000 vehicles per year being imported into Canada that may not meet current safety standards,[13] including standards regarding seat belts, child seat anchor points, fuel system integrity, and rollover protection. These older vehicles also often have outdated technologies; for example, first-generation air bags (those installed before 1996) have been found to cause injury and death because they were not designed for a wide range of driver heights and weights, and were designed specifically for head-on MVCs.[15] Researchers have outlined a number of concerns regarding older vehicles, including the greater likelihood of technical defects when compared to newer vehicles.[2] This is less of a problem in the United States, where the US Federal Motor Vehicle Safety Standards apply to vehicles up to 25 years of age and newer.[16] According to their website, Transport Canada is monitoring the risk and may consider regulatory change.[13]

Some imported vehicles are a concern for road safety (even if they are relatively new models) because they are not designed for local roadways, such as right-hand drive vehicles. Right-hand drive vehicles were not designed to be compatible with the Canadian road system (e.g., headlight angles, line of sight issues when passing other vehicles or making left turns) and have been associated with a 39 to 60 per cent increased risk of MVC compared to left-hand drive vehicles in BC.[17] An estimated 200 right-hand drive vehicles are imported into BC each month.[13] While importation standards are set by the Canadian federal government, territories and provinces can impose restrictions on vehicles allowed on their public roads through their registration and insurance requirements.[18]

THE ROLE OF VEHICLES IN MVCS IN BC

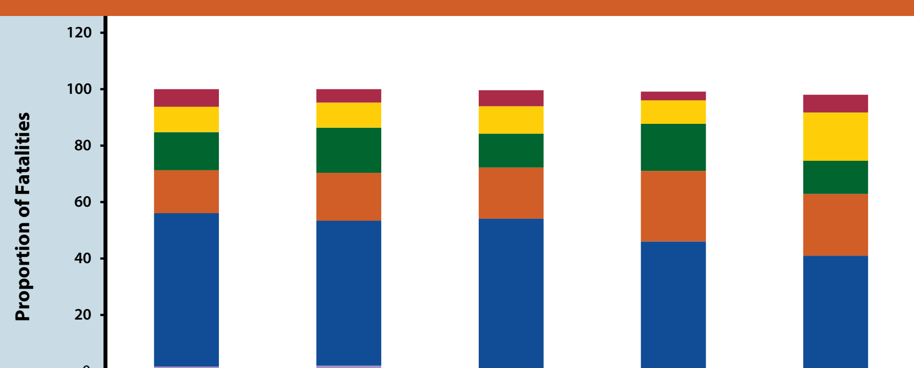
Vehicle design can reduce the risk of injuries and fatalities for all road users, including vulnerable road users.[19] The vital role of vehicle safety is emphasized by its inclusion in both the *British Columbia Road Safety Strategy: 2015 and Beyond*[20] and Canada's Road Safety Strategy 2015.[21]

Vehicle Types

Road users in North America use a wide variety of vehicles. These vehicles vary by type (e.g., size, weight, design), safety features (e.g., inclusion of **crash avoidance technologies** and crash protection technologies), age, and condition. According to the 2009 annual Canadian Vehicle Survey, there were about 2.7 million registered vehicles in BC.[ai,22] The vast majority of these (94.5 per cent) were light vehicles, weighing less than 4,500 kg, which include cars, station wagons, vans, sport-utility vehicles (SUVs), and pickup trucks.[22,23] The remaining 5.5 per cent consisted of about 130,000 **medium vehicles**, weighing 4,500 to 14,900 kg, and 17,000 heavy vehicles, weighing 15,000 kg and over.[22] According to the Insurance Corporation of British Columbia, approximately one-quarter of insured vehicles in 2009 (about 675,000 vehicles) were commercial vehicles.[24] These include vehicles such as taxis, passenger and delivery vans, emergency response vehicles, buses, and semi-trailer trucks, among others.[25]

Figure 8.1 shows the proportions of MVC fatalities in BC over time from 2008 to 2012, by vehicle type. Passenger car occupants had the largest proportion of fatalities over this five-year period, consistently representing over 40 per cent of occupant fatalities. This actually indicates an under-representation among MVC fatalities, given that the vast majority of vehicles on the road are light vehicles, as described earlier in this chapter. Truck and tractors (including pickup trucks) were the vehicles involved in the second highest proportion of MVCs fatalities during this time—an over-representation compared to their proportion of the vehicle fleet in BC.

Figure 8.1 **Proportion of Motor Vehicle Crash Fatalities, by Vehicle Type, BC, 2008 to 2012**



	2008	2009	2010	2011	2012
Panel Van	6.2	4.8	5.7	3.1	6.3
Sport-utility Vehicle	9.0	8.8	9.7	8.3	17.1
Motorcycle	13.5	16.0	12.0	16.7	11.7
Truck and Tractor	15.2	17.0	18.1	25.0	22.0
Passenger Car	54.3	51.4	54.2	46.1	41.0
Other	1.7	2.0	*	*	*
Total Fatalities	289	294	299	228	205

Year

Note: "*" Indicates rates based on numbers less than five. Vehicle type recorded refers to the vehicle the victim was in. "Truck and tractor" includes pickup trucks, single and combined unit light and heavy duty trucks, and tow trucks. See Appendix B for more information about this data source.
Source: Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia, 2008-2012. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

[ai] The Canadian Vehicle Survey excludes certain vehicle types, such as buses, motor homes, and motorcycles.

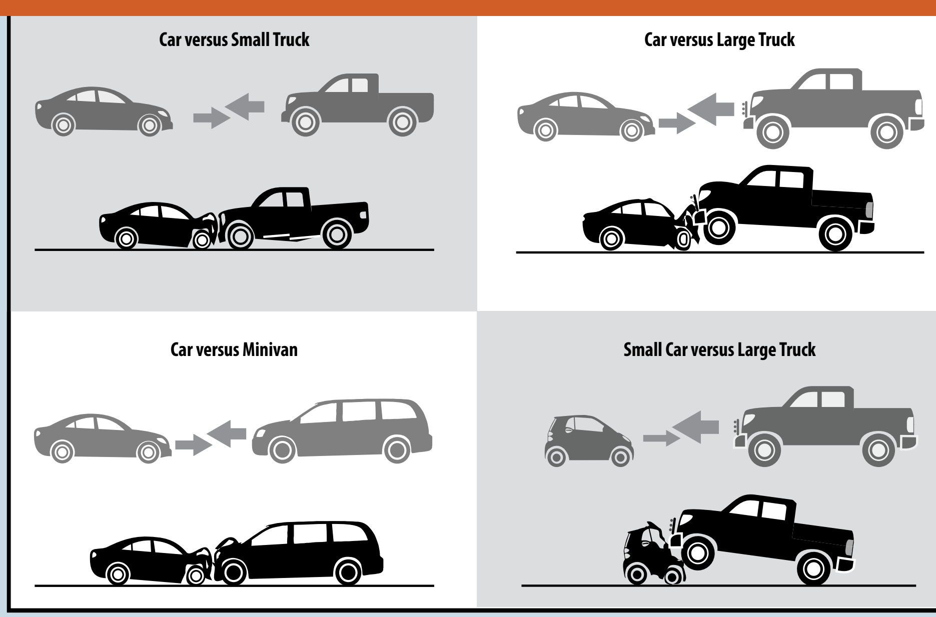
Vehicle Crash Incompatibility

The broad range of vehicle types on the road contributes to **vehicle crash incompatibility**, when the different shapes, sizes and conditions of the vehicles, and frame-to-frame misalignment. Figure 8.2 illustrates the difference in vehicle sizes and incompatibilities between various vehicles. Vehicle crash incompatibility is determined by a number of vehicle features, including a vehicle's front height, stiffness, size, and weight. In MVCs involving multiple vehicles, the occurrence of injuries and fatalities is higher among occupants of smaller vehicles than those of larger vehicles.[27] Research also suggests that the large weight and size of SUVs and light trucks increases the risk of injury to other road users involved in MVCs. For example, a study conducted by the National Highway Traffic Safety Administration in the United States looked at MVCs involving vehicles of multiple weights and sizes and found that there was greater risk of death for pedestrians struck by drivers of SUVs, vans, and large pickup trucks compared to those of passenger cars.[28]

The 2009 annual Canadian Vehicle Survey found that among light vehicles (vehicles weighing less than 4.5 tonnes), vehicle crash incompatibility in Canada has increased in the last 15 years.[29] As depicted in Figure 8.3, this survey found that there are more large personal vehicles on the road in Canada, with the proportion of cars decreasing from 60.5 to 55.4 per cent, while the share of SUVs doubled from 6.9 to 12.8 per cent. Additionally during this time, sub-compact vehicles and mini-compact vehicles, both very small vehicle types, have been introduced,[30,31,32,33,34] resulting in even more pronounced vehicle crash incompatibility.

The consequences of vehicle crash incompatibility in an MVC can be lessened by changing components of either vehicle.[35] Some measures that have been shown to improve safety during MVCs with vehicles of different types, such as greater side strength, greater stiffness and improved side air bags in smaller vehicles, as well as less rigidity and improved front-end crash absorption in larger vehicles.[36]

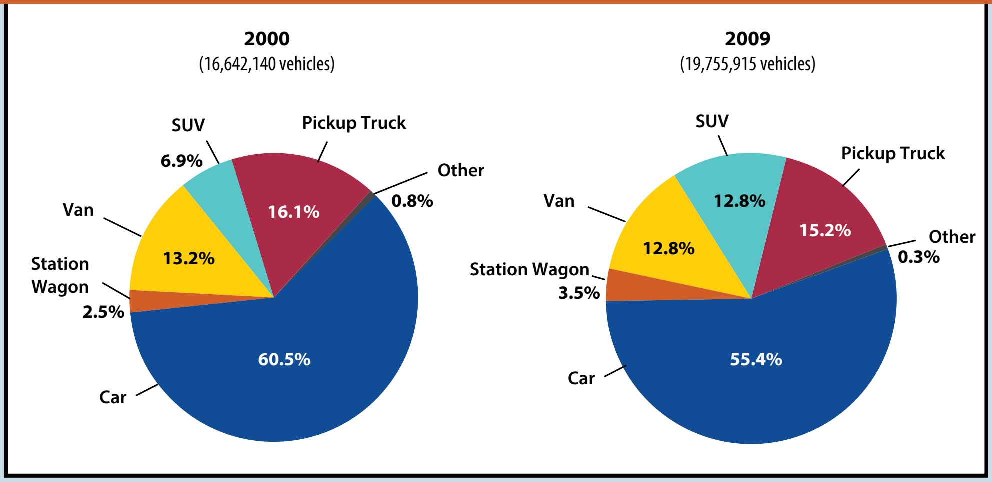
Figure 8.2 Vehicle Crash Incompatibility



Notes: For illustration purposes only.
Sources: Adapted from Moradi R, Setpally R, Lankarani H. 2013. *Use of Finite Element Analysis for the Prediction of Driver Fatality Ratio Based on Vehicle Intrusion Ratio in Head-On Collisions.*[26]

Figure 8.3

Distribution of Light Vehicles, by Body Type, Canada, 2000 and 2009

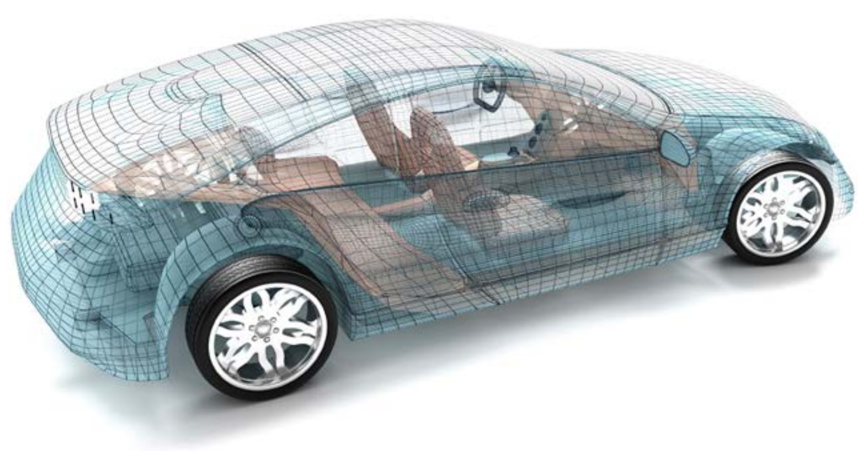


Note: "Light vehicles" are those with a gross vehicle weight less than 4.5 tonnes. "Other" includes straight trucks, tractor-trailers, and buses. This sample does not include motorcycles, buses, off-road vehicles, or special equipment such as snowplows.
Source: Reproduced with permission from Natural Resources Canada. 2011. *Canadian Vehicle Survey 2009: Summary Report*.[29] This figure is a reproduction and adaptation of an official work that is published by the Government of Canada, and the reproduction has not been produced in affiliation with, or with the endorsement of, the Government of Canada.

VEHICLE DESIGN AND SAFETY TECHNOLOGY

Research suggests that vehicle safety improvements, particularly those that increase vehicle crashworthiness, have prevented hundreds of thousands of MVC-related fatalities and countless injuries around the world.[3] For example, in the UK, motor vehicle safety improvements are thought to have been the most significant factor in reducing MVC-related serious injuries and fatalities in recent decades.[37]

Safety is among the top priorities for people purchasing new vehicles (along with price and fuel efficiency).[38,39,40] One study found that the top three priorities for Canadians when buying a vehicle were vehicle price (29 per cent), safety (15.6 per cent), and fuel consumption (13.2 per cent).[40] A wide range of motor vehicle safety technologies exist and more are emerging. These include crash avoidance technology—systems that helps drivers avoid MVCs—and crash protection systems—technology that protects all road users in the event of an MVC. These systems work together to compensate for normal or expected human errors and to mitigate the resulting injuries and fatalities. Further, while vehicle design can increase safety for all road users, the Organisation for Economic Co-operation and Development has specified that vehicle design that improves protection for both vehicle occupants and pedestrians could reduce risks, especially for older road users, who are generally more vulnerable to injury and death resulting from MVCs.[19]



Crash Avoidance Technologies

Crash avoidance technologies, also known as collision avoidance systems and active safety systems, warn a vehicle driver and/or intervene to avoid or reduce the severity of an impending MVC. Crash avoidance technologies range from assisting drivers to stay alert to their surroundings, to assuming control of the vehicle to prevent a crash if a driver is not responding appropriately (e.g., auto-braking).[41] Overall, crash avoidance technologies are crucial to road safety because they mitigate many human factors that can lead to an MVC, whether they are underlying issues such as a medical condition, specific incidents such as impairment or fatigue, a moment of distraction, or an assortment of other common human conditions and behaviours.[42]

Several new crash avoidance technologies are being developed and offered by car manufacturers,[42] in most cases as optional add-ons for vehicles rather than being standard inclusions in new vehicles. Conversely, as these technologies continue to advance, associated costs can be reduced, allowing for broader accessibility and distribution. This section will explore a few key crash avoidance technologies related to lighting, lane use, speeding, braking, and pedestrian detection.

Improved Lights

Daytime running lights (DRLs) are vehicle headlights that come on automatically when the engine is started. Their purpose is to increase the vehicle's visibility to oncoming traffic during daylight hours.[43] All new vehicles imported into or sold in Canada after December 1, 1989, must have DRLs.[4] Nova Scotia is the first and only province to require that all road users (including visitors and vehicles that are not subject to the CMVSS) use DRLs or low-beam headlights during daylight hours.[4] Research in the US has found a relationship between DRLs and MVC rates, where DRL-equipped vehicles were involved in fewer multiple-vehicle crashes and had lower rates of MVCs than vehicles without DRLs.[44,45]

Adaptive headlights point in the direction the vehicle is going rather than simply straight ahead, which helps a driver see around curves in the dark.[46] Adaptive headlights have been shown to reduce injury claims for insured vehicles.[46] In a US study, researchers found that adaptive headlights could prevent up to 142,000 MVCs each year (2 per cent of total MVCs), including 29,000 injury MVCs (about 4 per cent of total injury MVCs) and nearly 2,500 fatal MVCs (about 8 per cent of total fatal MVCs).[47] Adaptive headlights are not currently required by Transport Canada on new vehicles.

Lane Use

Several technologies are currently under development and already in use that assist drivers to stay in their lane or to change lanes with enhanced safety. **Lane departure warning systems** monitor the position of the vehicle relative to the lane boundary.[48] The system delivers a warning to the driver if the vehicle appears to be drifting or unintentionally departing from its lane (e.g., due to driver inattention)[48,49] so that the driver can correct the vehicle's course[50] and thus prevent lane departure crashes. Among surveyed drivers, some reported false warnings and many said the system was "annoying," raising concerns that drivers may turn off or tune out the system.[46] However, research in the US found that lane departure warning systems could be relevant in preventing up to 179,000 MVCs each year, including 37,000 injury MVCs (about 6 per cent of total injury MVCs) and 7,529 fatal MVCs (about 24 per cent of total fatal MVCs).[47] Other US research estimates that lane departure warning systems have the potential to reduce the number of MVCs by 8 per cent in the US each year.[51]

Lane keep assist is a type of lane departure warning system that helps a driver by controlling the vehicle to ensure it stays within its lane.[50] Research from Europe suggests that lane keep assist has the potential to reduce MVC fatalities by 15 per cent.[52] **Lane change assist** ssystems monitor the area immediately around and behind the vehicle to assist drivers when changing lanes. If the system detects a vehicle in the adjacent lane, it alerts the driver to the presence of the other vehicle. Research in the US estimates that side view assist (a type of lane change assistance technology) has the potential to reduce MVCs by as many as 395,000 each year (7 per cent of total MVCs), including 20,000 injury crashes (3 per cent of total injury MVCs) and 393 fatal crashes (1 per cent of total fatal MVCs).[47]

Speed and Vehicle Distance

Most vehicles are designed and manufactured to reach and travel at speeds that greatly exceed survivable speeds for road users, common roadway conditions, and common speed limits of public roadways.[53] As an alternative to limiting the maximum achievable speed of a vehicle, speed-related crash avoidance technologies have been developed. These include **intelligent speed adaptation** (ISA), **adaptive cruise control**, **forward collision warning systems**, and speed limiters for heavy trucks or commercial vehicles including public transit buses.

ISA detects when a driver is travelling over the posted speed limit based on electrical signals from a beacon/transmitter attached to roadside infrastructure, or via GPS technology.[54] It either audibly or visually warns the driver they are speeding, or it assumes control and limits the speed of the vehicle to prevent speeding. UK research has estimated that if ISA fittings that prevented vehicles from travelling over the posted limit were mandatory on all vehicles, an estimated 20 per cent of injury MVCs and 37 per cent of fatal MVCs could be prevented.[55]

Adaptive cruise control works in conjunction with regular **cruise control** (technology that maintains a consistent speed without using the gas pedal), automatically slowing the vehicle in heavy traffic to maintain a safe following distance from the vehicle in front and accelerating to maintain the preset cruise speed when traffic allows.[56] Forward collision warning systems was developed to avoid potential rear-end collisions.[57] The system monitors the distance to—and the relative speed of—the vehicle in front and alerts the driver when it senses an increased risk of an MVC due to the vehicle ahead slowing or stopping.[58] Some of these systems are also equipped with autonomous braking features that slow the vehicle if the driver fails to respond in time.[50] Forward collision warning systems have proven effective in reducing crashes and insurance claims in the US.[46]

Speed limiters are another vehicle technology that can prevent speeding, and some countries prevent heavy trucks and buses from exceeding speed limits through the use of mandatory speed limiters. These speed limiters are installed in the engine and prevent excessive speed.[59] Speed limiters are commonly required on heavy trucks and buses in the European Union but less so in Canada and the US.[60] Speed limiters are required on commercial trucks in Ontario and Quebec but not in BC.[61]

Safe Braking

In addition to vehicles assisting drivers to slow down or stop based on the detection of excessive speeds or unsafe vehicle distances, advancements in braking technologies can also help braking take place more safely. **Electronic Stability Control** (ESC) helps a driver maintain control by preventing skidding under most driving conditions, including on icy, slushy, and snowy roads.[62] ESC monitors the driver's use of the brake pedal, and, when steering direction does not match vehicle direction, ESC applies brakes to one or more wheels and/or reduces engine power to regain control.[63] In 2011, ESC became mandatory in Canada for all new vehicles sold in Canada.[63] It can also be installed as an after-market addition in older vehicles.

Anti-lock braking systems (ABS) also increase safety during braking. They do this by automatically modulating the pressure in the braking system to prevent the brakes from locking and allowing the driver to retain control of the steering while braking hard.[64] ABS became standard equipment on most vehicles sold in Canada in the 1980s but is not compulsory.[65]

Brake assist systems automatically apply brakes fully when the system detects panic braking, in order to prevent a crash or reduce the severity of an MVC.[66] Preliminary results from a German study suggest that autonomous braking systems reduce injuries by one-third and fatalities by 44 per cent for pedestrians involved in frontal MVCs.[67] In the European Union, brake assist systems have been compulsory for new vehicles since 2009,[68] but they are not currently required for vehicles in Canada.

Avoiding Pedestrians and Cyclists

Pedestrian active detection systems in vehicles use the combination of cameras and radar sensors to monitor obstacles in front of a vehicle, and have been shown to be effective in detecting pedestrians.[69] The radar measures how far away the obstacle is, while images from the camera are analyzed by image-recognition software to determine the nature of the obstacle. If the analysis determines the obstacle to be a pedestrian, the vehicle's brakes are automatically applied. Some systems are cooperative, in that the pedestrians and other road users wear a sensor that communicates with the mechanism on the vehicle.[70] These systems are not yet required on vehicles in Canada but are available from some manufacturers.[71,72]

Crash Protection Technologies

In addition to new and emerging technologies where vehicles assist in preventing MVCs, there have also been advancements in crash protection, which can prevent serious injuries and fatalities of road users when an MVC does happen. This is primarily achieved through vehicle design that maintains passenger compartment integrity during a crash and absorbs crash forces away from passenger areas; holds vehicle occupants in place during a crash using restraints; and cushions vehicle occupants with air bags.

"Crashworthiness" is a measure of a vehicle's structural ability to physically deform in the event of an MVC, while maintaining a space for occupants that allows them to survive crashes within a reasonable threshold of MVC severity.[73] Occupant crash protection includes features designed to maximize survivability in a crash, based on human tolerance to physical forces.[14,74] This requires having a stiff yet deformable structure with crumple zones to absorb the force of a serious crash from any direction, as well as fuel tank protection, and appropriate interior padding and energy-absorbing materials, among others.[73] Research in the US has shown that improving crashworthiness through vehicle design has contributed to reduced MVC-related injuries and fatalities.[3] In addition to protecting vehicle occupants, vehicle safety features are increasingly being developed to protect other road users when they come into contact with vehicles—particularly vulnerable road users such as cyclists and pedestrians.[75,76]

"Air bags, collapsible steering columns, padded dashboards, reinforced beams and doors, stronger seats and anchorages, and head restraints, have all transformed today's car, light truck and van into safer vehicles. At the moment of a collision, these safety devices all work together to preserve the life space of the occupants."

– Transport Canada, *Seat Belt Sense*[14]

Passenger Restraints

Seat belts are a key contributor to the reduction in MVC injuries and fatalities seen over the past 30 years.[77] In BC, the use of seat belts by motor vehicle occupants has been mandatory since 1977.[aj,6,78] Seat belts are typically a combination of a lap belt and a shoulder belt or harness, although older vehicles may only contain a lap belt. They are designed to restrain drivers and passengers in the event of an MVC, preventing them from hitting the inside of the vehicle, colliding with other vehicle occupants, or being thrown from the vehicle.[78] Technology for seat belts now also includes seat belt pretensioners that can tighten the seat belt in the event of an MVC to eliminate slack.[79] Seat belt load limiters absorb crash energy and reduce belt-induced injuries through the tightening and extension of the seat belt during the crash.[79,80]

In BC, the use of approved restraints for child passengers up to 18 kg has been legislated since March 1985, and booster

[aj] There are currently exemptions to this law under Division 32 of the Motor Vehicle Act Regulations.

seat laws for older and more fully grown children came into effect in July 2008.[81] The type of child seat used is based on age, weight, and height of the child. An American study found a 59 per cent decrease in the risk of injury among children age 4-7 when a booster seat was used instead of a seat belt alone.[83] Booster seats help protect children who have outgrown child safety seats but who are not yet tall enough to use adult seat belts safely by raising them to a height where the lap belt sits across their hips rather than their abdomen, and the shoulder belt fits across their chest and shoulder rather than across their neck.[84] While Transport Canada regulates child safety seats, regulations regarding their use in BC are determined by the provincial government.[82] (See Chapter 3 for more information about seat belts and child safety seats.)

Overall, seat belt use is crucial to road safety, and seat belts save an estimated 1,000 lives in Canada each year.[14] Seat belt use results in a 51 per cent reduction in the risk of fatality from an MVC, and a 67 per cent reduction in this risk when combined with air bags.[77]

Air Bags

Air bags are a vehicle safety device designed to inflate instantly in an MVC to protect the occupants inside the vehicle[85]—and in some cases vulnerable road users outside of the vehicle[86]—by cushioning them from hard surfaces. Air bags can be located in a variety of locations inside and outside of the vehicle, but are most typically front and side air bags found inside the vehicle.[86]

Front air bags are typically installed inside the steering wheel and dashboard of a vehicle and prevent the driver's and front passenger's heads from contacting these hard surfaces if they are thrust forward suddenly in an MVC.[87] They are designed to be supplementary to seat belts.[88] The National Highway Traffic Safety Administration in the United States estimates that air bags saved 8,369 lives from 1975 to 2001.[89] Passenger air bags have shown to be effective at reducing fatalities for front-seat passengers.[90]Modern vehicles provide both head and chest protection, with the combination of a head and torso bag or some form of head curtain, while older systems typically only offer chest protection. **Advanced front air bags** provide similar protection for the driver's and front passenger's heads but use a dual inflation system that deploys the air bags at varying pressure levels, depending on the severity of the crash, the size of the occupant, and how close the occupant is to the air bag.[79]

Side air bags are installed in the side door of the vehicle or the seatback and can provide protection to the head, chest, and torso for vehicle occupants involved in side crashes.[79] Evidence has shown the safety benefits of side air bags, as well as the additional protective effects of head-protecting side air bags.[91,92,95] Research from the US estimates that torso-only side air bags reduce the risk of fatality in an MVC by 26 per cent, while full side air bags, which also protect the driver's head, reduce the risk by 37 per cent.[93] Another study from Australia estimated that between 2001 and 2010, side air bags that protect the head and torso reduced the odds of MVC-related death and injury by 21.6 per cent overall.[94]

Safety Technology and Socio-economic Status

Research shows that the benefits of new vehicle designs and emerging safety technologies and innovations may not be equally shared among sub-populations with different socio-economic statuses (SES). Lower SES can create financial barriers to accessing newer models of vehicles, which thereby makes it more difficult for vehicle road users to benefit from emergent safety technologies. For example, one US study concluded that there is a "robust positive association" between a vehicle owner's SES (determined by the median household income and percentage of residents with a high school diploma for a set postal code) and the safety of household vehicles. Specifically, the study found that postal code areas with a lower SES were more likely to have older vehicles, and fewer vehicles with a "good" or "acceptable" vehicle safety rating (based on Insurance Institute for Highway Safety ratings).[96]

VEHICLE MAINTENANCE AND MODIFICATION

Vehicle Maintenance

Road safety necessitates that vehicles be maintained and be in good working condition to allow a driver to navigate and respond to roadway conditions and events appropriately. Good vehicle maintenance includes the consideration of vehicle condition and age.

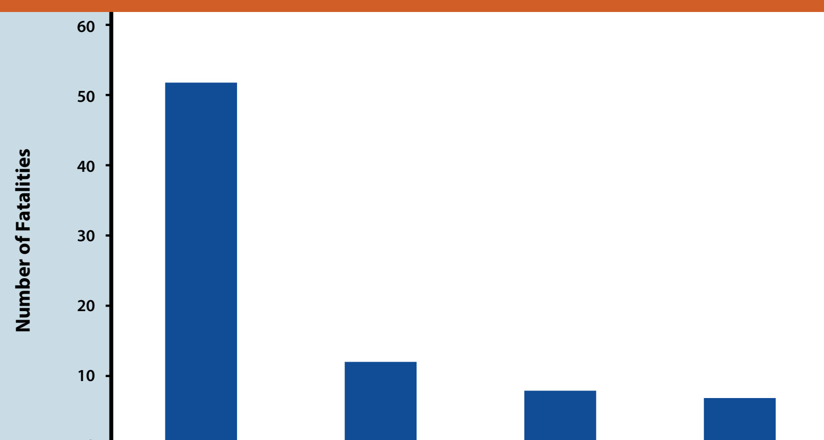
Vehicle Condition

In BC, like most Canadian provinces, vehicle owners are responsible for the maintenance of their vehicles;[53] however, there is no provincial practice to ensure that vehicle owners conduct appropriate vehicle maintenance, other than the possibility of police ordering a safety inspection on a vehicle they believe may be defective or unsafe.[97] Many jurisdictions in North America[98] and around the world require regular vehicle safety inspections, often as a condition of insuring the vehicle.[53]

On average for 2008-2012, 5.6 per cent of all factors reported by police for MVC fatalities in BC were related to vehicle condition.[100] As shown in Figure 8.4, the top four vehicle-

> **"…passenger vehicle owners are largely left on their own to maintain their vehicles properly, including ensuring that the brakes on them work, despite the fact that an unsafe vehicle introduces risk into the system for all road users."**
>
> – N. Arason, *No Accident: Eliminating Injury and Death on Canadian Roads*[53] (p.82)

Figure 8.4 **Top Four Vehicle Condition Contributing Factors in Fatal Motor Vehicle Crashes, BC, 2008-2012**



	Tire Failure/ Inadequate	Brakes Defective	Windows Obstructed	Headlights Defective/Out
Number of Fatalities	52	12	8	7
Percentage among Vehicle Condition-related Fatalities	56.5	13.0	8.7	7.6

Vehicle Condition Factor

Notes: Data are based on police reports from police-attended motor vehicle crashes (MVCs); therefore, contributing factors reported emphasize human error rather than other systemic factors (e.g., vehicle design, roadway design). Percentages will not add to 100 as less common factors are not shown, and MVCs can have more than one contributing factor. See Appendix B for more information about this data source.
Source: Police Traffic Accident System, Business Information Warehouse, Insurance Corporation of British Columbia, 2008-2012. Prepared by BC Injury Research and Prevention Unit, 2014; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

related factors contributing to fatal MVCs during this time period were tire failure or inadequacy, defective brakes, obstructed windows, and defective headlights. Among these, tire failure or inadequacy was the most common factor—appearing in 56.5 per cent of fatal MVCs with vehicle-related contributing factors. However, the technical failure of a vehicle is generally listed as a contributing factor only when an attending police officer can be certain of the fact—such as after a sudden or obvious event (e.g., tire blow out);[2] therefore, it is likely that vehicle condition as a contributing factor to MVCs is underreported.[2]

> **"There is no question that a vehicle that is maintained and working properly (e.g., properly inflated tires, tires with adequate tread depth, working brakes and adequate brake linings, fully functioning and optimized lights, steering component integrity, properly functioning suspension, adequate seat belts, fuel tank strength, etc.) is a vehicle that is better able to avoid crashes and better able to protect vehicle occupants and other road users in the event of a crash."**
>
> – N. Arason, J. Siemens, E. Desapriya, *Vehicle Safety Standards in Canada*[2]

The Automotive Industries Association of Canada estimates that at any given time there are approximately two million vehicles on Canada's roads that require brake servicing.[101] Some jurisdictions have vehicle inspection programs to improve road safety through the identification of mechanical issues. (See Sidebar: *AirCare*). In Pennsylvania, an annual safety inspection program costs vehicle owners an average of $16 to $23. The program aims to identify and remove unsafe vehicles from the road, and a review of the program estimates that it is successful in saving 127 to 187 lives each year. This same review also found that overall, US states that have vehicle safety inspection programs had less fatal MVCs compared to those that do not.[102]

Tires play a significant role in vehicle safety, including adequate tread, tire pressure, and appropriateness for the weather or road conditions. Proper tire pressure ensures even contact between the tires and roadway, allowing for a good grip.[103] This reduces MVCs caused by skidding and inadequate **braking distance**.[103] Tire pressure monitors are devices available for some vehicles that are mounted on the wheels to monitor the air pressure in each wheel and signal the driver when the tire pressure is too low.[4,104]

AirCare

AirCare was a program that required vehicle owners to pass an emissions test before being insurable in some parts of BC. While it focused on air quality and environmental health, it mandated vehicle maintenance. The program was terminated in 2014 to allow for program evaluation and planning of its future direction.[99] Previous to AirCare, BC had a mandatory vehicle inspection program that was terminated in 1983.[98] These programs demonstrate that it is possible to require vehicle maintenance.

Using appropriate tires for the weather conditions is important. Winter tires (also called snow tires) have been shown to improve traction, cornering, braking and, perhaps most importantly, stopping distance compared to all-season tires.[105] Effective September 21, 2015, the *Motor Vehicle Act* and its Regulations have been amended to clarify the definition of winter tires and traction devices such as chains, including when and where they must be used.[106] Snow tires and tire chains are not mandatory across BC, but they are required on certain road sections during the winter months (see Chapter 7 for further discussion of weather and road conditions).

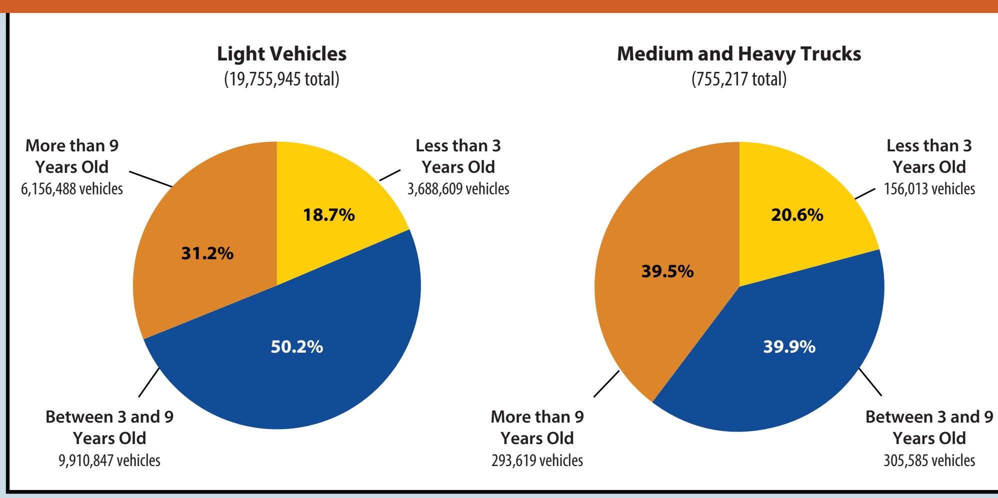
Vehicle Age

There is currently a considerable mixture of older and newer vehicles on the road.[22] The age of vehicles can impact their general condition and is a factor in maintenance for optimal road safety. Research has demonstrated that occupants of vehicle models that are 14 or more years old are at about three times the risk of MVC-related injuries than occupants of newer vehicles.[2]

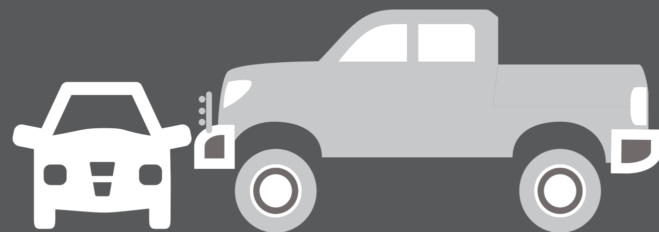
Figure 8.5 depicts the age distribution of vehicle fleets among light vehicles, and medium and heavy trucks in Canada in 2009. As shown, approximately 20 per cent of both vehicle types are three years old or younger. Light vehicles were more likely to be 3-9 years old than medium or heavy vehicles, and medium or heavy vehicles were more likely to be more than 9 years old.

According to the provincial-level analysis of this survey, nearly 10 per cent of the 2.5 million light vehicles registered in BC were pre-1991 models.[22] One US study found a significant association between socio-economic status and vehicle age, crash test ratings, and safety features such as electronic stability control and side-impact air bags, whereby lower income individuals and families were at increased risk.[96] A separate US study found that people with lower education (a proxy indicator for socio-economic status) were 2.4 times more likely to die in an MVC than people of higher education status in 1995 and 4.3 times more likely in 2010.[107] Research in the US and New Zealand has found that teenagers and other young

Figure 8.5 **Age Distribution of Vehicle Fleets by Vehicle Type, Canada, 2009**



Notes: "Light vehicles" are those with a gross vehicle weight less than 4.5 tonnes, "medium trucks" are those 4.5 to 15 tonnes, and "heavy trucks" are those more than 15 tonnes. This sample does not include motorcycles, buses, off-road vehicles, or special equipment such as snowplows. The total number of light vehicles listed above (19,755,945) does not equal the sum of light vehicles by age (19,755,944). This discrepancy is replicated from the source document.
Source: Reproduced with permission from Natural Resources Canada. 2011. *Canadian Vehicle Survey 2009: Summary Report.*[29] This figure is a reproduction and adaptation of an official work that is published by the Government of Canada. The reproduction has not been produced in affiliation with, or with the endorsement of, the Government of Canada.



> "After-market modifications like raising vehicle heights and/or installing bull bars increase the risk of MVCs occurring, and increase the severity of injuries to other road users when MVCs do occur."

drivers tend to drive older vehicles with low crashworthiness and without crash avoidance technologies.[108,109]

Vehicle Modification

Modifications to a motor vehicle by its owner, commonly referred to as after-market modifications, often do not comply with the safety standards outlined in the CMVSS. After-market modifications may also contribute to premature failure of steering and braking components and reduce the effectiveness of safety features when they are incompatible with modified vehicle height and weight.[110] However, some after-market modifications, such as the addition of safety features like back-up cameras, increase the safety of a vehicle. As will be discussed in this section, common modifications that increase the severity of MVC outcomes include raising the vehicle height with lift kits[110,111] or oversized tires,[111] and installing **bull bars**.[2,112,113]

After-market modifications that increase vehicle height may increase the risk of MVCs by limiting the driver's ability to see pedestrians, lower vehicles, and head, tail and signal lights. Headlights on raised vehicles are no longer at the right height for optimal visibility, and can also distract or visually impair other drivers.[110,111] Oversized tires can also rub the suspension, fender, frame, and steering arm components of a vehicle, decrease the vehicle's turning radius, and adversely affect the driver's ability to control the vehicle.[114] *Canada's Road Safety Strategy 2015* identified concerns with raised vehicles, noting an associated reduction in braking performance and stopping distance, and their significant risk to other road users in the event of an MVC, particularly pedestrians. It explains that when a vehicle is raised, pedestrians can be more seriously injured because they contact the rigid frame of the vehicle rather than the hood, and it recommends consideration of regulations by provinces/territories to limit or prohibit this modification.[115]

Bull bars, also known as *bush bars* or *crash bars*, are rigid metal bars affixed to the front of a vehicle (often an SUV or truck) to protect the vehicle and its occupants in case of collision with a wild animal.[113] They are designed for use particularly in rural areas but are also used for aesthetic reasons.[113] Bull bars have been associated with increased severity of MVCs and MVC-related injuries for the vehicle occupants and road users that the bull bars collide with.[2,112,113] *Canada's Road Safety Strategy 2015* also highlighted the risk of rigid bull bars, since they "concentrate blunt force and increase injury severity to pedestrians when struck," and recommended provincial/territorial regulation prohibiting their installation.[115]

COMMERCIAL VEHICLE SAFETY

A commercial vehicle can be any vehicle registered with a business and used to transport goods and/or passengers, including trucks, taxis, and buses.[25] In 2014, there were 739,000 insured commercial vehicles in BC.[116] BC currently has policies and programs in place to improve commercial vehicle safety. Private and commercial vehicle inspections are performed by authorized and qualified mechanics, and an audit system exists to ensure compliance.[117] In addition, the Enhanced Licence Plate Removal Program imposes requirements before re-licensing when vehicles are found to have defects, including defects in steering, wheels, tires, and brakes, among others.[118]

Research suggests that a number of new safety technologies could have a significant impact on reducing the number of MVCs involving large trucks. For example, some of these technologies include blind spot detection, forward collision warning, lane departure warning, and ESC. Together, these tools could reduce the number of crashes involving large trucks by an estimated 28 per cent each year.[119] In addition, side **underride guards** in large trucks could reduce injury risk in about three-fourths of crashes that produced serious injury or fatality.[120] Underride guards are steel bars extending downward from the back or sides of large trucks to prevent smaller vehicles from moving underneath the truck's trailer in an MVC.[121]

SUMMARY

The concept of safe vehicles is one of the Safe System Approach (SSA) pillars and it is fundamental to road safety. The top vehicle-related contributing factors to motor vehicle crashes in BC, including tire failure and defective brakes or headlights, are all related to poor vehicle maintenance. Moving vehicles pose an inherent risk on roadways, but vehicle design offers opportunities to increase road safety for vehicle occupants and vulnerable road users alike. Vehicle safety standards fall under both federal and provincial jurisdictions. The wide variety in vehicle designs on our roads can result in vehicle crash incompatibility. Crash incompatibility generally puts occupants of smaller vehicles, well over half of Canada's vehicle fleet, at disproportionate risk of injury or death. After-market vehicle modifications such as bull bars and increased vehicle height can create and/or exacerbate vehicle crash incompatibility. Many vehicles have important crash avoidance mechanisms such as daytime running lights and electronic stability control; most have crash protection technologies such as passenger restraints and air bags; and some newer vehicles have additional features such as lane keep assist, pedestrian detection, and intelligent speed adaption. Older vehicles generally do not offer these benefits to road users and this likely disproportionately affects people of lower socio-economic status.

The next chapter will explore road safety and the pillars of an SSA among Aboriginal people in BC.

Chapter 9

Road Safety and Aboriginal People in BC

The Provincial Health Officer would like to thank the First Nations Health Authority for contributing to the development of this chapter.[ak]

INTRODUCTION

Many improvements have been made in the health status of **Aboriginal people** in BC in recent years; however, many still experience poorer health outcomes than other BC residents, including higher rates of injuries and mortalities due to motor vehicle crashes (MVCs).[1] Indeed, the average age-standardized fatality rate for MVCs for **Status Indians** (see sidebar: *Aboriginal Terminology*) in BC is higher than for other residents.[2] This chapter uses the safe system framework described in Chapter 1, including a Safe System Approach (SSA), to explore road safety and MVCs while focusing specifically on Aboriginal peoples in BC. It presents data regarding serious injuries (hospitalizations) and fatalities resulting from MVCs, and discusses best practices in community programming that draws upon community strengths to reduce the burden of MVCs on Aboriginal peoples in BC.

Aboriginal Terminology

Aboriginal peoples are the descendants of the original inhabitants of North America. The terminology used to refer to Aboriginal peoples in Canada has varied over the years. The *Constitution Act* recognizes three groups of Aboriginal people: Indian, Inuit, and Métis.[3]

The term "Indian" is still used when referring to legislation or government statistics, although "First Nations" has largely replaced Indian as the terminology preferred by many Aboriginal people in Canada. The term "Status Indian" refers to those who are entitled to receive the provisions of the *Indian Act,* while Non-Status Indians are those who do not meet the criteria for registration or who have chosen not to be registered. First Nations refers to both Status Indians and Non-Status Indians. First Nations peoples are often members of a First Nations band. The Inuit are a distinct population of Aboriginal people. They live primarily in Nunavut, the Northwest Territories, and northern Labrador and Quebec.[4] The term "Métis" consists of people of mixed First Nations and European ancestry who identify themselves as Métis, and are distinct from First Nations peoples (Indians), Inuit, and non-Aboriginal peoples. Most Métis live in Alberta, Saskatchewan, or Manitoba.

In January 2013, the Federal Court of Canada ruled that both Métis and non-Status Indians are considered Indians under the *Constitution Act,* which is a new interpretation, and the implications of this ruling have yet to be determined. The federal government has appealed this decision, and the Supreme Court of Canada has agreed to hear the case.[5]

This report uses the term "Aboriginal" unless describing data pertaining specifically to Status Indians.

[ak] Data for this chapter were developed through different processes than the other chapters in this report, and data differ in the sources and years presented. See Appendix B for more information.

ABORIGINAL PEOPLES IN BC AND MVCS

The historic and current context of Aboriginal people is important in understanding and interpreting related MVC data, and for determining effective community responses to improve road safety. Aboriginal people today experience inequities in the social determinants of health;[1,6] a problem rooted in the ongoing legacy of colonization, systemic discrimination, and abuses experienced through residential schools.[1] The Social determinants of health are the cultural, social, economic, environmental, and individual contexts and conditions that impact health and shape lifestyle choices, both directly and indirectly.[7] Lower socio-economic status (SES), limited health resources, inter-generational trauma, and the remoteness of many Aboriginal communities in BC, can all play a role in the higher rate of MVC fatalities among Aboriginal people. Nevertheless, Aboriginal people show great resilience despite the challenges they face: communities are reclaiming culture, increasing self-determination, and working to build wellness into the future.

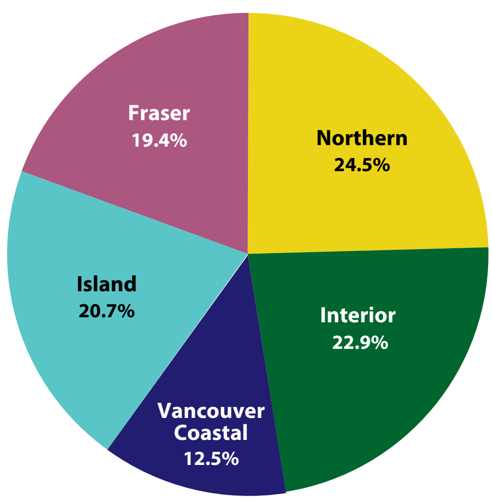
Road safety is one part of balanced, healthy communities. For many Aboriginal people, health is holistic—it focuses not only on the emotional, mental, spiritual, and physical balance of an individual, but also on the relationship of that individual with their environment and their community.[8] Wellness activities and programming in Aboriginal communities that are focused on the social determinants of health have the potential to contribute to improved road safety.[1,9,10] Many Aboriginal people already experience high levels of trauma and grief,[11] and MVC fatalities and serious injuries add to this.

Profile of Aboriginal Peoples in BC

According to the 2006 Census, there were 196,075 self-identified Aboriginal people living in BC, which represented approximately 4.8 per cent of the total BC population at that time. Of these individuals, 129,580 identified as **First Nations**[al] (66.1 per cent), 59,445 identified as **Métis** (30.3 per cent), 795 identified as **Inuit** (0.4 per cent), and 6,255 identified with multiple or other groups (3.2 per cent).[12]

Figure 9.1 shows the distribution of Aboriginal people living in BC in 2006 across the regional health authorities. As this figure indicates, Aboriginal people live in locations that are somewhat evenly distributed across the health authority areas, with a slightly smaller proportion in Vancouver Coastal Health (12.5 per cent) and the largest proportion in Northern Health (24.5 per cent).

Figure 9.1 Distribution of the Aboriginal Population, by Health Authority, BC, 2006



Note: "Aboriginal population" includes persons of self-reported Aboriginal identity residing in BC including North American Indians, Métis, Inuit, Treaty and Status First Nations. These proportions are additive and include both the on-reserve and off-reserve Aboriginal population.
Source: Statistics Canada, 2006 Census data, provided by BC Stats. Prepared by the Office of the Provincial Health Officer, 2015; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

[al] Individuals were identified as North American Indian in accordance with Statistics Canada terminology, but will be discussed here as First Nations.

While Aboriginal people are fairly evenly distributed throughout BC (Figure 9.1) there is variation in the proportion of the population they comprise within health authority areas. Figure 9.2 shows the proportion of Aboriginal people within the total population of each health authority. As this figure demonstrates, the greatest proportion of Aboriginal people is in Northern Health, at 16.6 per cent, and there were much lower proportions in Fraser and Vancouver Coastal (2.5 per cent and 2.3 per cent, respectively).

Tripartite Initiatives for Injury Prevention

The Government of Canada, the Government of British Columbia, and the First Nations Leadership Council have now entered into a collaborative tripartite partnership in order to more effectively provide health services to First Nations peoples in BC.[13] This has created opportunities for more equal, cooperative, and strategic partnerships that aim to narrow the social and economic gaps for First Nations in BC, including reducing deaths and injuries due to MVCs.

A growing number of important agreements and accords set the priorities, goals, roles, and responsibilities of this partnership, including the *Transformative Change Accord: First Nations Health Plan* in 2006.[10] The Tripartite First Nations Health Plan was then signed in 2007,[13] committing the tripartite partners[am] to focus on a number of specific health actions for health promotion and disease and injury prevention. Two action items within this Plan focus on prevention of death and injury due to MVCs:

- Action Item 13: Improve First Responder programs in rural and remote First Nations communities.

Figure 9.2 **Aboriginal Population as a Percentage of the Total Population, by Health Authority, BC, 2006**

	Northern	Interior	Island	Fraser	Vancouver Coastal
Percentage of Total	16.6	6.3	5.5	2.5	2.3

Note: "Aboriginal population" includes persons of self-reported Aboriginal Identity residing in BC including North American Indians, Métis, Inuit, Treaty and Status First Nations. These proportions are additive and include both the on-reserve and off-reserve Aboriginal population.
Source: First Nations Health Council. *Regional Profiles of First Nations Communities According to Current Provincial Health Authority Regions.*[60] Prepared by the Office of the Provincial Health Officer, 2015; and Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

[am] Inclusion in the term "tripartite partners" has evolved and expanded over time; at the time of publication, this term includes a broad range of content experts, partners, and organizations, including the federal and provincial governments, First Nations Health Authority, BC Association of Aboriginal Friendship Centres, Métis Nation BC, Aboriginal services providers, and more.

- Action Item 14: Develop an informational campaign to increase awareness about seat belt use and safe driving.[10]

The tripartite partners are responsible for developing strategic methodologies that allow for systemic change in injury prevention and health promotion for First Nations communities in BC.[14] The First Nations Health Authority (FNHA) has now taken a regional approach[15] to develop regional health and wellness plans with BC First Nations in order to establish agreed-upon roles, priorities, and approaches to regionally relevant work, including health promotion and disease and injury prevention as appropriate.[16]

Aboriginal Road Safety Data

There are several challenges in examining data related to MVCs among Aboriginal people in BC. Data for MVCs related to Métis, Inuit, and **non-Status Indians** are not currently available. Among data that are available and used in this report (see Chapter 1 and Appendix B), Aboriginal identity is captured differently; the Vital Statistics Agency and Discharge Abstract Database (DAD) use Status Indian data,[an] while the BC Coroners Service captures Aboriginal identity information that is inclusive of Métis, Inuit, and First Nations peoples.[ao] Furthermore, some aspects of the health and well-being of Aboriginal people in BC have been studied more than others. Among studies of the social determinants of health and health outcomes, researchers have employed different measurements, standards, and definitions of Aboriginal peoples. Therefore, there are challenges in conducting comparisons between data sources and in establishing trends across time. This presents difficulties in understanding injury patterns and trends for all Aboriginal residents, and subsequently, in planning injury prevention initiatives.

Lastly, many Aboriginal people in BC live in rural/remote and reserve communities that are accessible only by resource roads (e.g., forestry roads).[17,18] These resource roads are not included in police Traffic Accident System (TAS) data. As such, fatality data presented in this chapter are derived from BC Vital Statistics Agency data (rather than TAS data, like the other chapters of this report). This allows the inclusion of fatalities due to MVCs on all roads as well as off-road vehicles (e.g., snowmobiles, all-terrain vehicles [ATVs]), but does not allow analyses of contributing factors to the MVCs as with TAS data.

Despite these challenges, several initiatives are currently underway to support enhanced data regarding of the health and well-being

[an] Individuals are identified as Status Indian residents in the DAD if they are classified as such in any the following sources: Health Canada's Status Verification File, Vital Statistics, and the Status Indian entitlement files from the BC Medical Services Plan database.
[ao] Aboriginal identity is determined from the information gathered during a coroner's investigation, including information provided by the next of kin.

of Aboriginal people in BC, and these initiatives will likely enhance MVC-related data specific to Aboriginal people in BC. For example, as a response to the lack of injury data in First Nations and Inuit communities, the First Nations and Inuit Health Branch (FNIHB) of Health Canada supported the development of the Aboriginal Community Centered Injury Surveillance System (ACCISS), including national consultations.[21] This initiative was informed by the principles of ownership, control, access, and possession (OCAP) (see sidebar: *OCAP Principles*).[22] The Secwepemc Nation in BC has implemented this model in an injury surveillance and prevention program.[23] Also, the Aboriginal Administrative Data Standard (AADS), which came into effect in 2007, was created to ensure that ministries and their affiliated agencies are consistent in how Aboriginal identity information is collected[24] (although it has not been adopted by all organizations or government ministries).

In addition to these systemic improvements to the availability of data related to Aboriginal health and well-being, in 2007, FNIHB formed the First Nations and Inuit Children and Youth Injury Indicators Project Task Group. This is a federal group with representation from the Assembly of First Nations, which developed a list of injury indicators for First Nations and Inuit children and youth to inform policy and monitor the health of First Nations and Inuit children, youth, and their families. Indicators across all injury areas were identified, including the following that will be pertinent for monitoring MVC-related health and well-being in the future:

- Age and sex of First Nations road users involved in MVCs (including cars, ATVs, and snowmobiles) and road user type (driver, passenger, pedestrian, and/or cyclist).

OCAP Principles

The principles of ownership, control, access, and possession (OCAP), help First Nations communities and academic institutions establish research partnerships that protect the rights of First Nations peoples. These principles ensure that the rights of indigenous peoples are protected in research and information management, as these rights have not always necessarily been protected. OCAP principles honour the goals of Aboriginal self-determination and self-governance in research and information.

Ownership: The collective ownership, by a community or group, of their cultural knowledge, data, and information.

Control: The right of First Nations communities to control all aspects of the research process from planning to management of information.

Access: The right of First Nations communities to have access to all data and information on them regardless of where it is held. In practice, this can be achieved through standardized protocols.

Possession: The physical control of data, a mechanism by which ownership can be asserted and protected.

– First Nations Centre, *Ownership, Control, Access and Possession*[19] and First Nations Information Governance Centre, *The First Nations Principles of OCAP*[20]

- Number of MVCs involving First Nations children and youth, by type of vehicle and crash circumstances.
- Proportion of proper use of child vehicle restraints (car seats and booster seats).
- Number of seriously injured First Nations child and youth occupants who were not wearing a seat belt.
- Number of First Nations children and youth seriously injured or killed who were not wearing a helmet while riding ATVs, snowmobiles, and/or bicycles.
- Proportion of First Nations youth enrolment and completion of driver education courses—skills for car, snowmobile, boat, and ATV drivers (e.g., courses in the community or within 50 km of the community).[25]

The extent to which indicators are being used will vary as communities determine their own data collection methods, which means that communities will have varying levels of data to draw upon when developing community programming. With more community-based activities underway to collect more accurate, timely, and inclusive injury data, Aboriginal people will have information in order to better plan and implement programs that will help to reduce MVC rates.

ABORIGINAL MVC FATALITIES AND SERIOUS INJURIES IN BC

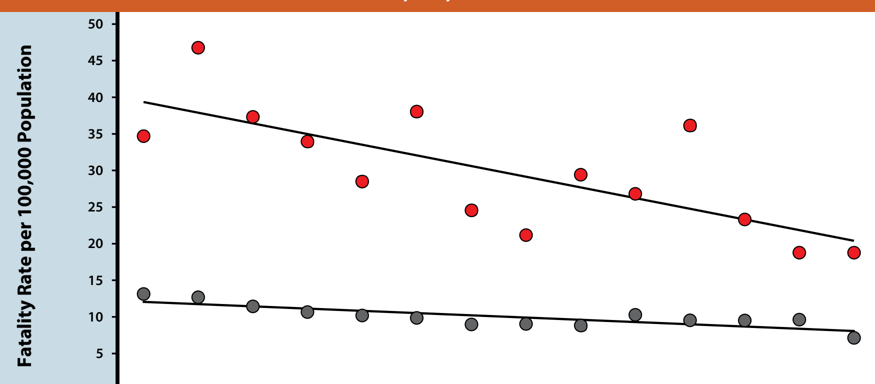
MVCs are a significant cause of injuries and death for Aboriginal people in BC, and are typically higher than for non-Aboriginal people.[2] The following section explores MVC fatalities among Status Indians in BC, and considers variables including health authority area, sex and age, and region.

MVCs were responsible for the largest number of deaths due to external causes among Aboriginal people in BC between 1992 and 2002.[2] During this time period, the age-standardized fatality rate (ASFR) for MVCs for Aboriginal people was nearly four times higher than the rate for other BC residents (38 per 100,000 Status Indians, compared to 10 per 100,000 other residents).[2]

Figure 9.3 shows that between 1993 and 2006, the ASFR for MVCs for Status Indians decreased by 45.8 per cent, from 34.7 per 100,000 Status Indian population to 18.8 per 100,000. However, the ASFR for Status Indians remained more than double that of other residents of BC in 2006, at 18.8 and 7.1 per 100,000, respectively.

Children and youth make up a larger percentage of the BC Aboriginal population compared to the non-Aboriginal population, with 28.0 per cent age 0-14 compared to 16.5 per cent of other residents, and 18.2 per cent age 15-24 compared to 12.9 per cent of other residents.[26] Unlike other leading causes of death such as cancer and heart disease, which more typically impact older populations, injuries, such as those resulting from MVCs, have a large impact on younger populations. Therefore, it is important to consider the high proportion of young Aboriginal people when interpreting the higher rates of MVCs for Aboriginal peoples. Summary measures of premature death are potential years of life lost (PYLL) and PYLL standardized rate (PYLLSR), which help to account for population age differences by explicitly weighting deaths that occur before a standard baseline age of 75.

Figure 9.3 **Age-standardized Motor Vehicle Crash Fatality Rate per 100,000 Population for Status Indians and Other Residents, BC, 1993 to 2006**



	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Status Indian (SI) Fatality Rate	34.7	46.8	37.3	34.0	28.5	38.1	24.6	21.2	29.4	26.8	36.1	23.3	18.8	18.8
Other Residents (OR) Fatality Rate	13.1	12.7	11.4	10.7	10.2	9.9	9.0	9.0	8.8	10.3	9.5	9.5	9.6	7.1
Number of SI Fatalities	39	51	48	43	38	46	35	30	34	32	50	36	30	27
Number of OR Fatalities	440	444	415	398	385	381	353	363	345	422	397	399	415	307

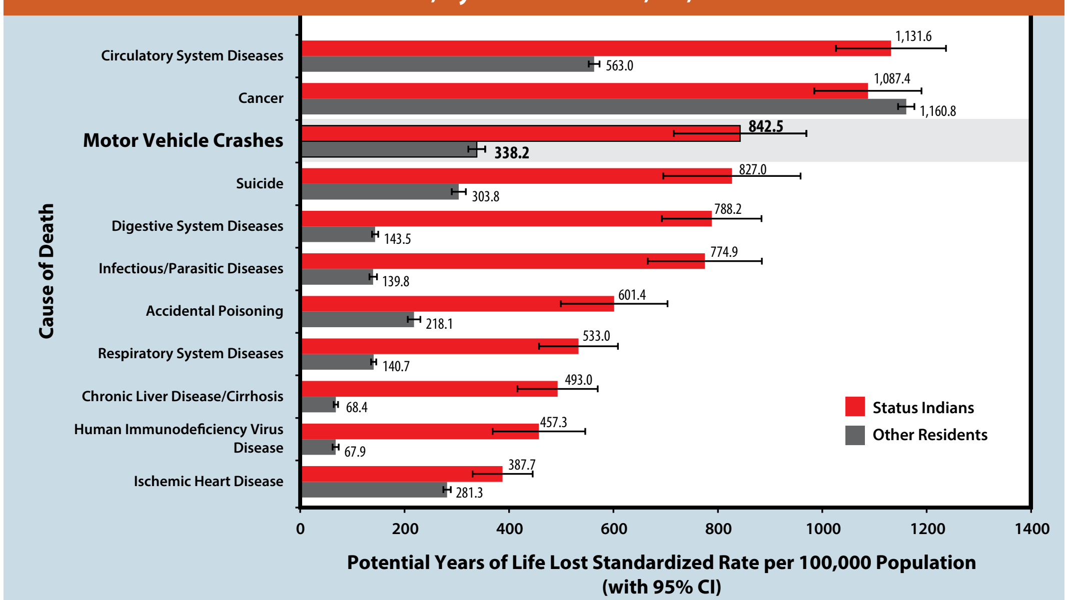
Year

Notes: Age-standardized rates are calculated using Canada 1991 Census population. See Appendix B for more information about this data source.
Source: BC Vital Statistics Agency, data as of January 2, 2008. Prepared by Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

Figure 9.4 presents PYLLSRs, showing the rate of PYLL per 100,000 standard population, and comparing specific causes of death for the Status Indian population and other BC residents for 2002-2006. For all specific causes of death except cancer, Status Indians have higher PYLLSR than other BC residents. MVCs are the third highest PYLLSR for Status Indians at 842.5 per 100,000—more than double that of other residents.

In addition to a higher burden of MVC fatalities, Aboriginal people in BC also experience higher rates of hospitalization for serious injuries resulting from MVCs

Figure 9.4 **Potential Years of Life Lost Standardized Rate per 100,000 Population for Status Indians and Other Residents, by Cause of Death, BC, 2002-2006**



Note: Potential years of life lost (age under 75 years) standardized rate is calculated using Canada 1991 Census population. See Appendix B for more information about this data source.
Source: BC Vital Statistics Agency, data as of January 11, 2008. Prepared by Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

compared to other residents. As shown in Figure 9.5, for 2004/2005-2006/2007, MVCs and cyclist crashes were the third leading specific cause of hospitalizations for external causes for Status Indians, at 214.7 hospitalizations per 100,000 Status Indian population, (after falls, and adverse effects, misadventure and post-operative complications).

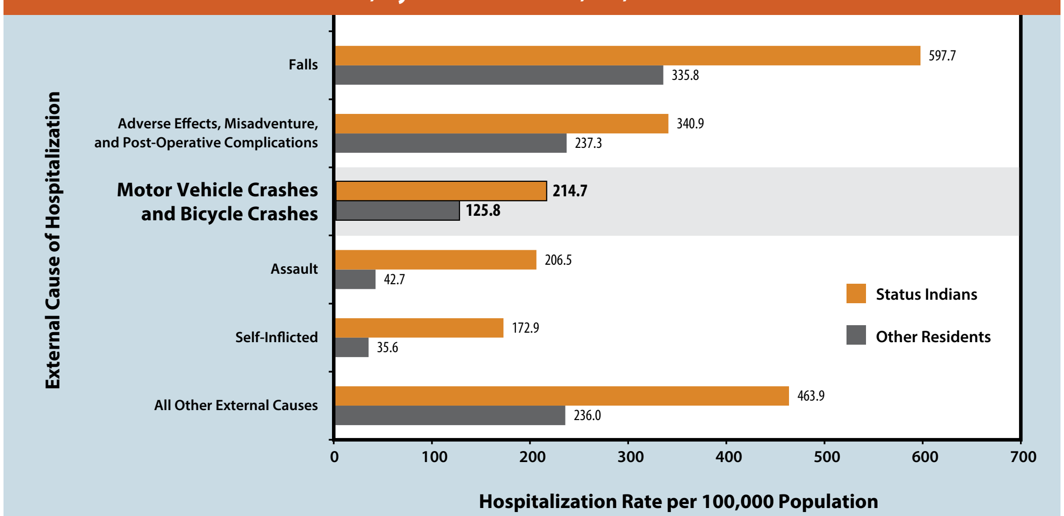
The disparity among these rates has been observed elsewhere in Canada as well; a Calgary-based study of major trauma between 1999 and 2002 found that Status Indians were at nearly four times higher risk of sustaining an MVC injury than the general population. The study also found that MVCs accounted for the overwhelming majority of deaths as a result of a severe injury in both Status Indian and non-Status Indian groups. The researchers speculated that this could be due to environmental factors, including road conditions on reserves; social factors, such as driving behaviours, seat belt use, or number of car occupants; lifestyle factors involving frequent highway driving; and vehicle factors, such as vehicle maintenance.[27]

Analysis by Region

As shown in Chapter 2 of this report, in BC, the number of MVC-related fatalities varies by region, and this is true for the distribution of MVC fatalities for Aboriginal people as well. Figure 9.6 shows that the ASFR was higher for Status Indians than for other BC residents across the regional health authorities. The highest ASFR for Status Indians was in Interior Health at 35.9 per 100,000 Status Indian population, while the rate for other residents in Interior was less than half of that, at 15.7 per 100,000.

As shown earlier in this report, Interior Health and Northern Health have higher proportions of MVC fatalities than their respective proportions of the BC population. Since Interior Health (shown in Figure 9.6 with a large difference between Status Indians and other residents) and Northern Health (which has a smaller difference) are both rural/remote areas, these data suggest that the differences in MVC rates between Aboriginal peoples in BC and other residents have more complex causes than simply geographical

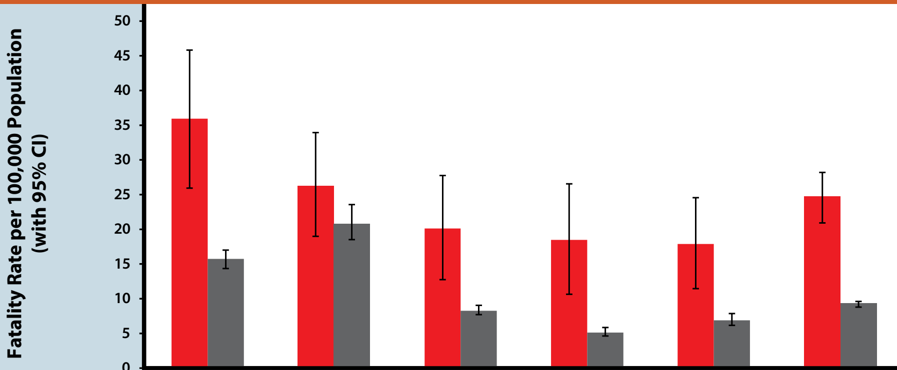
Figure 9.5 Age-standardized Hospitalization Rate per 100,000 Population for Status Indians and Other Residents, by External Cause, BC, 2004/2005-2006/2007



Notes: "All other external causes" includes poisoning (accidental), other transport, fire/flames and hot substances (burns), and drowning/submersion. Age-standardized rates are calculated using Canada 1991 Census population. Data analysis is based on Harvard Codes. See Appendix B for more information about this data source.
Source: Discharge Abstract Database, Ministry of Health Services 2004/2005-2006/2007; data accessed April 2008. Prepared by Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

Figure 9.6

Age-standardized Motor Vehicle Crash Fatality Rate per 100,000 Population for Status Indians and Other Residents, by Health Authority, BC, 2002-2006



	Interior	Northern	Fraser	Vancouver Coastal	Island	BC Total
Status Indian (SI) Fatality Rate	35.9	26.1	20.2	18.6	18.0	24.6
Other Residents (OR) Fatality Rate	15.7	20.7	8.4	5.2	7.0	9.2
Number of SI Fatalities	50	47	28	21	29	175
Number of OR Fatalities	535	259	602	282	261	1,940

Health Authority

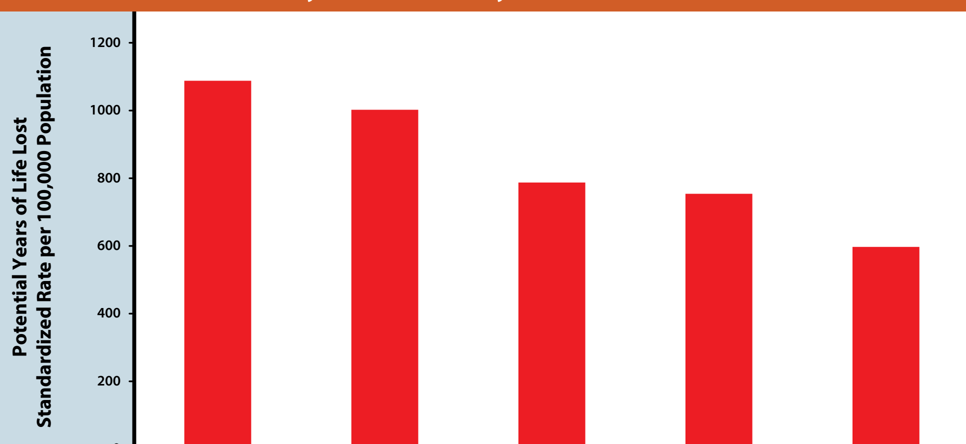
Notes: Age-standardized rates are calculated using Canada 1991 Census population. See Appendix B for more information about this data source.
Source: BC Vital Statistics Agency, data as of January 02, 2008. Prepared by Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

differences. Furthermore, the higher rates of MVC fatalities among Status Indians is also demonstrated in urban areas.

Figure 9.7 shows the variation in PYLLSR for MVCs among Status Indians by regional health authority for 2002-2006. The highest burden for Status Indians was again found in Interior Health at a rate of 1,088 per 100,000 Status Indian population, while the lowest rate was found in Vancouver Coastal Health at 597 per 100,000. During

Figure 9.7

Potential Years of Life Lost Standardized Rate per 100,000 Status Indian Population due to Motor Vehicle Crashes, by Health Authority, BC, 2002-2006



	Interior	Fraser	Northern	Island	Vancouver Coastal
Years of Life Lost	1,088	1,002	787	754	597

Health Authority

Note: Potential years of life lost (age under 75 years) rate calculated using Canada 1991 Census population.
Source: Provincial Health Officer. 2009. *Pathways to Health and Healing: 2nd Report on the Health and Well-being of Aboriginal People in British Columbia. Provincial Health Officer's Annual Report 2007*. Chapter 4 Data File.[28] Prepared by Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

> "In 1992-2006, MVCs were the leading cause of death for Status Indians age 1-4 years."

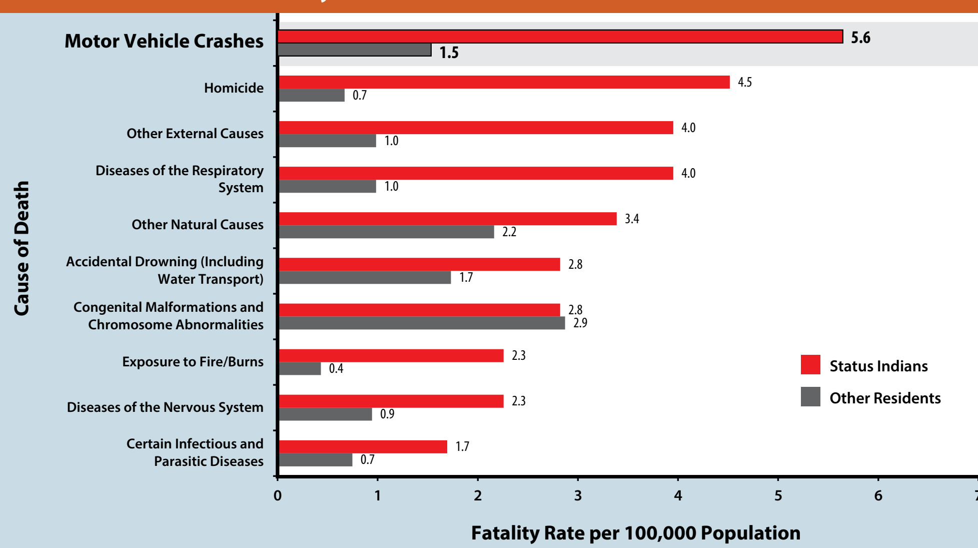
this same period, the provincial PYLLSR for MVCs among Status Indians overall was reported to be 840 per 100,000, compared to 340 per 100,000 for other residents.[28]

Analysis by Sex and Age

As discussed in Chapter 2 of this report, males are generally at increased risk for being involved in an MVC because they tend to engage in more risky behaviours, such as driving after drinking or not wearing a seat belt, and because they drive more kilometres per year than females, thereby increasing their exposure to risk.[29,30,31,32,33,34] Compared to other BC residents, between 1991 and 2001, the PYLL rate for Status Indian males was over three times higher than the rate for other male BC residents: 20.8 per 1,000 population compared to 6.1 per 1,000.[35] For female Status Indians, the rate was almost four times higher, at 9.0 per 1,000 compared to 2.3 per 1,000 for other female BC residents.[35]

Figure 9.8 presents fatality rates among Status Indian children age 1-4 years. It shows that for 1992-2006, MVCs were the leading cause of death for this group, with a rate of 5.6 per 100,000 population. This rate was nearly four times higher than the rate for other BC children 1-4 years of age (1.5 per 100,000).

Figure 9.8 **Fatality Rate per 100,000 Population among Children Age 1-4 Years for Status Indians and Other Residents, by Cause of Death, BC, 1992-2006**



Notes: Rates are calculated using age-specific population numbers. See Appendix B for more information about this data source.
Source: BC Vital Statistics Agency, data as of June 19, 2008. Prepared by Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

SAFE SYSTEM APPROACH

Application of an SSA to road safety is consistent with Aboriginal health perspectives in that it views road safety as a holistic system of road users, speeds, roadways, and vehicles, rather than an MVC being viewed as an isolated product of one person's behaviour. It also offers a framework from which to explore why the rates of MVC injuries and fatalities among Aboriginal people are higher than for other residents. Examination of the pillars of an SSA in Chapters 3 to 8 of this report apply to Aboriginal people in BC overall, but the following section offers additional considerations with respect to these pillars and how they relate to Aboriginal people in BC.

Safe Road Users

Substance-based Impairment

As is the case in many marginalized populations, some Aboriginal individuals struggle with addictions to alcohol and other drugs. For Aboriginal peoples, historical events such as colonization, residential schools, and the systemic loss of culture and traditions, as well as lower socio-economic status, can act as contributing factors to substance use.[36] In 2009, a report by the BC Provincial Health Officer showed that for the five-year period of 2002-2006, 41 per cent of MVC fatalities among Status Indians were alcohol-related, which was over twice the proportion of other BC residents at 19 per cent.[1] However, it is now known that due to a systematic underreporting of alcohol involvement in MVC fatalities, these levels are higher than previously reported for all BC residents, including Aboriginal residents.

There is also a difference in MVCs with alcohol impairment between Aboriginal populations who live on reserve and those who live off reserve in BC.[ap] In BC, 44.2 per cent of Registered (Status) Indians live on reserve.[26] According to the Insurance Corporation of British Columbia (ICBC), for 2003-2007, 39.3 per cent of MVC fatalities that occurred on reserve in BC involved alcohol impairment, compared to 26.4 per cent of related fatalities that occurred off reserve.[37] In fact, for on-reserve MVC fatalities, alcohol impairment was the leading contributing factor, just ahead of speed at 37.5 per cent and well ahead of not using a restraint at 21.4 per cent.[37] A survey of Aboriginal youth in BC found that while the proportion of off-reserve Aboriginal youth who reported engaging in alcohol-impaired driving was fairly stable from 2003 to 2008 (at 5 and 6 per cent, respectively), the rate for youth who lived on reserve increased from 8 per cent in 2003 to 17 per cent in 2008.[38]

Alcohol impairment and MVCs among Aboriginal people has also been studied in other provinces. A 2005 Alberta study of First Nations drivers age 18-29 years found that patterns of use and attitudes regarding alcohol were strongly influenced by the community context. Factors that contributed to drinking and driving cited by young drivers included normalization of the behaviour in the community; role modeling of risky drinking and driving behaviour in the home; poverty; unemployment; and poorly maintained rural roads. The study also highlighted factors that deterred First Nations youth from drinking and driving, such as the trauma of seeing family and community members killed or injured. The researchers recommended that drinking and driving interventions consider the effect of community norms, social realities, and peer relationships.[39] Results from a three-year study in Saskatchewan from 2003 to 2005 comparing MVCs involving alcohol-impaired drivers[aq] showed that MVCs with alcohol as a contributing factor were almost

[ap] A reserve is land set aside by the federal government for the use and benefit of a First Nation.

[aq] In this study, "impaired" is defined as blood-alcohol content (BAC) 0.08 or higher.

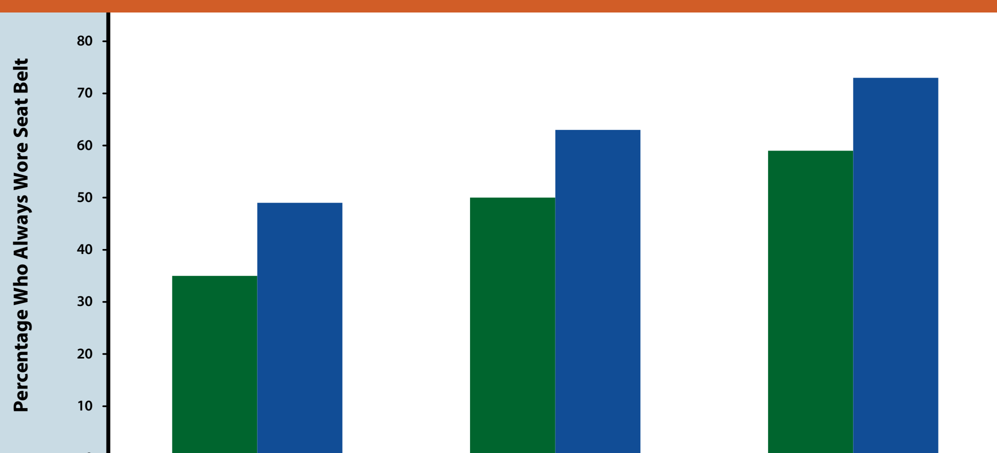
three times more likely to occur on reserve than off reserve. MVCs involving drivers who were drinking, but not legally impaired, were 4.8 times more likely to occur on reserve than off reserve. The study also identified additional factors in on-reserve MVCs, such as younger drivers, older vehicles, lower seat belt use, and poorer road conditions.[6]

Restraint Use

The importance of restraint use and the associated reductions in MVC fatalities and serious injuries has been explored earlier in this report. Data regarding MVCs and restraint use among Aboriginal people in BC are limited; however, two recent studies have reported some applicable data. A recent review of restraint use among Aboriginal people in BC found that of the 65 Aboriginal occupants who died in MVCs between 2003 and 2005, 30 (46.2 per cent) were not restrained, and 19 (29.2 per cent) were restrained.[ar,40] Although not directly comparable, this estimate is approximately double the estimate for MVC vehicle occupant fatalities across BC provided in Chapter 3. It is possible that being unrestrained accounts for at least some of the higher rates of MVC serious injuries and deaths among Aboriginal people compared to other residents in BC.

Figure 9.9 shows a selection of the results of a survey of youth in BC, with a focus on Aboriginal youth. According to survey responses, rates of seat belt use increased among Aboriginal youth both on and off reserve between 2003 and 2013.[38] This indicates that seat belt use is improving among Aboriginal youth in BC; however, youth living on reserve report lower levels of always wearing a seat belt than those living off reserve at all three points in time.

Figure 9.9 **Percentage of Youth On- and Off-reserve Who Always Wore a Seat Belt When Riding in a Vehicle, BC, 2003, 2008, and 2013**



	2003	2008	2013
On-reserve	35	50	59
Off-reserve	49	63	73

Year

Note: See Appendix B for more information about this data source.
Source: Adolescent Health Survey, McCreary Centre Society, 2003, 2008, 2013. Prepared by Population Health Surveillance, Engagement and Operations, Ministry of Health, 2015.

[ar] The remaining 16 (24.6 per cent) had unknown restraint use. This review had issues with underreported data so caution should be used when interpreting results.

Safe Speeds

Data are somewhat limited in examining Aboriginal people and speeding behaviours in BC. Some investigations have compared on- and off-reserve speeding behaviour within BC among all residents and found they are quite similar; for example, according to ICBC police-reported data for 2003-2007, 37.5 per cent of on-reserve MVC-related fatalities involved speeding, compared to 37.2 per cent of off-reserve MVC fatalities.[37] Excessive speed for condition was cited in 44 per cent of Aboriginal child deaths in 2007 according to the Child Death Review Unit, BC Coroners Service.[41]

Safe Roadways

There are several considerations related to safe roadways that impact MVC rates and road safety strategies for Aboriginal people in BC, such as use of rural/remote roads, reserve roads, and socio-economic factors.

In BC, many First Nations communities and reserves are located in rural and remote areas,[42] and a considerable proportion of the Status Indian population in BC live on reserve.[26] As discussed in Chapter 7 of this report, rural and remote roads present numerous challenges related to road safety, including, but not limited to, greater response times and farther distances required to travel for emergency services.[43,44] Furthermore, rural living can necessitate longer travel distances to carry out daily or weekly activities and involve rougher roads and terrain[41,45]—all of which expose rural residents, including Aboriginal people, to more risk.

Roads leading to and on reserves have varied governance structures and different parties are responsible for maintenance than for other roads in BC.[46] Some rural and remote reserve communities are only accessible by resource roads (e.g., forestry roads).[17] These communities share resource roads with industrial traffic (such as logging trucks), and industries are responsible for road maintenance on those roads.[18] However, since resource roads are built for industries to access natural resources, they are not built to the same standards as public highways,[47] and are typically only maintained by industry when in use.[18] The *Natural Resource Road Act* project, led by the Ministry of Forests, Lands and Natural Resource Operations, aims to reduce inconsistencies in the management and administration of resource roads by creating a single framework to govern all of BC's resource roads. This project has the potential to increase safe access to remote First Nations communities in BC through consolidated and updated legislation.[as] The new legislation would consolidate 11 separate pieces of legislation.[48]

While research related to reserve roads in BC is limited, the Saskatchewan study that compared MVCs on off-reserve roads with those on on-reserve roads from 2003-2005 found that the key factors for MVCs occurring on reserves included poor road conditions and high-crash intersections.[6]

Safe Vehicles

Despite improvements in many of the social determinants of health, Aboriginal people in BC still face lower levels of educational achievement, higher levels of unemployment, and are more likely to earn income under $20,000 per year.[1] Lower socio-economic status negatively influences a person's ability to own a new car or a car with up-to-date safety features and technologies.[49] Furthermore, lower socio-economic status and a lack of vehicle maintenance facilities in rural and remote areas or on reserves may also create challenges for properly maintaining a vehicle.[44] The Saskatchewan-based study of Aboriginal people involved in MVCs found that compared to off-reserve MVCs, on-reserve MVCs were more likely to involve a vehicle 20 years old or older.[6]

[as] Information on the *Natural Resource Road Act* project can be found at www.for.gov.bc.ca/mof/nrra/.

> **"…First Nations communities of Northern BC are spread across a massive geographic area, and many are only accessible by resource roads, which are poorly maintained and rarely policed. Crashes involving wildlife are also more common on so-called "bush roads." Inadequate vehicle maintenance is not only related to poverty but to the reality that many smaller, remote communities have no mechanical services available. Gravel and forest service roads are rough, and increase the likelihood of mechanical breakdown for all vehicles. It has been noted that on reserve especially, vehicles may be overloaded, seat belts are not utilized, and children [are] not properly secured in child safety seats. Access to the nearest town which acts as a service centre to the First Nations community can be a challenge for many First Nations peoples who don't own a reliable vehicle."**
>
> – D. Bowering, *Crossroads: Report on Motor Vehicle Crashes in Northern BC*[44]

PREVENTING MVCS IN ABORIGINAL COMMUNITIES

Interventions designed to improve rates for Aboriginal populations will need to consider the inequities in the social determinants of health, rural and remote factors, as well as the legacy of colonization. For example, initiatives designed to promote community health, emotional well-being, self-determination, and empowerment have the potential to result in positive, measurable effects on many health outcomes, including reduced injury and death due to MVCs.

The US Centers for Disease Control and Prevention have an online resource for promoting road safety among American Aboriginal peoples (American Indians and Alaskan Natives). These resources and evidence-based recommendations are aimed at tribal governments and health care professionals with the aim of addressing seat belt use, child safety seat use, and impaired driving in tribal communities.[50]

In BC, the best opportunity for engaging communities in developing culturally appropriate, evidence-based, data-informed MVC prevention programs and initiatives is through the FNHA, Aboriginal organizations, and the work underway by the Tripartite partners. Leveraging the work of Tripartite partners and supporting work in the Tripartite First Nations Health Plan action items identified earlier in this chapter has the potential to strengthen health partnerships and improve road safety among Aboriginal communities.

Best and Promising Practices for Road Safety among Aboriginal Peoples

Several reviews have examined best practices in injury prevention interventions among Aboriginal peoples.[51,52,53] All of these reviews identified a lack of rigorous research or evaluation of injury prevention activities among Aboriginal peoples. One of these reviews by the Public Health Agency of Canada's Canadian Best Practices Portal (CBPP) team identified elements of success for a select number of Aboriginal injury prevention interventions based on anecdotal evidence gained in the literature or by key informants.[at,51] A selection of these elements of success include:

1. Adapt to local cultures and values. Do not assume a program developed for non-Aboriginal communities will work in Aboriginal communities.
2. Work in close partnership with communities and with organizations that have a clear understanding of Aboriginal culture and values.
3. Assure project outcomes (e.g., resources) meet the community's needs.
4. Involve Elders in safety program development and delivery.
5. Use instructors that are familiar with and have knowledge of the communities they work with.
6. Consider the costs of recommended injury prevention programs and support participant communities in obtaining any recommended resources (e.g., helmets).
7. Address community injury prevention priorities.[51]

Case Study: Safer Nations-Injury Prevention Video Contest

Community-produced videos are one way to engage communities in important health and safety topics. In 2012, the First Nations Health Authority held a video contest with an injury prevention theme to inspire communities to be creative in the promotion of injury prevention from their own perspectives. Nine communities participated, with public service announcement style videos and topics ranging from ensuring seat belt use, proper child car seat use, warnings not to text while driving, bike safety, being injury-free communities, and being safe in sweat lodge ceremonies. Many videos incorporated traditional culture and teachings, and involved children, youth, and Elders.[54]

A 2008 review of injury prevention programs in Aboriginal communities in BC by the BC Injury Research and Prevention Unit found that injury prevention activities are occurring throughout BC.[53] They found that injury prevention is rarely delivered as a single, stand-alone program. In seven out of 18 programs (38.9 per cent) it was a smaller component of a larger initiative, suggesting a broader holistic approach to programming. Despite this, the review underscored the need for more injury prevention initiatives aimed at Aboriginal people.[53]

[at] The evaluation criteria were not defined by Aboriginal communities, who may define best practices differently.

"…[T]here are deep underlying factors such as individual and institutional racism, racial segregation, income inequalities, access to social and economic resources, and stress associated with belonging to a minority group that contributes to multiple disparities. Increasing seat belt use is important, but so is insuring equal access to education and health care, enforcement of fair housing laws, and community development efforts that address these deep underlying causes of many health disparities, including rates of traffic-related injuries."

– D.W. Schlundt, Reducing Unintentional Injuries on the Nation's Highways: A Literature Review, *Journal of Health Care for the Poor and Underserved* [29]

Expertise and capacity related to injury prevention has been building in Aboriginal communities,[54] and evaluations of approaches and related effectiveness of injury prevention programs by communities could leverage lessons learned in order to help establish best practices within communities. Lessons learned can also be shared with other communities to maximize efficiencies and limited resources, although what works well in one particular First Nation or Aboriginal community will not necessarily be as effective in another.[16,52]

Addressing Challenges in Road Safety for Aboriginal Peoples

Contextual factors are often at the root of many risk-taking behaviours, including alcohol-impaired driving and lack of seat belt use. A focus on system- and community-level interventions helps individuals reduce these risk-taking behaviours while acknowledging that there are larger social and economic determinants at work.

Child Passenger Safety

Aboriginal communities in BC vary in their capacity to deliver child passenger safety programming, based on location and size of the community, access to resources, and the number and ages of children in the community; however, a number of initiatives are underway to increase access to information about child car seats.[55] Studies have shown that child passenger safety initiatives have improved road safety in Aboriginal communities. For example, studies published in 1992 and 2002 reviewed the 1988 Navajo Nation's child occupant restraint laws and public education campaign and found an increase in seat belt use and decreased hospitalizations among children due to MVCs.[56,57]

ICBC supports a program that helps increase child passenger safety through increased and improved use of car seats. It is geared specifically towards Aboriginal communities and is delivered through the Child Passenger Safety Network.[au] They provide child passenger safety educator training to community members and staff, community education and awareness sessions, assistance with child seat loaner programs, and information about subsidized child passenger restraint programs. Resources and education delivered through the Child Passenger Safety Network are often co-funded by First Nations communities for local programming. In 2014, six training sessions were held, five with First Nations communities and one with people who work with high-risk communities with a total of 30 student participants. This focus on capacity building within First Nations communities has resulted in a growing number of First Nations Child Passenger Safety Educator Instructors who are trained and have the ability to certify educators. In 2015, review sessions will be held for certified child seat educators with an opportunity to refresh skills and get information on current issues, concerns, and products.[58]

In 2012, the FNHA created a guide called the *First Nations Child Seat Share Co-operative*, which provides First Nations communities with the knowledge needed to effectively develop and operate a car seat share co-operative (CSSC) program. A CSSC program is a sharing program that provides culturally appropriate education and access to safe child seats. The guide includes information on ways to manage the lending of car seats, how to handle liability concerns, and other information necessary to start and operate a CSSC program.[55]

Northern and Rural Road Safety

The RoadHealth regional task force was created in 2005 to focus on motor vehicle injuries, road safety, and driver education in northern BC communities. Partners in the RoadHealth initiative include ICBC, the RCMP, WorkSafeBC, the BC Ambulance Service, BC Forest Safety Council, and related provincial government ministries.[av,59] In October 2006, RoadHealth held a First Nations and Roads Summit that focused on engagement, awareness, and initiatives in First Nations communities in northern BC.[59] Summit participants identified actions and next steps to improve road safety, which included increasing education and awareness among industry and First Nations communities, clarifying jurisdictional issues, improving road maintenance, and approaching road safety as a public health issue.[59]

[au] The Child Passenger Safety Network's goal is to empower Aboriginal communities with tools to ensure all residents are traveling in vehicles as safely as possible.

[av] Partners from the provincial government include representatives from the following organizations: Ministry of Forests, Lands and Natural Resource Operations; Ministry of Transportation and Infrastructure; and BC Coroners Service.

SUMMARY

Aboriginal people experience inequities in the social determinants of health, which play a large role in the elevated rates of motor vehicle crash (MVC) fatalities and serious injuries among Status Indians and other Aboriginal peoples in BC. Speed, substance-based impairment, and not using restraints, were among the top contributing factors for MVCs involving Aboriginal people, which is similar to the situation for the broader population. For Aboriginal people living rurally or on rural reserves, additional contributing factors have been identified, including longer driving distances for day-to-day activities, longer distances from emergency health services, lack of rural and remote road maintenance, and, for some, economic and geographic barriers to acquiring newer vehicles and maintaining older vehicles. Efforts to address MVCs among Aboriginal people must be contextualized within historical and present-day systemic health, economic, and social realities, which in turn have roots in colonialism, discrimination, and the social determinants of health. Approaching road and vehicle safety using a Safe System Approach and a population health approach is necessary to broaden the response to MVCs beyond addressing individual behaviours. Many First Nations communities are working to better understand and prevent MVCs through innovative and collaborative programs addressing issues such as child vehicle occupant safety. The Tripartite partnership in BC presents an opportunity to collectively address these issues, with the common goal to reduce the rates of MVCs among Aboriginal people in BC.

The following chapter presents recommendations for improving road safety and reducing the burden of injuries and fatalities for all British Columbians, including Aboriginal people.

Chapter 10

Discussion and Recommendations

DISCUSSION OF KEY FINDINGS

This report explored road safety and motor vehicle crashes (MVCs) in BC and examined the related burden of serious injuries and fatalities experienced in our province. This report employed a safe system framework with four pillars (safe road users, safe speeds, safe roadways, and safe vehicles) informed by a combination of a population health approach, a public health approach, and a Safe System Approach (SSA). Using this framework, this report explored how to best promote health and prevent injuries and fatalities resulting from MVCs in the population as a whole and highlighted sub-populations that face a greater burden of MVC serious injuries and fatalities based on health authority region, road user type, sex, and age group.

The SSA entails a modern view of road safety, in which MVCs are seen as systemic failures, and related deaths and serious injuries are considered preventable through systemic interventions. This is a broad and comprehensive view of road safety that highlights not only the users of the road but the roadways they use, the vehicles they operate, and the speed and manner in which they operate them. By taking steps to reduce the number and severity of MVCs we can prevent related serious injuries and fatalities and enhance the health of all road users in BC.

Compared to the MVC fatality rate per 100,000 population in other countries in the same year, Canada was ranked 15th (together with France) out of 36 jurisdictions. Leaders in road safety (Iceland, the UK, Norway, Denmark, and Sweden) had fatality rates between 2.8 and 3.0 per 100,000—half that of Canada. Comparisons based on MVC fatality rate per billion vehicle kilometres show similar results: Canada ranked 13th out of 22 jurisdictions at 5.9 fatalities per billion vehicle kilometres, while leaders (Iceland, Norway, Denmark, Ireland, Sweden, and the UK) had rates between 2.9 and 3.6 fatalities per billion vehicle kilometres.

In BC in 2011, there were about 432,000 people involved in an MVC, 292 MVC fatalities, and 3,038 MVC serious injuries. In 2012, the MVC serious injury rate for BC was slightly below the Canadian average for all provinces at 444.5 per 100,000 population (the average among the provinces was 475.3 per 100,000). With respect to fatalities, the BC rate (6.2 per 100,000) was slightly above the 6.0 per 100,000 average among Canadian provinces, but notably higher than Ontario's rate of 4.2 per 100,000 population, and is more than double the rate of the world's best performers.

In the last two decades there have been many successes in road safety, and reductions in MVC injuries and fatalities in BC. This is particularly notable given the increase in population size and in active driver's licences in BC, and the associated increase in road traffic volume over the same period. Data from the years analyzed show that despite these successes, there are still hundreds of MVC-related fatalities and thousands of related serious injuries occurring in BC each year.

Some populations in BC face a higher burden of MVC-related serious injuries and fatalities than others. Comparing regional health authorities in 2012, 15.9 per cent of the BC population lived in Interior Health, but 38.8 per cent of MVC fatalities occurred there, while 24.7 per cent of the population lived in Vancouver Coastal Health, but only 12.5 per cent of MVC fatalities occurred there. Overall, there have been decreases in the age-standardized rates per 100,000 population of MVC fatalities and serious injuries for both males and females over the last decade. While the rates were higher for males at all points in time, there has been a greater decrease in the rates for males over time, narrowing the gap between males and females in recent years. Males also had higher rates of fatalities and serious injuries per 100,000 than females across all age groups, with the rate for males 16 to 65 years old being at least double that for females in the same age group. Analyses based on age group presented in this report showed that the highest MVC fatality and serious injury rates per 100,000 population were among those age 16-25 and age 76 and up.

Analyses in this report examined various road user types and their respective burden of MVC fatalities and serious injuries. Vulnerable road users are those who do not have the protection of an enclosed vehicle—including pedestrians, cyclists, and motorcyclists. More than one third (38.7 per cent) of MVC serious injuries in 2009 were among vulnerable road users. This increased to 45.7 per cent in 2013. Almost one third (31.7 per cent) of MVC fatalities in 2009 were vulnerable road users. This increased to 34.9 per cent in 2013. Among vulnerable road users, the highest proportion of fatalities was among pedestrians, while the highest proportion of hospitalizations was among motorcyclists. Cyclist data and related trends are more challenging to compare because we lack comprehensive data on how many British Columbians cycle and how many trips and kilometres they travel by bicycle.

Speed, impairment, and distraction were the top contributing factors recorded by police for fatal MVCs in BC between 2008 and 2012. The number and rate of MVCs per 100,000 population with these factors have improved in recent years. However, the proportions of MVC fatalities with speed or distraction as a contributing factor have increased, demonstrating unequal progress compared to impairment and other causes of MVC fatalities. Analyses of these contributing factors by sex and age group showed that while the gap has narrowed over time, males have consistently more speed-related MVC fatalities per 100,000 population than females, with the highest rates among males from age 16 to 45. The distraction-related MVC fatality rate is also highest among males (particularly those age 76 and up), although the rate decreased slowly from 2005 to 2013. Among females, the trend was also decreasing slowly, but with greater year-to-year fluctuations than the male rate. Similarly to MVC fatalities related to speed or distraction, the number and rate of impaired-related MVC fatalities have declined overall but were consistently much higher among males both over time and across all age groups, with the highest levels among males from age 16 to 35.

The examination of roadways and MVC fatalities in this report showed that roadway type and location have an impact on MVC fatality rates. The highest potential for collisions between vehicles, and between vehicles and vulnerable road users, occurs at intersections. Highways are also hazardous due to the high speeds at which vehicles travel. There are multiple challenges for road safety on rural/remote roads, which are often highways, due to high travel speeds combined with longer emergency response times and further distances to health care services. For 2008-2012, about one-quarter of MVC fatalities had one or more environmental contributing factor identified on police crash reports; road condition and weather were the most frequently reported among them. A number of safety measures focusing on roadway design are explored in this report, including traffic-calming methods, cycling infrastructure, intersection design, and more. Improving roadway design will be particularly important as the population and the number of active drivers in BC continues to increase, creating additional volume on roadways in BC.

This report also examined the role of vehicles and vehicle design in MVCs and related serious injuries and fatalities. Among fatal MVCs with one or more contributing factors related to vehicle condition, police reports identified tire failure/inadequacy as the most-often reported contributing factor by far. Vehicle modifications (such as raising vehicles or adding bull bars) can pose road safety hazards, including the creation and/or exacerbation of dangers related to vehicle incompatibility. However, the extent to which vehicle design and modifications are contributing to MVCs in BC is only partially understood, because data currently do not capture all relevant vehicle design factors, such as if the involved vehicles had crash avoidance or protection technologies or if vehicle incompatibility was an issue. Road safety measures focusing on vehicle design explored in this report include crash avoidance technologies (e.g., improved lights and braking systems, pedestrian and cyclist avoidance systems) and crash protection technologies (e.g., passenger restraints, air bags). Vehicle maintenance is also an important component in ensuring vehicle safety. Research findings related to socio-economic status (SES), link lower SES and ownership of vehicles that are more likely to have lower safety ratings and fewer standard safety features such as side air bags and electronic stability control.

Aboriginal peoples' wellness in relation to road safety was explored by considering the overall burden of MVC fatalities and serious injuries among Aboriginal peoples in BC, as well as exploring the role of safe road user behaviours, safe speeds, safe roads, and safe vehicles in Aboriginal communities.[aw] The ongoing legacy of colonization has direct and indirect influences on serious injuries and fatalities among Aboriginal peoples. In BC, Status Indians have a higher age-standardized MVC fatality rate than other residents; however, this gap has decreased over the last 20 years. MVC fatality rates among the Status Indian population were highest in Interior and Northern Health Authorities. Similar to other BC residents, among Status Indians, males experience the greatest burden of MVCs as measured by Potential Years of Life Lost. For First Nations peoples on reserve, alcohol impairment, speed, and not using a restraint were the top recorded contributing factors to MVC fatalities identified in available data. Some initiatives for improving road safety in Aboriginal communities are already underway, and communities across the province continue to make progress in designing and implementing injury prevention programs tailored to their needs. The First Nations Health Authority is well positioned to support and help expand these efforts.

Overall, this report identified many achievements in road safety and related improvements in rates of MVC fatalities and serious injuries in BC. At the same time, data showed that little progress has been made in reducing the number of MVCs overall, and in decreasing mortality and serious injury among vulnerable road users. Improving road safety in BC requires a comprehensive approach that promotes health by increasing safety for all road users. It also requires safe speeds, safe vehicles, and safe roadway designs to prevent MVCs from occurring, and to reduce their severity when they do occur. This can be achieved by

- Increasing viable public and active transportation options to reduce traffic volume.

[aw] Challenges to data analyses regarding Aboriginal peoples in BC and road safety are described in Chapter 9.

- Enhancing the safety of roadway sections known to pose increased risks (intersections, highways, and rural/remote roads).
- Addressing top human contributing factors (speed, impairment, and distraction).
- Emphasizing the protection of more vulnerable road user groups (pedestrians, cyclists, and motorcyclists).
- Targeting populations most burdened by MVC injuries and fatalities (children, seniors, males, Aboriginal peoples, and those in rural/remote communities).

RECOMMENDATIONS

Governance related to road safety and MVCs is complex, and there has already been considerable collaboration and work done in BC and Canada to improve road safety. International comparisons indicate that a 50 per cent reduction in the number of fatalities and serious injuries resulting from MVCs in BC is an achievable intermediate public health goal as we work toward the *British Columbia Road Safety Strategy: 2015 and Beyond* vision of having the safest roads in North America and the ultimate goal of zero traffic fatalities ("Vision Zero").[1] With new technologies and innovative infrastructure available, Vision Zero is an achievable goal, and as such, pursuit of this goal is a responsibility of public health and road safety partners.

Based on the framework and data presented in this report, the Provincial Health Officer has identified key areas for action to improve road safety and related public health outcomes in BC. These recommendations have four underlying principles:

A. Viable alternatives to vehicle use must be meaningfully supported at the provincial level through infrastructure, related services, and policies for all communities.

B. Public health and the pillars of a Safe System Approach should be considered in all road policy and programming initiatives.

C. The health and protection of vulnerable road users should be at the forefront of policy and programming decisions.

D. Due to the complexity of road safety governance in BC, there is a need for strong collaboration, partnerships, and communication, between and across multiple levels of government and non-government organizations, to make roadways safer for British Columbians.

It is within the context of these four principles that the following 28 recommendations are proposed, with the aim of leveraging and expanding upon existing programs and successes, enhancing road safety, and improving related health outcomes in BC.

A Strategic Approach to Road Safety in BC

International comparisons provide examples of substantial safety improvements that can be made by adopting a road safety paradigm in which there is shared responsibility across the full system, including its designers.[2,3] This requires shifting the way that we think about road safety, as well as making the safety of road users a key priority for BC. Increasing road safety also means ensuring that active transportation, public transportation, and other alternatives to personal vehicles are viable options within and across all BC communities. Not only does this reduce the number of vehicles on the road, and subsequently the number of MVCs,[3] but it also encourages physical activity and supports healthy lifestyle choices and healthy communities. A shared responsibility for increasing road safety necessitates inter-sectoral and inter-ministerial collaboration, in particular between the Ministry of Health, Ministry of Transportation and Infrastructure, Ministry of Justice, municipalities, police, and health authorities in BC.

1. Support the BC Road Safety Strategy, and work collaboratively across all levels of government and with non-government partners to achieve Vision Zero, including having "the safest roads in North America and work[ing] toward an ultimate goal of zero traffic fatalities" as laid out in the provincial strategy, *British Columbia Road Safety Strategy: 2015 and Beyond*.[1] This should include ensuring the related steering committee and working groups have sufficient resources to achieve their mandates.

2. Establish and resource an independent Centre for Excellence in Road Safety in BC to work in collaboration with the steering committee and working groups for the BC Road Safety Strategy. A multi-agency governance committee should be created to support this centre, with authority to ensure that road safety data are made available to researchers, including data from the Insurance Corporation of British Columbia, the Ministry of Health, BC Ambulance Service, and more. This centre should be university based with a priority mandate to collect, analyse, and house provincial and community-level data related to all aspects of road safety and motor vehicle crashes, with the overall goal of improving the health and safety of road users in BC. The mandate would include collecting data to support the assessment of both systemic and human factors, identifying and addressing data gaps and limitations, and creating more efficient linkages between databases to facilitate meaningful and timely analyses.

3. Employ the principles of a Safe System Approach in all relevant policies and programs in BC. This approach considers road users, safe speeds, safe roadway design, and safe vehicle design in strategies and initiatives, and considers motor vehicle crash fatalities and serious injuries as systemic failures that are inherently preventable.

4. Focus provincial strategies, programs, and policies regarding roadways and infrastructure on the health and safety of vulnerable road users, and increase opportunities for safe, active transportation and public transportation. This should include commitments to develop vulnerable road user and active transportation-friendly plans for each region of BC. This also includes modifying intersections and other roadway infrastructure according to evidence-based safety designs to increase the visibility of vulnerable road users, increase traffic flow clarity, and better protect cyclists and pedestrians through methods such as prioritizing sidewalks, bicycle lane networks, and crosswalks. By focusing on increased protection of vulnerable road users, the health and safety of all road users can be improved.

Safe Road Users

Road user behaviour is a traditional area for interventions for road safety and has the potential to reduce the number of MVC-related serious injuries and fatalities with additional support. Improving road safety by addressing human factors and risk-taking behaviours requires collaboration between many partners, in particular, the Ministry of Health and Ministry of Justice.

5. Establish a more consistent approach to education, enforcement, and related penalties for the top three contributing factors in motor vehicle crash injuries and fatalities in BC: impairment, distraction,

and speed. This includes expanding penalties and legal consequences for driver distraction and speeding to be commensurate with penalties for alcohol-impaired driving (e.g., penalties incurred with the Immediate Roadside Prohibition Program), and increasing the visibility of enforcement for all three factors.

6. Extend the required zero (0.00) blood alcohol content for new drivers beyond completion of the Graduated Licensing Program, to age 25.

7. Continue to reduce alcohol-impaired driving through expansion and evaluation of policies and strategies that limit the availability of alcohol as per recommendations in the report, *Public Health Approach to Alcohol Policy: An Updated Report from the Provincial Health Officer*.[4] This includes evaluating the impact of increased access to alcohol introduced in BC in 2013,[5] and taking action as needed to adjust that access through increased prices and lower density of places that sell alcohol. This strategy should also include introducing random breath testing and implementing best practices for introducing and using ignition interlocks.

8. Improve capacity to identify impaired driving. This requires collaboration between researchers, law enforcement, and government and non-government partners to develop objective measures to assess impairment from all types of drugs. This should include support for research to better understand the impact of the use of all types of drugs on driving ability (e.g., prescription drugs, over-the-counter medications, and illegal drugs).

9. Support existing campaigns and increase public awareness of the laws designed to eliminate the use of cell phones and other handheld devices while driving. Preventing driver distraction should include emphasis on education and awareness of the dangers of this behaviour to complement related increased penalties.

10. Develop a strategy to assist individuals with physical, cognitive, and/or visual impairment—whether due to age or other factors—to be safe road users with ongoing independence and mobility in their communities. This should include improving and enhancing the processes for referrals for assessments and related follow-up, and a focus on identifying, developing, implementing and promoting appropriate transportation alternatives.

Safe Speeds

Speed is the largest contributing factor to MVC fatalities in BC, and vehicles travelling at unsafe speeds should be a priority to focus immediate efforts and resources on, in order to reduce speed-related fatalities and serious injuries. These recommendations highlight the need for an evidence-based, health and safety-first approach to setting speed limits that would increase safety for all road users. Reducing speed-related serious injuries and fatalities requires collaboration between the Ministry of Health, Ministry of Justice, Ministry of Transportation and Infrastructure, and local governments.

11. Set speed limits throughout the province based on roadway type, with consideration of the most vulnerable road users who frequent each type of roadway and the associated survivable speed for those road users during a motor vehicle crash. This includes monitoring and assessing the impacts of any increases in speed limits introduced, in addition to other policy changes that may result in increased speed, and appropriate corrective action to safeguard the health of BC road users.

12. Amend the *Motor Vehicle Act* to reduce the default speed limit on roads within municipalities and treaty lands from 50 km/h to a maximum of 30 km/h (the survivable speed for pedestrians and cyclists). This approach is consistent with road use best practices and increases consistency in speed limits across the province.

13. Establish appropriate speed limits for road and weather conditions and increase related driver awareness and education. This should include reduced speed limits as needed during winter weather and related road conditions.

14. Implement electronic speed management province-wide. This could include speed cameras, point-to-point speed control, or other speed monitoring technologies. The program should be transparent in the selection of locations and in the use of revenue generated. Any revenue generated should be allocated to funding additional road safety programs including a Centre for Excellence in Road Safety. Further, the program should be implemented starting in areas identified by communities as high risk and supported by road safety data where available.

Safe Roadways

There have been many improvements to roadway infrastructure in BC over the last few decades; however, further work is required to improve the health of road users while meeting the growing demands of the population, including greater access to public transit and increased safety and opportunities for vulnerable road users. Rural and remote areas face additional challenges (e.g., longer emergency response times, less public transit, and more wildlife interactions) that must be considered when working to enhance roadways in BC. Improving the safety of BC's roadways requires collaboration between many partners, particularly the Ministry of Health, Ministry of Justice, Ministry of Transportation and Infrastructure, and local governments.

15. Ensure that roadways in BC are safe for all road users by prioritizing pedestrian and cyclist health and safety in road and intersection design. This includes evaluating and improving existing intersections and roadways as appropriate. New or improved infrastructure should be evidence based and may include overhead lighting, improved traffic light timing, restricted turning behaviour, raised pedestrian crosswalks, protected pedestrian crossing phases, protected bicycle paths and bicycle lane networks, public transit-only lanes, protection of roadside workers such as emergency response personnel, and other design elements.

16. Continue to increase the safety of highways and rural and remote roads by implementing and/or expanding evidence-based road safety technologies and methods that can reduce motor vehicle crash fatalities and serious injuries. This should include increased installation of rumble strips and barriers, improved weather warning systems, greater prevention of conflicts with wildlife, and more efficient systems for identifying and responding to crashes in rural/remote areas.

Safe Vehicles

Some motor vehicle crashes in BC are directly attributable to vehicle design or condition (e.g., defective tires, brake failure). Innovations and improvements in vehicle design and engineering can prevent motor vehicle crashes from occurring and prevent fatalities and serious injuries of road users when they do occur. Improving road safety through safer vehicles in BC requires collaboration between the Insurance Corporation of British Columbia, the Ministry of Transportation and Infrastructure, and Transport Canada.

17. Collaborate with car manufacturers and encourage them to promote safety features that align with evidence-based best practices. This should include the expansion of safety features that come standard in new vehicles (e.g., pedestrian detection), and mechanisms to

prevent unsafe driving behaviour (e.g., technology that assists drivers in maintaining safe speeds or in detecting roadway dangers).

18. Implement a vehicle safety testing program in BC that requires regular basic vehicle safety checks (e.g., of tires, brakes, steering) as a condition of vehicle insurance, and offers incentives to British Columbians to acquire safety technologies (e.g., installation of speed limiting devices and breathalyzer ignitions). This program should be based on model examples of vehicle maintenance programs in other jurisdictions and should be cost neutral to vehicle owners by offsetting the required costs with commensurate reductions in insurance fees.

19. Increase the safety of vehicles imported into Canada and BC by requiring vehicles up to 25 years old to meet safety standards (up from the current 15 years) and eliminating the importation of right-hand drive vehicles into the province.

20. Regulate and set limits on the kind of vehicle modifications allowed in BC. This includes, but is not limited to, restricting how high a vehicle can be raised and prohibiting bull bars in urban areas.

21. Collaborate with professional associations to reduce motor vehicle crashes involving commercial vehicles. This includes implementation of new crash avoidance and safety technologies, evaluation and improvement of processes for monitoring vehicle maintenance, and improved monitoring and regulation of driver conditions and behaviours such as driver fatigue.

Road Safety for Aboriginal Communities

The creation of the First Nations Health Authority in BC and their leadership in the development of regional wellness plans[6] present a prime opportunity to facilitate First Nations community-driven solutions in partnership with the provincial and federal governments, other health authorities, Aboriginal organizations, and industry. These recommendations will require resources, meaningful partnerships, and commitment from stakeholders in order to reduce the disproportionate burden of motor vehicle fatalities on Aboriginal peoples in BC. Improving road safety for Aboriginal peoples requires collaboration between the Ministry of Health, Ministry of Transportation and Infrastructure, Ministry of Justice, Ministry of Aboriginal Relations and Reconciliation, and the First Nations Health Authority.

22. Following principles of ownership, control, access, and possession (OCAP), support the development of community-driven research on motor vehicle crash fatalities and serious injuries, including their associated risk factors and appropriate interventions for Aboriginal peoples in BC.

23. Continue to support the First Nations Health Authority to develop an Aboriginal injury prevention strategy that has key targets for improving road safety. This strategy should include improving first responder programs in rural and remote First Nations communities, and increasing awareness about seat belt use and safe driving. Related actions should include the development and evaluation of community-based injury prevention priority initiatives and related educational materials in Aboriginal communities, and support for the evaluation of

existing injury prevention initiatives to assess cultural relevancy and use of best practices.

24. Implement the Aboriginal Administrative Data Standard in organizations that collect motor vehicle crash and related data, including the Insurance Corporation of British Columbia for traffic claims data; police for Traffic Accident System data (police-recorded data); and health authorities for hospitalization data.

Education, Awareness, and Enforcement

Knowledge and awareness about road safety and the consequences of unsafe road use allow all road users to make informed choices about their behaviour, while enforcement—and the visibility of that enforcement—encourages adherence to safe road use standards and practices. Improving road safety education, awareness, and enforcement through policies about vehicles in BC requires collaboration between the Ministry of Health, Ministry of Justice, Ministry of Education, local governments, police, and related community groups.

25. Using evidence-based best practices, reinvigorate road safety campaigns for road users, with particular emphasis on the populations with the heaviest burden of motor vehicle crash fatalities and serious injuries—including males, people age 16-25 and 76 and up, Aboriginal peoples, and those in rural and remote communities—and targeting specific health and safety concerns. This may include both the use of traditional methods such as school seminars and mainstream media, and modern methods such as social media. Campaigns should be coordinated at local, regional, and provincial levels, and should target topics based on regional- and community-level road safety issues, including restraint use, alcohol and/or drug impairment, speeding, vehicle maintenance, and others. Education should focus on knowledge about health promotion and injury prevention, such as an understanding of survivable speed, rather than solely on awareness of related penalties.

26. Use a healthy communities approach to increase road safety among all school-aged children and youth, particularly with respect to pedestrian and cycling safety. This should include re-launching bicycle safety education initiatives through community programs and services, such as sponsoring annual bicycle rodeos, promoting walk/bike to school weeks, and more.

27. Develop a comprehensive education plan for youth that leverages the stages and requirements of BC's Graduated Licensing Program with the goal of increasing education and training about the top contributing factors to motor vehicle crashes: speed, impairment, and distraction.

28. Increase public education and awareness of the risks and consequences of speed, road user distraction, and all forms of impaired driving, and expand related enforcement efforts. This should include awareness of the increase in injury severity as speed increases; the dangers of using handheld devices while driving; the array of impacts that result from impairment from alcohol and other substances such as legal and illegal drugs (e.g., marijuana, prescription medication); and the dangers of cognitive impairment and fatigue.

Update on Road Safety Governance and Leadership for Recommendations

Organizational changes within government can further complicate the already complex governance of road safety in BC, but they may also enable opportunities for new and innovative approaches and potential collaborations. After content for this report was finalized, the BC Ministry of Public Safety and Solicitor General was re-established, and RoadSafety BC was moved under this ministry.[ax] While some of the recommendations presented in this chapter have a clear provincial ministry lead, others will require co-leadership and/or cross-ministry partnerships. It is recommended that leadership for this report's 28 recommendations be as follows:

Lead Organization	Recommendations
Ministry of Public Safety and Solicitor General (PSSG)	#1, #2, #5, #6, #7, #8, #10
Ministry of Transportation and Infrastructure (MoTI)	#13, #16, #18, #20, #21
Shared between PSSG & MoTI	#14
Ministry of Health (MoH)	#22, #23, #24
Insurance Corporation of BC (ICBC)	#9, #25, #26, #27, #28
Transport Canada	#17, #19
Shared between PSSG, MoTI, MoH, ICBC, and local governments	#3, #4, #11, #12, #15

CONCLUSION

Road safety in BC is a critical public health issue. There have been many successes in road safety in BC over the last few decades, including advancements in vehicle design, roadway design, and road user behaviour. Despite the growth in the population and the associated stress on roadway systems in the province, the result of these improvements is that the numbers and rates of motor vehicle crash (MVC) fatalities and serious injuries have decreased. However, preventable MVC fatalities and serious injuries still occur in BC and the overall decline has not kept pace with other jurisdictions. In addition, some populations experience a disproportionate burden of MVC fatalities and serious injuries, and specific contributing factors (e.g., distracted driving) are associated with an increasing proportion of MVC fatalities. Furthermore, there has not been proportionate and meaningful declines in death and serious injuries for vulnerable road users.

We know that BC could achieve lower death and injury rates and that enhancing road safety will not only avert preventable mortality and morbidity but also foster more active and ecologically friendly transportation—improving both human and environmental health. The recommendations offered in this report aim to address challenges to road safety while building upon our current successes. Any preventable death or serious injury is unacceptable, including those that occur as the result of an MVC.

[ax] Since this reorganization took place after this report was finalized, it is not reflected in discussions regarding governance over roads and road safety.

Appendix A

Glossary

A

Aboriginal people	The descendants of the original inhabitants of North America. The terminology used to refer to Aboriginal people in Canada has varied over the years. The *Constitution Act* recognizes three groups of Aboriginal people: Indian, Inuit, and Métis. See also: *First Nations, Inuit, Métis*, and *Status Indians*; and sidebar *Aboriginal Terminology* in Chapter 9.
Active transportation	All human-powered forms of travel, such as walking, cycling, using a wheelchair, inline skating, skateboarding, skiing, canoeing, etc.[1] Walking and cycling are most popular and can be combined with other modes of travel, such as public transit.[2]
Adaptive cruise control	A vehicle technology that works in conjunction with regular cruise control to automatically slow the vehicle in heavy traffic to maintain a safe following distance from the vehicle in front, and to accelerate to maintain the preset cruise speed when traffic allows.[4] See also: *cruise control.*
Adaptive headlights	A vehicle technology that points the vehicle's headlights in the direction the vehicle is going rather than straight ahead. This helps a driver see around curves in the dark.[5]
Advanced front air bags	These air bags provide similar protection for the driver and front passenger as regular air bags but use a dual inflation system that deploys the air bags at varying pressure levels depending on the severity of the crash, the size of the occupant, and how close the occupant is to the air bag.[3] See also: *air bag*.
Age-standardized rate	The summary of age-adjusted death rates by age and sex, which have been standardized to a 1991 Canada Census "standard" population for the purpose of rate comparisons between sexes, different time periods, or different geographic locations. The age-standardized fatality rate per 100,000 population is the theoretical number of deaths that would occur per 100,000 population if the specific population had the same age structure as the standard population.
Air bag	A vehicle safety device designed to inflate instantly in a motor vehicle crash to protect the vehicle occupants[6]—and in some cases vulnerable road users outside of the vehicle—from injury or death by cushioning them from hard vehicle surfaces. They are designed to supplement seat belts. See also: *advanced front air bags*.
Alcohol impairment	In BC, a driver is considered impaired by alcohol when they have a blood alcohol content (BAC) level of 50 milligrams of alcohol per 100 millilitres of blood.[7] In Canada, it is a criminal offence to operate a motor vehicle with a BAC of 80 milligrams of alcohol per 100 millilitres of blood or higher.[8] See also: *blood alcohol content, impairment*.

Anti-lock braking systems	A vehicle technology that increases safety during braking by automatically modulating the pressure in the braking system to prevent the brakes from locking. This allows the driver to retain control of the steering while braking hard.[9] This technology became standard on most vehicles sold in Canada in the 1980s but is not compulsory.[10]

B

Blood alcohol content (BAC)	A unit of measurement for the amount of alcohol in a person's body. It is measured as milligrams of alcohol per 100 millilitres of blood. It can be measured with a breath sample or a blood sample.[7] See also: *alcohol impairment*.
Brake assist	A vehicle technology system that automatically responds to panic braking by applying the brakes fully in order to prevent a crash or reduce the severity of a crash.[11]
Bull bars	Rigid metal bars affixed to the front of a vehicle (often a sport-utility vehicle or truck), usually as an after-market modification to protect the vehicle in case of collision, especially with a wild animal.[12]

C

Cognitive impairment	The reduced ability to operate a vehicle due to inadequate mental function. This could result from a variety of conditions such as age, illness, fatigue, and/or disability. See also: *impairment*.
Commercial drivers	People who drive as part of their core business activity and often receive related special training.[13] Examples of commercial drivers include bus drivers, taxi drivers, couriers, emergency vehicle drivers, and drivers of heavy commercial vehicles.[14] Commercial drivers are different than occupational drivers. See also: *occupational drivers*.
Commercial vehicles	A commercial vehicle can be any vehicle registered with a business and used to transport goods and/or passengers. Examples of commercial vehicles include trucks, taxis, buses, ambulances, and dump trucks.[14]
Contributing factors	The events and circumstances that are perceived to have contributed to a motor vehicle crash (MVC). In this report, these are factors that an attending police officer records in an accident report after an MVC,[15,16] and they fall within four broad categories: (1) human conditions, e.g., distraction of a driver or other road user, driver inattention, driver impairment; (2) human actions, e.g., driver error, speeding, failing to yield right of way; (3) environmental conditions, e.g., road conditions, weather, wild animals; and (4) vehicle condition, e.g., defective tires, defective brakes.[15,16]
Crash avoidance technologies	A vehicle system that warns a driver and/or intervenes in driving to avoid or reduce the severity of an impending motor vehicle crash. They range from assisting drivers to stay alert to their surroundings to assuming control of the vehicle to prevent a crash if a driver is not responding appropriately (e.g., auto-braking, auto-steering).[17] Crash avoidance technologies are also known as collision avoidance systems and active safety systems.

Crashworthiness	Crashworthiness is a measure of a vehicle's structural ability to physically deform in the event of a motor vehicle crash, while maintaining a space for occupants that allows them to survive crashes within a reasonable threshold of crash severity.[18]
Cruise control	A vehicle technology that maintains a consistent speed without using the gas pedal.[19] See also: *adaptive cruise control*.

D

Daytime running lights	Vehicle headlights that come on automatically when the engine is started. Their purpose is to increase the vehicle's visibility to oncoming traffic during daylight hours.[20] All new vehicles imported into or sold in Canada after December 1, 1989, must have daytime running lights.[21]
Distracted driving	Occurs when a driver's attention is diverted to an object, activity, event, or person not related to driving. It can include a wide range of non-driving activities, including eating and drinking, smoking, personal grooming, adjusting the stereo, interacting with passengers, using a vehicle navigation system, and any use of cellular phones (both handheld and hands-free) or other electronic devices while driving.[22,23] It is not attributable to a medical condition or impairment.[24] See also: *road user distraction*.
Distraction	See *road user distraction*.
Drug impairment	The reduced ability to operate a vehicle due to the consumption of legal drugs (such as medications) and illegal or illicit drugs. See also: *impairment*.

E

Electronic stability control	A vehicle technology that helps a driver maintain control by preventing skidding under most driving conditions, including on icy, slushy, and snowy roads.[25] Electronic stability control (ESC) monitors the driver's use of the brake pedal, and when the steering direction does not match vehicle direction, ESC applies brakes to one or more wheels and/or reduces engine power to regain control.[26] In 2011, ESC became mandatory for all new vehicles sold in Canada.[26]
Environmental streets	Roadways that use a variety of built elements, usually aesthetically rendered, to calm and slow traffic, and encourage driver attention (e.g., planter boxes, pedestrian refuges on road crossings, raised pedestrian crosswalks).[27]

F

First Nations	A collective term used to identify Aboriginal people who are often members of a First Nation band or tribe. First Nations refers to both Status Indians and Non-Status Indians. The term First Nations has largely replaced the term Indian as the terminology preferred by many Aboriginal people in Canada; however, Indian is still used when referring to legislation or government statistics. See also: *Aboriginal people, Non-Status Indians, Status Indians*.

Forward collision warning systems	A vehicle technology designed to help prevent rear-end collisions[28] by monitoring the relative speed of the vehicle in front and the distance between the two. The system alerts the driver when it senses the vehicle ahead slowing or stopping and there is a risk of a motor vehicle crash.[29]

H

Heavy vehicle	The largest vehicle weight/size class, but the weight/size varies by source (as noted in related discussions in this report). Heavy vehicles include both straight trucks (engine unit and flatbed that cannot be detached), tractors (a cab accompanied by a detachable trailer),[30] and in some cases includes public buses.[15] These vehicles are generally used for commercial purposes. See also: *light vehicle, medium vehicle*.
High-risk driver	Drivers who drive in an aggressive manner or in a way that may harm property or another person and who may display risk-taking behaviour or hostile behaviour toward another individual.[31] They can also be identified as drivers with high numbers of driving violations compared to average drivers.[32]
Highway	Major roadways that are designed for large volumes of traffic (including commercial transport vehicles) moving intra-provincially, inter-provincially, and/or internationally. Larger highways are often called freeways or expressways, and speed limits are typically higher than on local roads.[33]

I

Ignition interlock	A breath-testing device to measure blood alcohol content that is connected to a vehicle's ignition system to prevent an alcohol-impaired person from driving the vehicle. The device requires a breath test from the driver before the vehicle will start and randomly when the vehicle is in operation. If a breath sample tests positive for alcohol, the interlock prevents the vehicle's engine from starting, or if the vehicle is in operation, the device repeatedly instructs the driver to turn off the vehicle.[34]
Immediate Roadside Prohibitions	A BC program that enables police officers to seize an alcohol-impaired person's driver's licence, issue a driving prohibition to remove driving privileges for up to 90 days, and impound the driver's vehicle for up to 30 days.[35]
Impairment	The reduced ability to operate a vehicle due to one or more causes, including consuming alcohol, consuming drugs (legal, illegal or illicit), inadequate cognitive function, or inadequate physical function. See also: *alcohol impairment, cognitive impairment, drug impairment*, and *physical impairment*.
Intelligent speed adaptation	A vehicle technology that detects when a driver is travelling over the posted speed limit based on electrical signals from a beacon/transmitter attached to roadside infrastructure or via global positioning system (GPS) technology.[36] It either audibly or visually warns the driver they are speeding or assumes control of limiting the speed of the vehicle to prevent speeding.
Intersection	An area where two or more roads cross each other.[37] In this report it is categorized as a roadway type.

Inuit	A distinct population of Aboriginal people that lives primarily in Nunavut, the Northwest Territories, and northern Labrador and Quebec. See also: *Aboriginal people*.

L

Lane change assist	A vehicle technology that monitors the area immediately around and behind a vehicle to assist a driver when changing lanes. If the system detects a vehicle in the adjacent lane, it alerts the driver to the presence of the other vehicle.[38]
Lane departure warning systems	A vehicle technology that monitors the position of a vehicle relative to the lane boundary.[38] The system delivers a warning to the driver if the vehicle appears to be drifting or departing from its lane (e.g., due to driver inattention),[38,39] so that the driver can correct the vehicle's course,[40] and thus prevent lane departure crashes.
Lane keep assist	A type of lane departure warning system that helps a driver by controlling the vehicle to ensure it stays within its lane.[40] See also: *lane departure warning systems*.
Leading pedestrian intervals	Signal timing that allows pedestrians to begin crossing the street before vehicles (usually by 3-7 seconds), with the purpose of increasing pedestrian visibility and thus reducing pedestrian motor vehicle crashes.[41]
Light vehicle	The smallest vehicle weight/size class, but the weight/size varies by source (as noted in related discussions in this report). Light vehicles generally include cars, station wagons, vans, sport-utility vehicles, and small pickup trucks.[30] These vehicles may be used for personal or commercial purposes. See also: *heavy vehicle, medium vehicle*.
Local roads	These roads are the lowest functional road class,[42] and are usually used by light vehicles, cyclists, and pedestrians. Definitions of local roads vary; for example, roads giving access to individual land use such as residences[42] or roads without a centre line.[43] See also: *major roads*.

M

Major roads	These are roads with a higher functional road class than local roads, and a lower class than highways. They are usually the roads that connect activity centres, residential areas, and service areas.[42] See also: *local roads*.
Medium vehicle	The mid-sized vehicle weight/size class, but the weight/size varies by source (as noted in related discussions in this report). Medium vehicles are usually straight trucks (an engine unit and flatbed that cannot be detached)[30] but can also include sport-utility vehicles, pickup trucks, and vans. These vehicles may be used for personal or commercial purposes. See also: *light vehicle, heavy vehicle*.
Métis	A distinct people of mixed First Nation and European ancestry who identify themselves as Métis, and are distinct from Status Indians, Inuit, and non-Aboriginal people. Most Métis live in Alberta, Saskatchewan, or Manitoba. See also: *Aboriginal people*.
Motorcycle	A motor vehicle that runs on two or three wheels, and has a saddle or seat for the driver to sit on.[44]

N

Non-Status Indians	People who identify as First Nations but either do not meet the criteria for registration as a Status Indian under the *Indian Act* or who have chosen not to be registered. See also: *Aboriginal people, Status Indians*.

O

Occupational drivers	Drivers who are required to drive for work-related purposes, but driving is not their principal occupation. They are not necessarily professional drivers, and they have generally not received related specialized training or testing. Examples of occupational drivers include community health professionals, and workers in retail, wholesale, and service industries.[13] Occupational drivers are different than commercial drivers. See also: *commercial drivers*.

P

Painted cycling lanes	Designated cycling lanes located directly adjacent to a motor vehicle roadway and indicated with painted lines.[46,47] See also: *protected cycling paths*.
Pedestrian	A person on foot or the equivalent, such as using a wheelchair, stroller, or walker.[48] In this report, pedestrians also include people travelling on skateboards, roller skates, and more.
Pedestrian scramble	A type of signalized intersection designed to protect pedestrians by providing an exclusive pedestrian crossing phase. Pedestrians can typically cross the street in any direction, including diagonally.[32]
Pedestrian streets	Roads strictly for pedestrian use (i.e. closed to vehicles), and usually located in a busy commercial area.[49]
Physical impairment	The reduced ability to operate a vehicle due to physical functioning. This could result from a variety of conditions such as age, illness, and/or disability. See also: *impairment*.
Protected cycling paths	Designated paths for cyclists that are protected from motor vehicle traffic by a buffer space or physical barrier, such as curbs or bollards (short posts that divide traffic).[46,47] See also: *painted cycling lanes*.

R

Red light camera	Cameras affixed to traffic lights that automatically photograph vehicles that travel through an intersection when the light is red, in order to issue a violation ticket.[50]
Reserve	Refers to a First Nations reserve, which is a piece of land owned by the Government of Canada and set aside for use by a First Nations band.[45] People, services, objects, or events, such as motor vehicle crashes, occurring within this land are recognized as "on-reserve."

Resource roads	One or two lane, gravel roads in remote areas built for commercial access to natural resources such as forests, petroleum, and minerals. They also include *Land Act* roads and special-use permit roads.[51]
Road	In this report, road and roadway are used interchangeably and generally mean the open way for vehicles and persons. A road may include only the strip used for travel (usually paved or gravel) or may encompass related features on the right-of-way such as the shoulder or sidewalk. See also: *highway, local roads, resource roads, rural roads*.
Road rage	An extreme form of driver aggression and high-risk driver behaviour that typically results from high levels of driver frustration, stress, anger, and hostility.[52,53] It is an overreaction of aggressive thoughts, behaviours, and emotions of a driver targeted at a victim in response to a road-related incident.[54]
Road user	Anyone using a roadway. This includes but is not limited to pedestrians, cyclists, motorcyclists, vehicle drivers, and bus occupants.[55]
Road user distraction	When a road user's attention is diverted to an object, activity, event, or person not related to the road. It can include a wide range of activities, such as eating and drinking, smoking, personal grooming, interacting with other people, using a navigation system, and any use of cellular phones (both handheld and hands-free) or other electronic devices.[22,23] See also: *distracted driving*.
Roadway	See *road*.
Roadway departure	The act of driving off the portion of the road intended for motor vehicles, usually unintentionally.[56]
Roundabouts	Circular intersections that do not have electronic signals or stop signs,[57] in which traffic flows around a center traffic island.[49]
Rural roads	A road, often a highway or major road, located in an area outside of a municipality.[58]

S

Safe System Approach	An approach to understanding road safety that is guided by the concepts that road systems should be designed to accommodate inevitable human error and should account for the limitations of the human body to withstand physical force, and that the responsibility for road safety is shared across the system by users, designers, and policy makers.[59] There are some variations of this approach, but the four main pillars examined in this report are safe vehicles, safe speeds, safe roads, and safe road users.
Sobriety checkpoints	A temporary roadway cordon established by road authorities to check driver's licences and/or vehicle safety, and to evaluate drivers for alcohol impairment. Sobriety checkpoints are also known as roadblocks. See also: *blood alcohol content, impairment*.
Speed camera	A device that uses laser and radar technology to detect when a vehicle is speeding and takes a photograph of the speeding vehicle in order to issue a penalty to the vehicle owner.[61]

Speed hump	A speed-reducing device consisting of an artificial elevation, usually the height of the pedestrian curb, that often spans a residential roadway.[49] Speed hump designs can vary, as can the terminology referring to them; some researchers distinguish specifically between speed humps and speed bumps, while others use them interchangeably.[62]
Speed limiters	Devices installed in a vehicle's engine to prevent excessive speed.[63] They are most commonly used in heavy commercial vehicles.
Speeding	Speeding in BC includes driving faster than the designated speed limit and driving too fast for the conditions (which may be lower than a posted limit). Excessive speeding is when an individual drives at a speed more than 40 km/h over the speed limit.[60]
Status Indians	People who identify as First Nations and who are entitled to receive the provisions of and have registered under the *Indian Act*.[64] See also: *Aboriginal people*, *Non-Status Indians*.
Survivable speed	The maximum vehicle travelling speed at which the human body is likely to survive impact from a motor vehicle crash if it should occur. Vulnerable road users have lower survivable speeds than vehicle occupants.[32,65]

T

Traffic calming	The modification of a roadway and its design in a way that is intended to improve road safety, especially for vulnerable road users, by reducing and slowing the flow of traffic in the area. Safety is increased by implementing changes that aim to minimize the negative impacts of vehicle use, reduce traffic volume, change drivers' behaviours, lower speeds, and reduce conflict between road users with improved conditions for pedestrians and cyclists.[66] Examples of traffic calming modifications include changes to the road layout, creation of one-way streets, addition of roundabouts, addition of speed bumps, and more.[67]

U

Underride guards	Steel bars extending downward from the back or sides of large trucks to prevent smaller vehicles from moving underneath the truck's trailer in a motor vehicle crash.[68]
Urban play streets	Residential roads designed for non-vehicle road use, including play, rather than vehicles, and where only residential vehicles are allowed.[49]

V

Vehicle crash incompatibility	The mismatch of vehicle designs (shapes, sizes, and conditions), which makes safety features less likely to function optimally during a motor vehicle crash (MVC), thereby resulting in a greater likelihood of serious injury or fatality to some vehicle occupants in the event of an MVC (usually the smaller vehicle's occupants).[69]

Vehicle kilometres	An estimate of traffic volume calculated by multiplying the number of vehicles on the road by the distance travelled. The distance travelled can be determined by odometer readings, traffic counts, household surveys, and/or fuel sales.[70]
Vulnerable road user	Any road user who does not have the protection of an enclosed vehicle, and is therefore at heightened risk of injury or fatality related to a motor vehicle crash.[71] This generally includes pedestrians, cyclists, and motorcyclists.[72]

Appendix B

Data Sources Technical Appendix

The BC Injury Research and Prevention Unit provided most of the analyses presented in this report, as well as this technical appendix. The Provincial Health Officer would like to thank the Unit for their contributions in these capacities.

To examine motor vehicle crashes (MVCs) in BC, this report uses data from multiple sources that have been compiled and analyzed by the BC Injury Research and Prevention Unit (BCIRPU), with additional analyses and work by the Population Health Surveillance, Engagement and Operations team at the BC Ministry of Health. Data sources are introduced in Chapter 1 of this report and additional information is presented here.

DATA SOURCES

BC Vital Statistics

The BC Vital Statistics Agency registers events such as births, deaths, and marriages in BC and provides a range of vital statistics-related products and services to meet public needs. Data entered into the mortality database consist of injury event classifications, region of residence, unique identifiers, place of injury occurrence, nature and cause of injury, anatomical location, pre-event circumstances, manner of death, and toxicology reports. BC Vital Statistics uses the World Health Organization's International Statistical Classification of Diseases (ICD) codes (Version 10) to present data, including death data. MVCs are associated with the following codes: V02-V04, V09, V12-V14, V190-V196, V20-V79, V803-V805, V820-V821, V823-V890, V899, Y850.

BC Vital Statistics data regarding MVC fatalities were used in this report in Chapter 9 for analyses of causes of death and MVCs among Status Indians (and other residents) in BC, because Traffic Accident System data (discussed later in this chapter) do not include information about Aboriginal identity. For the years presented in this report, Status Indian residents of BC were those identified in any of the following three sources: Health Canada's Status Verification File; Vital Statistics birth and death registrations; or the Status Indian entitlement files from the BC Medical Services Plan database.

Discharge Abstract Database

The Discharge Abstract Database (DAD), housed at the Ministry of Health, records detailed patient information, including ICD Version 10 diagnostic codes (listed earlier) that describe the causes and types of injury for transport-related incidents. The database includes all transport injuries with a "road motor vehicle" (this excludes non-road motor vehicles such as trains, planes, and boats). The DAD only reflects data for those persons who were admitted to hospital for an overnight stay that did not result in death, and the record ends when the patient is discharged from hospital. The DAD does not include emergency room data or fatalities. If the patient is transferred to a new facility, a new record is created at that facility.

Hospitalization is used in this report as a proxy indicator for a serious injury. Serious injury (hospitalization) data include acute, rehabilitation, and surgery cases that required at least one overnight stay in the hospital.

To avoid multiple counts of the same injury, when a patient was hospitalized more than once during a fiscal year (e.g., re-admitted, transferred to another hospital), only the first admission was counted. Fatalities that occurred in hospital as a result of a serious injury were excluded from serious injury counts. Typically, DAD data are reported by fiscal year. The hospitalization data in this report are depicted by calendar year (based on the admission dates) so as to be consistent with the fatality data sources. Further, there are many reasons beyond decreasing MVCs that could contribute to decreasing hospital admission rates over time, such as advancements in related technologies (e.g., improved diagnostic and treatment technologies).

DAD Road User Definitions

Pedestrian: any person involved in an accident who was not at the time of the accident riding in or on a motor vehicle, railway train, streetcar, or animal-drawn or other vehicle, or on a pedal cycle or animal. This includes people walking, riding in a stroller, working on the side of the road (e.g., changing a tire) roller-skating, skiing, sledding, or those riding a scooter, skateboard, or wheelchair.

Motorcycle occupant: anyone riding a motorcycle, including motorcycle drivers, and passengers.

Cyclist: any person riding on any land transport vehicle operated solely by pedals; this includes bicycles, tricycles, and unicycles, but excludes motorized bicycles.

Other road user: includes occupants of animal-powered transport on roads governed by the *Motor Vehicle Act*, railway trains, streetcars, industrial, agricultural, or construction vehicle, and unknown or unspecified vehicles.

DAD Vehicle Definitions

Passenger vehicle: includes cars, trucks, sport-utility vehicles, commercial vehicles, and heavy trucks, and excludes motorcycles.

Motorcycle: a two-wheeled vehicle with one or two riding saddles and sometimes with a third wheel for the support of a sidecar. This includes mopeds, motor scooters, motorcycles, motorized bicycles, and speed-limited motor-driven cycles. This excludes motor-driven tricycles.

Pedal cycle: any land transport vehicle operated solely by pedals, including a sidecar or trailer attached to such a vehicle. This includes bicycles and tricycles, and excludes motorized bicycles.

Business Information Warehouse

The Business Information Warehouse (BIW) is part of the Insurance Corporation of British Columbia (ICBC) and contains information about BC, including the number of active BC driver's licences, the number of registered vehicles over time, and the number of people involved in MVCs. Data from the BIW were used in this report to examine driver populations. The BCIRPU has reported the data by health authority region for this report. Therefore, the data in this report are not presented by the typical regions used by ICBC when reporting. Further, ICBC data regarding number of crashes will differ from police-reported data, as police do not attend all MVCs.

Traffic Accident System Database

The Traffic Accident System (TAS) database is also part of ICBC, and contains information from the Traffic Accident Reporting Form (MV6020) completed by police at the scene of an MVC. TAS road user and vehicle definitions are based on ICBC's Traffic Accident Reporting Police

Procedures Manual. The TAS contains detailed information related to the crash itself such as contributing factors (e.g., speed, alcohol use, distraction, weather); type of victim (e.g., driver, passenger, pedestrian); and outcome (e.g., death, major injury, minor injury). In the TAS, a fatality is defined as a road user who dies from injuries resulting from an MVC within 30 days of the incident. This includes only MVCs that occur on roadways where the *Motor Vehicle Act* applies and excludes roads where the Act does not apply, (e.g., forest service roads, industrial roads, and private driveways). Fatal victims of off-road snowmobile accidents, and vehicle-involved homicides or suicides are also excluded from the database. Therefore, the number of MVC fatalities reported in the TAS is lower than what is reported by the BC Vital Statistics Agency. The TAS data have been reconciled with BC Coroners data, Royal Canadian Mounted Police data, and other police data. The reconciliation of TAS data with Coroners Service data is limited to basic information regarding the death (e.g., date of the MVC, date of death, age and sex of the victim, total number of fatalities), and does not include confirmation of contributing factors to the MVC noted by police. Discrepancies in definitions may exist between these data sets.

When police complete the MVC reporting form they assign contributing factors, which are any factors the attending officer perceives to have directly contributed to the MVC. Up to four contributing factors may be attributed to each vehicle or driver involved in the MVC. As such, the fatal victim is not necessarily the perpetrator of the police-identified contributing factor. For example, if alcohol impairment was a contributing factor in an MVC where a pedestrian was killed by a vehicle, either the pedestrian or the vehicle driver may have been the impaired person in the MVC. Contributing factors assigned by police typically focus on human contributing factors and other factors related to the *Motor Vehicle Act*, rather than providing a broader systemic focus on contributing factors that emphasize the potential for prevention and harm reduction through vehicle design, roadway design, and appropriateness of speed limits.

This report derives fatality data from the TAS. It does not use serious injury data from the TAS because, due to a 2008 legislation change, police are no longer required to attend all non-fatal MVCs. Since police do not fill out police reports for MVCs they do not attend, the TAS injury data from 2008 onward do not accurately reflect MVC injuries in BC. In this report, distracted driving is defined using three TAS codes: 34 (Communication/Video Equipment); 85 (Driver Inattentive); and 86 (Driver Internal/External Distraction).

TAS Road User Definitions

Pedestrian: any person not in or upon a motor vehicle or other road vehicle. This includes a person afoot, sitting, lying, or working upon a roadway or land, and a person in or operating a pedestrian conveyance (e.g., baby carriage, push-cart, push-chair, roller-skates, scooter, skateboard, wheelchair). This excludes a person boarding or exiting a vehicle, and a person jumping or falling from a motor vehicle in transport.

Motorcycle occupant: anyone riding a motorcycle, including motorcycle drivers and passengers.

Cyclist: anyone riding on any land transport vehicle operated solely by pedals. This includes bicycles, tricycles, and unicycles but excludes motorized bicycles.

Other road users: occupants of animal-powered transport on roads governed by the *Motor Vehicle Act* and of railway trains.

TAS Vehicle Definitions

Motor vehicle: any mechanically or electrically powered device, not operated upon rails, upon which or by which any person or property may be transported or drawn upon a highway. Any object such as a trailer, coaster, sled, or wagon being towed by a motor vehicle is considered a part of the motor vehicle, including such devices detached while in motion, or set in motion by a motor vehicle, such as during pushing. Also, the load, including occupants, upon or in the motor vehicle, or upon or in the device being towed or pushed, is considered part of the motor vehicle. This includes, but is not limited to an automobile such as a car, bus, truck, van, or motorcycle; a motorized bicycle or scooter; a trolley bus not operated upon rails; construction machinery; farm and industrial machinery such as a road roller, tractor, army tank, highway grader, or similar devices equipped with wheels or threads; and special motorized devices such as snowmobiles, swamp buggies, or similar devices.

Passenger vehicle: includes cars, trucks, sport-utility vehicles, commercial vehicles, and heavy trucks, and excludes motorcycles.

Commercial vehicle: includes heavy vehicles, such as trucks, trailers, tractors, buses, and construction vehicles.

Motorcycle: includes mopeds, limited speed motorcycles (power-assisted bicycles), scooters, and tricycles (three-wheeled motorcycles).

Other vehicles: includes all-terrain vehicles, buses, recreational vehicles, motor homes, and general construction vehicles, as well as animal-drawn vehicles driven on roads governed by the *Motor Vehicle Act*.

Cycle: a vehicle operated solely by pedals and propelled by human power. This includes bicycles, tricycles, and unicycles. This excludes bicycles, tricycles and unicycles when being towed by a motor vehicle.

WorkSafe BC MVC-related Insurance Claim Data

WorkSafe BC is responsible for educating employers and workers about the Occupational Health and Safety Regulation[1] (a regulation under the *Workers Compensation Act*) and for monitoring their compliance with the regulation. WorkSafe BC also works with employees and their employers to provide return-to-work rehabilitation, financial compensation, health care benefits, and a range of other services when they experience work-related injury or disease. For this report, WorkSafe BC provided data on the number of MVC-related insurance claims and the costs of the claims paid by WorkSafe BC. They also provided information about the age and sex of the claimants.

CAUTIONS AND LIMITATIONS OF DATA

Data analyses presented in this report provide information that is the most current available at the time of developing the report, and great efforts have been made to ensure the data and associated methodologies used are accurate and reliable. However, like all data sources and methodologies, there are some limitations that necessitate caution when interpreting results.

Among databases, including those used in analyses for this report, misclassified, unspecified, and missing values are an inevitable limitation.[2] Additionally, for live databases like DAD and TAS, data may change over time, due to reporting corrections, adjustments, and reconciliation of data.

There are also some limitations and gaps in data available, which limits some of the methodologies employed in this report. There is currently no data source that provides a reliable and province-wide count of active cyclists and pedestrians in BC to provide a denominator for motorcyclists, cyclists, and pedestrians in BC; therefore, in this report rates for these groups are calculated based on the overall BC population. Thus, it is very likely that the resulting MVC fatality and serious injury rates greatly underestimate the risk and burden of injuries and fatalities. Also, as identified earlier regarding TAS data, since the contributing factors to MVCs with fatalities reported in TAS are assigned to MVCs (rather than road users), this report is not able to indicate whether a fatal victim of an MVC is at fault or whether the victim was associated more generally with the MVC. This allows for presentation and discussion of the sub-populations experiencing the burden of MVCs, but limits the ability to examine sub-populations that are causing the MVCs. Lastly, this report presents the rates together with the raw numbers (counts) of fatalities and serious injuries in order to account for the growing population of BC. However, rates can be misleading for small populations: small populations with few fatalities or injuries may appear to have large year-to-year variability, but in reality have very small differences in the number of fatalities in those years.

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