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Motor vehicle crashes among Canadian Aboriginal people: a review of the literature

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Introduction: Aboriginal people are substantially more likely to be injured or die in motor vehicle crashes (MVCs) than the general population. However, research examining MVCs among Canadian Aboriginal populations is limited. We examine trends and gaps in the Canadian literature and suggest priorities for future research.
Methods: We conducted a systematic review of the published and grey literature on MVCs involving Canadian Aboriginal people. We used the Haddon matrix of injury epidemiology and prevention to identify trends in crash-related risk factors.
Results: We reviewed 20 studies, which consisted of research at both national and provincial levels. We identified various risk factors related to human (e.g., male sex, substance use), vehicle and equipment (e.g., driving an older vehicle, driving a car [v. other types of vehicles]), and physical environment (e.g., occurring on-reserve, muddy and loose-gravel road conditions) variables. However, we did not find research that examined risk factors related to the social environment, such as perspectives related to MVCs.
Conclusion: This review indicates that rates of death, hospital admission and injury related to MVCs are twice as high among Aboriginal populations than the general Canadian population, which highlights a major public health concern. Priorities for future research should include examination of the social environment, more rigorous methods and collaborative research in partnership with Aboriginal communities.

Introduction : Les personnes autochtones sont beaucoup plus susceptibles que les membres de la population générale d'être victimes d'une blessure ou de mourir dans un accident de véhicule à moteur (AVM). La recherche sur les AVM dans les populations autochtones du Canada est toutefois limitée. Nous analysons les tendances et les lacunes des publications canadiennes et suggérons des priorités pour des recherches futures.
Méthodes : Nous avons procédé à une synthèse systématique des publications et de la littérature grise sur les AVM mettant en cause des personnes autochtones au Canada. Nous avons utilisé la matrice Haddon d'épidémiologie et prévention des blessures pour dégager des tendances des facteurs de risque liés aux accidents.
Résultats : Nous avons analysé 20 études comportant des recherches menées aux échelles nationale et provinciale. Nous avons dégagé divers facteurs de risque portant sur les variables relatives aux personnes (p. ex., sexe masculin, consommation de substances), au véhicule et au matériel (p. ex., conduite d'un véhicule moins récent, conduite d'une automobile [c. autres types de véhicules]), ainsi qu'à l'environnement physique (p. ex., accident se produisant dans une réserve, où les routes sont en général boueuses et en gravier). Nous n'avons toutefois pas trouvé de recherche portant sur les facteurs de risque liés à l'environnement social comme les perspectives sur les AVM.
Conclusion : Cette synthèse indique que les taux de mortalité, d'hospitalisation et de traumatisme liés aux AVM sont 2 fois plus élevés dans les populations autochtones que dans la population canadienne en général, ce qui dégage un important problème de santé publique. Les priorités pour les recherches futures devraient inclure l'examen de l'environnement social, des méthodes plus rigoureuses et une recherche concertée menée en partenariat avec des communautés autochtones.

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INTRODUCTION

Research has consistently shown high rates of unintentional injury among Aboriginal populations.[1,2] Rates of injury and death related to motor vehicle crashes (MVCs) among Aboriginal people compared with the general population are particularly alarming, and MVCs are the leading cause of unintentional death for this population in the United States.[2] However, this public health concern has not been as extensively examined in Canadian Aboriginal populations as it has been internationally, with most published research having been conducted in the US, Australia and New Zealand. To develop a better understanding of rates of injury and death related to MVCs among Canadian Aboriginal people, we examined the published and grey literature (i.e., non-peer-reviewed literature, such as federal, provincial and territorial government reports) on MVCs among Canadian Aboriginal people. In this review, the term Aboriginal refers to First Nations, Inuit and Metis people, as recognized in the Constitution of Canada. In Canada, status Indians are First Nations individuals registered with the government, who are entitled to treaty rights.[3] Group-specific data will be presented where available.

Motor vehicle crashes are a substantial cause of economic, societal and personal burden. About 10% of global mortality can be attributed to MVCs.[4] Moreover, by 2030, MVCs are projected to be either the third or fourth leading cause of global mortality, ahead of heart disease.[5] Specifically in Canada, 2209 people were killed and 172 883 were injured in an MVC in 2009.[6] Furthermore, the overall costs related to these deaths and injuries are estimated to be $25 billion a year, including direct and indirect costs.[6] It is clear that there is a high burden associated with MVCs. Because Aboriginal people experience higher rates of MVCs than non-Aboriginal people,[1] research in this area has implications for public policy in Canada.

The Haddon matrix[7] is the conceptual framework most commonly employed in the injury prevention literature and, as expanded by Christoffel and Gallagher,[8] is applicable to MVCs (Table 1[9]). This framework aids in identifying precrash, crash and postcrash risk factors. In terms of injury prevention, precrash- and crash-related risk factors hold heightened importance. Because preventing crashes is the ultimate goal, a focus is needed on precrash risk factors. However, not all crashes result in injuries; therefore, an understanding of crash-related risk factors (e.g., seat belt noncompliance) provides useful information for minimizing the occurrence of serious injuries. The Haddon matrix identifies 4 sets of factors to explain injuries: human (e.g., alcohol impairment), vehicles and equipment (e.g., regular vehicle maintenance), physical environment (e.g., presence of guard rails) and social environment (e.g., attitudes toward speeding). In this review, we employed the Haddon matrix to categorize trends existing within the published and grey literature.

This review examines trends and gaps in the national-level research on injuries related to MVCs as well as independent provincial-level research that has been conducted in Newfoundland and Labrador, Quebec, Ontario, Manitoba, Saskatchewan, Alberta, British Columbia and the Northwest Territories. Examining provincial data is important because Aboriginal communities can vary greatly based on environmental, cultural and political differences. We highlight priority areas of investigation to advise future research agendas.

METHODS

Data sources

We performed a systematic review of the published and grey research literature, following the literature search approach outlined by the Cochrane Collaboration[10] and meta-analytic methods.[11] Online resources and search terms used to identify the studies examined in this review can be found in Box 1.

Table 1. Examples of risk factors in the Haddon matrix of injury epidemiology and prevention applied to motor vehicle crashes[8,9]

Phases	Factors			
	Human	Vehicle/equipment	Physical environment	Social environment
Precrash	Driver experience Substance impairment	Speed Maintenance	Road design Speed limits	Attitudes toward speeding
Crash	Seat belt use Child restraint use	Crash protective design Occupant restraints	Presence of guard rails Other vehicles	Attitudes toward occupant restraints
Postcrash	Age of victims Health status of victims	Ease of access Fire risk	Proximity to rescue facilities	Attitudes toward emergency care in hospitals

Table adapted from Norton et al.,[9] with permission from The World Bank Publications.

Study selection

We reviewed research studies that examined the epidemiology of MVCs among Aboriginal populations in Canada. An initial search resulted in 223 studies with potential relevance. We included studies that were published after 1980 and reported at least 1 objective and quantified outcomes. We did not select studies based on metrics of overall quality (e.g., measurement error, control groups).[12] Of the 20 studies that met inclusion criteria, 13 were found in peer-reviewed journals and 7 appeared in the grey literature.

Data extraction

We extracted data based on the following categories: objective of the study, population (geographical location, Aboriginal population and sample size), data source, key findings and identified crash-related risk factors. Results from the studies were not statistically pooled because of the high heterogeneity between studies, including vast differences in study design and quality.

RESULTS

Summaries and results of the studies included in the systematic review are presented in Tables 2[13–22] and 3.[23–32]

Rates of injury and death related to MVCs

National and provincial rates

We found higher rates of injury and death from MVCs among Aboriginal populations than non-Aboriginal populations. Between 1991 and 2001, national age-standardized mortality related to MVCs among Aboriginal people ranged from 11.2 to 33.2 per 100 000 person-years at risk, compared with 3.8 to 9.4 among non-Aboriginal people.[18,19] Additionally, in western Canada during 2000, the age-standardized rate of hospital discharge for MVCs among First Nations (300 per 100 000 population) was more than double the rate among the rest of western Canada (130 per 100 000 population).[15]

Studies examining national MVC trends over time revealed some interesting findings. Trovato[22] reported an increase in mortality related to MVCs among First Nations adults during the 1980s. Other research suggests that MVC rates on Canadian reserves decreased 33.8% between 1991 and 1993.[14]

Provincial studies revealed elevated MVC rates, including elevated mortality, rates of hospital admission and injury, and injury severity, among specific Aboriginal populations compared with the rest of the province. Alaghehbandan and colleagues[23] found a higher MVC-related hospital admission rate of 277 per 100 000 population among Aboriginal people (including Metis, Inuit and Innu) compared with

Box 1. Online resources and search terms used to identify studies for review

Resources

- Academic Search Complete
- Australian Indigenous Health*Info*Net
- The Cochrane Library
- ERIC (Educational Resources Information Center)
- Google
- Google Scholar
- First Nations and Inuit Health, Health Canada
- Indian Health Service, US Department of Health and Human Services
- Indigenous Studies Portal
- Manitoba Aboriginal and Northern Affairs
- MEDLINE
- National Aboriginal Health Organization (NAHO)
- National Indian and Inuit Community Health Representative Organization (NIICHRO)
- ProQuest Dissertations and Theses Database
- PsycARTICLES
- PsycINFO
- Public Health Department of the Cree Health Board
- ScienceDirect
- Social Sciences Citation Index
- Transport Canada
- Web of Science

Search terms

- Aboriginal
- Canada
- First Nations
- Indian
- Indigenous
- Injury prevention
- Inuit
- Metis
- Motor vehicle accident
- Motor vehicle collision
- Motor vehicle crash
- Native
- Road safety
- Traffic accident
- Transport
- Unintentional injury

Table 2. Summaries and results of the national studies included in the review (part 1 of 2)

Study; source	Objective	Population (location, Aboriginal population and sample size)	Data source	Key findings	Identified precrash and crash risk factors
Allard et al.[13]; PR	To compare PYLL (before age 75) in health regions with high Aboriginal populations with other health regions	Canada; Aboriginal; "high-Aboriginal population" (≥ 19%) health regions = 18, "low-Aboriginal population" (< 19%) health regions = 120; *n* = NA	Mortality data from the Canadian Vital Statistics Database and population estimates for 1995–1997	PYLL rate for MVCs was higher in high-Aboriginal populations (9.0) than low-Aboriginal populations (3.8); rate difference = 5.2; rate ratio = 2.35	Sex PYLL caused by MVCs among males: high-Aboriginal = 12.2; low-Aboriginal = 5.4; rate difference = 6.7; rate ratio = 2.24 PYLL caused by MVCs among females: high-Aboriginal = 5.6; low-Aboriginal = 2.2; rate difference = 3.4; rate ratio = 2.54
Health Canada[14]; GL	To examine the health status and conditions of Aboriginal people living on-reserve in Canada	Canada; First Nations; *n* = NA	Data from Health Canada's First Nations and Inuit Health Branch for on-reserve Aboriginal people	Although MVCs were a leading cause of death among First Nations people, rates decreased 33.8% between 1991 and 1993	Age MVC mortality in 1999 (per 100 000): 0–9 yr = 10.0; 10–19 yr = 30.9; 20–44 yr = 35.7; 45–64 yr = 37.8; ≥ 65 yr = not a leading cause of death
Health Canada[15]; GL	To examine use of health services among First Nations people living on- and off-reserve in western Canada	Western Canada (Alberta, BC, Saskatchewan and Manitoba); First Nations; *n* = NA	Provincial hospitals administrative databases in western Canada	In 2000, the age-standardized hospital discharge rate for MVCs was higher among First Nations people (300/100 000) than the rest of Canada (130/100 000); rate ratio = 2.4	Sex Hospital discharge rates (per 100 000) for MVCs, among First Nations people: males = 320; females = 250; rate ratio = 1.3
Postl and Moffatt[16]; PR	To compare the health of Canada's Aboriginal population with the rest of the national population	Canada; Aboriginal; *n* = NA	*Medical Services Branch: Annual Report* (Health and Welfare Canada, 1978) and *Vital Statistics* (Statistics Canada, 1974)	In the 1970s, Aboriginal people had higher rates of death (60.5/100 000) than the rest of the national population (26.9/100 000)	Age Violent deaths (including MVCs) among Aboriginal people were higher than the rest of the national population for all age levels; 5–14 yr = 3 times the national rate; 15–44 yr = 4–5 times the national rate; among Aboriginal people ≥ 15 yr, the leading cause of death was MVCs (29%)
Tjepkema[17]; PR	To compare nonfatal injuries among off-reserve Aboriginal people (12–64 yr) with those of other Canadians	Canada; Metis, Inuit, First Nations and "North American Indians"; Aboriginal, *n* = 8106; non-Aboriginal, *n* = 210 655	Two cycles of Statistics Canada's Canadian Community Health Survey conducted in 2000/01 and 2003	In the provinces, Aboriginal people had higher rates of transportation crashes compared with non-Aboriginal people in 2000/01 and 2003 The amount of activity limitation due to injuries from MVCs did not differ significantly between Aboriginal and non-Aboriginal people	Residence Rates of transportation crashes in past year in the provinces: Aboriginal = 7.6%; non-Aboriginal = 6.4% Rates of transportation crashes in past year in the territories: Aboriginal = 75.1%; non-Aboriginal = NA
Tjepkema et al.[18]; PR	To compare mortality patterns among Metis and Registered Indian adults (≥ 25 yr) with those among non-Aboriginal people	Canada; Metis and First Nations Registered Indians; Metis, *n* = 11 800; Registered Indian, *n* = 56 700; non-Aboriginal, *n* = 2 624 300	1991–2000 Canadian census mortality follow-up study	Age-standardized MVC mortality (per 100 000) was higher among Metis and Registered Indians (11.2 and 21.8, respectively) than non-Aboriginal people (4.7)	Sex Age-standardized mortality among males (95% CI): Metis = 37.2 (24.2 to 57.2); Registered Indian = 51.1 (42.9 to 60.9); non-Aboriginal = 11.6 (10.9 to 12.2) Age-standardized mortality among females (95% CI): Metis = 11.2 (5.2 to 23.5); Registered Indian = 21.8 (17.3 to 27.5); non-Aboriginal = 4.7 (4.4 to 5.1)

Continued

Table 2. Summaries and results of the national studies included in the review (part 2 of 2)

Study; source	Objective	Population (location, Aboriginal population and sample size)	Data source	Key findings	Identified precrash and crash risk factors
Tjepkema et al.[19]; PR	To compare mortality patterns of urban (population ≥ 10 000) Aboriginal adults (≥ 25 yr) with those of urban non-Aboriginal people	Canada; First Nations, Inuit and Metis; Aboriginal, *n* = 16 300; non-Aboriginal, *n* = 2 062 700	1991–2000 Canadian census mortality follow-up study	Age-standardized MVC-related mortality was higher among Aboriginal males and females (33.2 and 15.6, respectively) than non-Aboriginal males and females (9.4 and 3.8, respectively)	Sex and residence Age-adjusted mortality rate ratios (95% CI) among males: all urban areas = 3.51 (2.32 to 5.32); metropolitan areas (population ≥ 100 000) = 3.67 (2.16 to 6.23); smaller urban centres (population ≥ 10 000) = 2.96 (1.51 to 5.78) Age-adjusted mortality rate ratios (95% CI) among females: all urban areas = 4.13 (2.46 to 6.93); metropolitan areas (population ≥ 100 000) = 5.24 (2.87 to 9.59); smaller urban centres (population ≥ 10 000) = 2.22 (0.82 to 6.06)
Tjepkema et al.[20]; PR	To compare mortality patterns of status Indians (25–74 yr) living on- and off-reserve with those of non-Aboriginal people	Canada; First Nations status Indians; status Indian, *n* = 55 700; non-Aboriginal, *n* = 2 475 700	1991–2000 Canadian census mortality follow-up study	PYLL rate was higher among status Indian males and females (14 676 and 8261, respectively) than non-Aboriginal males and females (5984 and 3134, respectively) Percentage of PYLL from MVCs was higher among status Indian males and females (9.9% and 6.7%, respectively) than non-Aboriginal males and females (3.4% and 2.7%, respectively)	Sex and residence Age-standardized rate ratios (95% CI) among males: total = 4.09 (3.11 to 5.37); on-reserve = 4.54 (3.37 to 6.13); off-reserve = 2.88 (1.62 to 5.15) Age-standardized rate ratios (95% CI) among females: total = 3.95 (2.78 to 5.61); on-reserve = 4.52 (3.01 to 6.77); off-reserve = 2.70 (1.56 to 4.66)
Tjepkema et al.[21]; PR	To compare mortality patterns of Metis and non–status Indians (25–74 yr) with those of non-Aboriginal people	Canada; Metis and First Nations non–status Indians; Metis, *n* = 11 600; non–status Indian, *n* = 5400; non-Aboriginal, *n* = 2 475 700	1991–2000 Canadian census mortality follow-up study	PYLL rate was higher among Metis males and females (12 025 and 6139, respectively) and non–status Indian males and females (11 480 and 8844, respectively) than non-Aboriginal males and females (5984 and 3134, respectively) Percentage of PYLL from MVCs was higher among Metis males and females (9.1% and 5.0%, respectively) and non–status Indian males and females (9.2% and 3.0%, respectively) than non-Aboriginal males and females (3.4% and 2.7%, respectively)	Sex Rate ratio (95% CI) in males: Metis = 3.12 (1.66 to 5.85); non–status Indian = 4.11 (1.62 to 10.44) Rate difference (95% CI) in males: Metis = 880 (75 to 1685); non–status Indians = 1290 (–292 to 2873) Rate ratio (95% CI) in females: Metis = 1.85 (0.82 to 4.18); non–status Indian = 1.60 (0.37 to 6.86) Rate difference (95% CI) in females: Metis = 143 (–106 to 391); non–status Indian = 100 (–280 to 488)
Trovato[22]; PR	To compare mortality patterns of status Indians with those of non-Aboriginal people during infancy (0–1 yr), early childhood (1–4 yr), late childhood (5–14 yr) and adulthood (≥ 15 yr), at 2 points in time (1981 and 1991)	Canada; First Nations status Indians 1981: Aboriginal, *n* = 279 957; non-Aboriginal, *n* = 23 777 497 1991: Aboriginal, *n* = 396 988; non-Aboriginal, *n* = 26 899 882	Mortality data (1979–1983 and 1990–1992) and population statistics (1981 and 1991) from Health Canada Medical Service Branch	MVC-related mortality among First Nations adults increased during the 1980s	Age Maximum likelihood estimates: 0–1 yr = –0.338; 1–4 yr = –3.22; 5–14 yr = –0.743; ≥ 15 yr = –0.124

CI = confidence interval; GL = published as grey literature; MVC = motor vehicle crash; NA = not available; PR = published in a peer-reviewed journal; PYLL = potential years of life lost.

Table 3. Summaries and results of the provincial studies included in the review (part 1 of 3)

Study; source	Objective	Population (location, Aboriginal population and sample size)	Data source	Key findings	Identified precrash and crash risk factors
Alaghen-bandan et al.[23]; PR	To compare unintentional injuries among children and adolescents in Aboriginal and non-Aboriginal communities	Newfoundland and Labrador; Innu, Inuit and Metis; Aboriginal, *n* = 2768; non-Aboriginal, *n* = 133 624	Provincial hospital discharge and mortality data from April 1995 to March 2001	Rate of hospital admission for MVCs: Aboriginal community, 277/100 000; non-Aboriginal communities, 158.5/100 000; rate ratio 1.75 (95% CI 1.30 to 2.43)	None
Bridges and Kunselman[24]; PR	To identify areas of health service delivery in BC for which status Indians had the highest excess premature mortality due to suicide, homicide and MVCs	British Columbia; First Nations status Indians; *n* = NA	PYLL data (before age 75) from BC Vital Statistics Agency and First Nations and Inuit Health Branch between 1991 and 2001	Rate of PYLL due to MVCs was 248% higher among status Indians than all other residents PYLL rate ranges: status Indians = 8.0–22.7; other residents = 2.0–9.9	Sex PYLL rates among status Indian males exceeded those of status Indian females PYLL rates among status Indian females exceeded those of non-Aboriginal males
BC's Office of the Provincial Health Officer[25]; GL	To compare the health and well-being of Aboriginal people with that of non-Aboriginal people living in BC	British Columbia; First Nations status Indians; *n* = 167 782	BC Ministry of Health, Indian and Northern Affairs Canada and Health Canada	MVC mortality (per 10 000) was higher among status Indians than non-Aboriginal people: 1993: status Indian = 3.5; non-Aboriginal = 1.3 2001: status Indian = 2.9; non-Aboriginal = 0.9 2006: status Indian = 1.9; non-Aboriginal = 0.7	Alcohol Proportion of MVC deaths related to alcohol between 2002 and 2006: status Indian = 41%; non-Aboriginal = 19%
Desapriya et al.[26]; GL	To examine the prevalence of, and factors related to, motor vehicle restraint use during fatal MVCs among Aboriginal people living in BC	British Columbia; Aboriginal; *n* = NA	BC Coroners Service reports of sudden and unexpected deaths from 2003 to 2005	Between 2003 and 2005, 87 Aboriginal MVC fatalities occurred in BC Drivers = 39.1%; passengers = 35.6%; pedestrians = 19.5%	Sex Males = 49.4%; females = 50.6% Age 33.3% involved people aged 16–25 yr Restraint use Using restraints = 29.2%; non-restrained = 46.2%; unknown = 24.6% Alcohol 50.8% involved alcohol Speeding 24.6% involved speeding Drugs 16.9% involved drugs (including medications) Fatigue 12.3% involved fatigue Without due care 9.2% involved careless driving

Continued

Table 3. Summaries and results of the provincial studies included in the review (part 2 of 3)

Study; source	Objective	Population (location, Aboriginal population and sample size)	Data source	Key findings	Identified precrash and crash risk factors
Desapriya et al.[27]; PR	To compare on-reserve with off-reserve MVCs in Saskatchewan between 2003 and 2005	Saskatchewan; Metis and First Nations; on-reserve collisions, *n* = 1270; off-reserve collisions (randomly selected comparison group), *n* = 1270; people involved in on-reserve collisions, *n* = 1677; people involved in off-reserve collisions, *n* = 1370	MVC data from Saskatchewan Government Insurance between 2003 and 2005	On-reserve MVCs were more severe than off-reserve MVCs OR (95% CI): personal injury, 2.63 (2.11 to 3.28); multiple collisions, 4.8 (3.75 to 6.09) On average, on-reserve MVCs had significantly more injured victims (0.41) than off-reserve MVCs (0.18)	Sex Males: on-reserve = 47.2%; off-reserve = 70.2% Females: on-reserve = 35.8%; off-reserve = 28.0% Age Individuals aged ≤ 15 yr were more likely to be involved in on-reserve than off-reserve MVCs; OR 7.53 (95% CI 2.66 to 21.3) Substance use On-reserve MVCs were more likely to involve the use of substances OR (95% CI): alcohol (BAC < 0.8) = 7.49 (4.09 to 13.7); alcohol (BAC > 0.8) = 4.87 (2.96 to 8.03); prescription or illicit drugs = 3.75 (0.42 to 33.6) Time of day More on-reserve MVCs (33.6%) occurred during the daytime, between 8:00 and 16:00 Restraint use Restraints were more likely not used or improperly used in on-reserve (40.6%) compared with off-reserve (16.5%) MVCs Additional risk factors OR (95% CI): inattentiveness = 2.02 (1.52 to 2.67); driver inexperience = 2.58 (1.80 to 3.69); too fast for conditions = 1.97 (1.38 to 2.82); vehicle year (≤ 1989) = 1.37 (1.03 to 1.83); vehicle type (car) = 1.48 (1.20 to 1.82); road surface (snow) = 1.7 (1.32 to 2.20); road surface (gravel) = 2.88 (2.10 to 3.94); road surface (mud) = 3.83 (1.83 to 8.00); intersection rural road = 1.75 (1.28 to 2.40); domestic animal interaction = 3.39 (2.01 to 5.72)
Fantus et al.[28]; PR	To compare injuries leading to hospital admission in First Nations communities with those in small (population < 10 000) northern and southern communities in Ontario	Ontario; First Nations; First Nations, *n* = 28 816; northern, *n* = 211 834; southern, *n* = 650 002	Provincial hospital discharge data from 2004	Age- and sex-adjusted hospital admission rate for MVCs (per 1000): First Nations = 1.4; northern = 1.1; southern = 1.1 Relative risk: First Nations v. northern = 1.3; northern v. southern = 1.0; First Nations v. southern = 1.2	Sex Age-adjusted hospital admission rates (per 1000) for males: First Nations = 1.7; northern = 1.6; southern = 1.5 Age-adjusted hospital admission rates (per 1000) for females: First Nations = 1.0; northern = 0.6; southern = 0.8 Relative risk: First Nations v. northern = 1.7 (female), 1.1 (male); northern v. southern = 0.8 (female), 1.1 (male); First nations v. southern = 1.3 (female), 1.2 (male)

Continued

Table 3. Summaries and results of the provincial studies included in the review (part 3 of 3)

Study; source	Objective	Population (location, Aboriginal population and sample size)	Data source	Key findings	Identified precrash and crash risk factors
Northwest Territories Health and Social Services[29]; GL	To examine the incidence and pattern of intentional and unintentional injuries in the Northwest Territories and provide a comparison with Canadian rates	Northwest Territories; Inuit, Dene and Metis; *n* = NA	Northwest Territories Vital Statistics and Canadian Institute for Health Information Discharge Abstract Database	MVC mortality rates (per 100 000) between 1990 and 1999: Dene = 22.99; Inuit = 19.4; Metis and non-Aboriginal = 8.4 MVC hospital admission rates (per 100 000) between 1995/96 and 1999/2000: Dene = 157.3; Inuit = 138.1; Metis and non-Aboriginal = 96.2	<u>Seat belts</u> Only 58% of Dene reported that they always used a seat belt
Karmali et al.[30]; PR	To compare the incidence and characteristics of severe trauma among Aboriginal adults (≥ 16 yr) with non-Aboriginal adults living in Alberta	Alberta; First Nations status Indians; *n* = NA	Calgary Health Registration between 1999 and 2002	MVC injury risk ratio comparing status Indians with non-Aboriginals: 4.8 (95% CI 3.5 to 6.5)	None
Manitoba Health[31]; GL	To examine the burden of intentional and unintentional injury in Manitoba	Manitoba; First Nations; *n* = NA	Manitoba Health	MVC mortality (per 100 000) between 1992 and 1999: First Nations = 18.2; non-Aboriginal = 9.4 First Nations hospital admission rates (per 100 000) due to MVC between 1992 and 2001 = 270.7	<u>Sex</u> MVC mortality (per 100 000) between 1992 and 1999 among males: First Nations = 24.3; non-Aboriginal = 12.6 First Nations MVC hospital admission rates (per 100 000) between 1992 and 2001 among males = 291.5 MVC mortality (per 100 000) between 1992 and 1999 among females: First Nations = 11.6; non-Aboriginal = 6.3 First Nations MVC hospital admission rates (per 100 000) between 1992 and 2001 among females = 249.8 <u>Age</u> MVC mortality rates (per 100 000) between 1992 and 1999: 0–1 yr = 0.0; 1–4 yr = 10.6; 5–9 yr = 11.9; 10–14 yr = 0.0; 15–19 yr = 31.1; 20–24 yr = 31.3; 25–34 yr = 29.8; 35–44 yr = 23.6; 45–54 yr = 18.5; 55–65 yr = 21.1; ≥ 65 yr = 0.0 First Nations males aged 20–24 had the highest MVC mortality between 1992 and 1999 (48.0/100 000) and the highest MVC hospital admission rate (573.8/100 000)
Schnarch[32]; GL	To compare the health and health determinants of Aboriginal people living in the Cree communities of Eeyou Istchee with the rest of Quebec	Quebec; Cree; *n* = NA	Quebec Ministry of Health Services between 1993 and 1997	Age-adjusted MVC mortality (per 100 000): Eeyou Istchee = 26.7, Quebec = 11.2; rate ratio = 2.4 PYLL due to MVC = 542.5	<u>Sex</u> Age-adjusted MVC mortality (per 100 000): Males: Eeyou Istchee = 27.6; Quebec = 16.0; rate ratio = 1.7 Females: Eeyou Istchee = 25.8; Quebec = 6.7; rate ratio = 3.9

BAC = blood alcohol content; CI = confidence interval; GL = published as grey literature; MVC = motor vehicle crash; NA = not available; OR = odds ratio; PR = published in a peer-reviewed journal; PYLL = potential years of life lost.

159.5 per 100 000 population among non-Aboriginal people in Newfoundland and Labrador. Fantus and colleagues[28] found a higher age-adjusted MVC hospital admission rate of 1.4 per 1000 population among First Nations communities in Ontario compared with 1.1 per 1000 population among small (population < 10 000) southern and northern communities in Ontario. In Quebec, a higher age-adjusted MVC-related death rate of 26.7 per 100 000 population was found among Cree communities of Eeyou Istchee compared with 11.2 per 100 000 population among non-Aboriginal people.[32] A government review reported a higher MVC death rate of 18.2 per 100 000 population among First Nations people compared with 9.4 per 100 000 among non-Aboriginal people in Manitoba.[31] Desapriya and colleagues[27] compared on-reserve with off-reserve MVCs and reported odds ratios (ORs) of 2.63 for personal injury and 4.8 for multiple collisions in Saskatchewan. In Alberta, Karmali and colleagues[30] compared injury incidence among First Nations and non-Aboriginal people and found that the First Nations population had an increased risk of MVC-related injury (relative risk ratio 4.8). A report from BC found higher MVC-related mortality ranging from 1.9 to 3.5 per 10 000 population among First Nations people compared with rates ranging from 0.3 to 1.7 per 10 000 among non-Aboriginal people in that province.[25] A government report found a higher MVC-related death rate of 22.9 per 100 000 population among Dene people and 19.4 per 100 000 among Inuit people compared with 8.4 per 100 000 among Metis and non-Aboriginal people in the Northwest Territories.[29]

Moreover, an interesting trend emerged in the province of BC. Although First Nations people consistently experienced higher mortality from MVCs compared with non-Aboriginal people, rates during 1993 (3.5/10 000), 2001 (2.9/10 000) and 2006 (1.9/10 000) decreased over time among First Nations people.[25] A slight decrease in MVC-related mortality among the non-Aboriginal population also emerged during this time.[25]

Collectively, this research summarizes the extent of MVC-related injuries among Canadian Aboriginal people. Specifically, with the exception of Ontario, rates of injury associated with MVCs were at least double among Aboriginal compared with non-Aboriginal populations across provinces, with some regional variation.

Potential years of life lost

Potential years of life lost (PYLL) is a common measure used in injury epidemiology research. Aboriginal life expectancy in Canada remains shorter than for the general population (males: 68.9 yr among Aboriginal people v. 76.3 yr among the general population; females: 76.6 yr among Aboriginal people v. 81.8 yr among the general population),[14] a finding at least partially attributable to causes that tend to occur relatively early in life. Therefore, this measure is suitable because it gives more weight to deaths that occur at younger ages.[13] The PYLL rate is calculated by dividing the PYLL (commonly before age 75) by the person-years at risk. A total of 5 studies, 3 national and 2 provincial, examined PYLL from MVCs among Aboriginal Canadians.

National PYLL rates among Canadian Aboriginal people ranged from 6139 (among Metis females) to 14 676 (among status Indian males) per 100 000 person-years at risk, compared with non-Aboriginal Canadian males (5984) and females (3134).[20,21] The percentages of PYLL from MVCs were also exceedingly higher among Aboriginal people, ranging from 9.9% (among status Indian males) to 3.0% (among non–status Indian females), compared with non-Aboriginal males (3.4%) and females (2.7%).[20,21] Additionally, elevated rates were reported in regions with a high Aboriginal population (9.0/1000 person-years) compared with regions with a low Aboriginal population density (3.8/1000 person-years).[13] Similar patterns were revealed in 2 provincial studies. In the Cree communities of Eeyou Istchee, Quebec, the number of PYLL due to MVCs was 542.5, and in BC the PYLL rate due to MVCs was 248% higher among status Indians than among all other residents (PYLL range: 8.0–22.7 among status Indians v. 2.0–9.9 among other residents).[24,32]

National and provincial studies conducted with Aboriginal populations support the notion that Canadian Aboriginal people have substantial premature mortality and years of life lost due to MVCs. These statistics highlight the relevance of research and program development targeted toward prevention of MVCs among Aboriginal people in Canada.

Precrash and crash risk factors

Human

Of the studies reviewed, 12 examined sex and 6 examined age as related risk factors. In the national research, higher rates of death and injury related to MVCs are consistently observed among Aboriginal males than Aboriginal females.[13,15,18–21] These studies indicate that the rates among Aboriginal females are

generally higher than the rates among non-Aboriginal males.[13,15,18–21] The pattern of higher rates among Aboriginal males versus females was also evident in most of the provincial research, including the research from Ontario, Quebec, Manitoba, Saskatchewan and BC.[24,27,28,31,32] However, one BC study found the difference in percentages between males and females was not statistically significant.[26]

The national data indicated that MVC-related mortality was the highest in adulthood. Health Canada reported the highest mortality among populations aged 20–44 years (35.5 per 100 000 population) and 45–64 years (37.8 per 100 000 population).[14] Postl and Moffatt[16] revealed that MVCs were the leading cause of death (29%) among Aboriginal people aged 15 years and older. Furthermore, being a young adult was found to be a risk factor for involvement in an MVC.[26,27,31] In Manitoba, First Nations males aged 20–24 years had the highest MVC-related mortality and rate of hospital admission.[31] Desapriya and colleagues[26] found that 33.3% of Aboriginal people in BC who died from MVCs were aged 16–25 years. Data from Saskatchewan suggest that being younger (≤ 15 yr) was a significant risk factor for involvement in an on-reserve MVC.[27]

Alcohol use was examined in 3 provincial studies, and drug use was researched in 2 provincial studies. Between 2002 and 2006 in BC, 41% of MVC-related fatalities among First Nations people involved alcohol, whereas only 19% among non-Aboriginal people involved alcohol.[25] Another BC study revealed that 50.8% of MVC-related fatalities among Aboriginal people involved alcohol, and 16.9% involved drugs, including medications.[26] In Saskatchewan, individuals involved in on-reserve MVCs had greater odds of having used substances than individuals living off-reserve, with ORs of 3.75 for drug use (i.e., prescription or illicit drugs), 4.87 for impairment by alcohol use (i.e., blood alcohol content > 0.8) and 7.49 for some alcohol use (i.e., blood alcohol content < 0.80).[27]

Although Canada has one of the highest rates of seat belt use in the world (i.e., in 2005–2006, seat belt use in Canada reached 90.8%),[33] seat belt noncompliance among Aboriginal Canadians appears to be a relevant risk factor related to MVCs. Three provincial studies examined restraint use. In Saskatchewan, Desapriya and colleagues[27] found a greater proportion of noncompliance or improper use by individuals involved in on-reserve (40.6%) than off-reserve (16.5%) MVCs. In BC, 46.2% of Aboriginal people involved in an MVC reported that they had not been restrained.[26] In the Northwest Territories, only 58% of Dene individuals reported that they always used a seat belt.[29]

Additional human risk factors have been identified, primarily relevant to awareness while driving and driver experience. For instance, Desapriya and colleagues[27] revealed that inattentiveness (OR 2.02) and driver inexperience (OR 2.58) were significant risk factors for on-reserve MVCs in Saskatchewan. Moreover, driving too fast for the conditions was related to on-reserve compared with off-reserve MVCs in this province (OR 1.97).[27] In BC, 12.3% of MVC-related fatalities among Aboriginal people involved fatigue, and 9.2% involved careless driving.[26] Moreover, this study indicated that 24.6% of MVC-related deaths among Aboriginal people involved speeding, highlighting speeding as a relevant risk factor.[26]

Vehicle and equipment

One of the reviewed studies, conducted in Saskatchewan, examined vehicle and equipment factors in relation to MVCs.[27] Results indicated that vehicle type (i.e., cars v. pickup trucks, trucks heavier than 4.5 tons, panel vans and power units for semitrailers) and vehicle year (i.e., older than 1990) were relevant factors associated with on-reserve MVCs.[27]

Physical environment

A few national studies compared MVCs among Aboriginal and non-Aboriginal people across geographic locations. Tjepkema[17] found that MVCs occurred more commonly in the territories than the provinces. In urban areas, MVC-related mortality was higher among Aboriginal than non-Aboriginal people, and although the rate ratio is slightly larger in metropolitan areas (population ≥ 100 000) than smaller urban centres (population ≥ 10 000), the pattern is consistent.[19] When examining MVCs occurring on-reserve compared with those occurring off-reserve, research indicates that MVC-related mortality is higher among First Nations people than non-Aboriginal people in both contexts; however, the rate ratio is exceedingly larger on-reserve than off-reserve.[20]

Provincial studies have also examined the physical environment. In comparing First Nations communities with small (population < 10 000) northern and southern communities in Ontario, Fantus and colleagues[28] found that females in First Nations communities had higher MVC rates than females in northern communities. Desapriya and colleagues[27]

revealed several physical environment–related risk factors pertaining to MVCs occurring on-reserve in Saskatchewan. Time of day was a factor for on-reserve MVCs; compared with off-reserve MVCs, more on-reserve MVCs occurred during the day, between 8 am and 4 pm. Other risk factors related to on-reserve MVCs included road surface (i.e., packed snow, loose gravel or muddy road), intersection with local streets and interaction with domestic animals. However, MVCs at intersections with highways and, interestingly, MVCs that involved interaction with wild animals were significantly less likely on-reserve than off-reserve.

Social environment

Of the studies reviewed, no research examined risk factors related to the social environment.

DISCUSSION

Trends in the Canadian literature

Our review identified several general trends in the published and grey literature on MVCs among Canadian Aboriginal people.

Rates of death, hospital admission and injury related to MVCs are at least double among Aboriginal than non-Aboriginal populations, both nationally and across most of the provinces. In terms of human factors, death and injury rates are generally higher among Aboriginal males than Aboriginal females, and individuals aged 65 and older do not appear to be at increased risk for MVCs. Use of substances (including alcohol and prescription or illicit drugs), not using seat belts and restraints, inattentiveness, inexperience, fatigue and speeding are relevant risk factors. In terms of vehicle and equipment factors, driving in a vehicle older than 1990 and driving a car (v. another type of vehicle) is more frequently associated with on-reserve than off-reserve MVCs. In terms of physical environment factors, MVCs occur more frequently in the territories than the provinces, and on on-reserve roads than off-reserve roads. Moreover, on-reserve MVCs are more likely to occur during the day and at intersections with local streets, and are more likely to involve road surfaces with packed snow, loose gravel or mud, and domestic animal interaction than off-reserve MVCs. None of the research reviewed examined how social environment may be associated with MVCs among Canadian Aboriginal people.

Many of these trends are supported in the international research. Aboriginal males, as well as males in the general public, tend to be at higher risk for MVCs than females.[9] Moreover, it appears that Aboriginal and non-Aboriginal people older than 65 years of age are not at heightened risk for MVC-related injury.[34,35] Poor road conditions, living in a rural area, speeding and the influence of alcohol consistently emerge as major risk factors for MVCs among Aboriginal people.[2,35] However, there appears to be a general lack of research worldwide examining social factors in relation to MVCs among Aboriginal people.

Current gaps and future research

From this review, it is apparent that gaps exist within the Canadian literature on MVC-related injury among Aboriginal people. Few studies employed an injury framework, such as the Haddon matrix,[7] to help address why Canadian Aboriginal people are at risk for MVCs and how to prevent injuries. Of the 20 articles reviewed, only 5 examined risk factors other than age and sex. Additionally, of the studies reviewed, no research examined the risk factors for MVCs related to the social environment. The Michon model[36] emphasizes the importance of the social environment. A driver's beliefs and personality can be linked to 3 levels of driving, decision-making and task performance: strategic level (i.e., decisions regarding the driving plan, such as choosing to not drive while impaired), tactical level (i.e., decisions relevant to the vehicle handling, such as choosing not to speed) and operational level (e.g., driving actions, such as braking). This model identifies a framework for examining the social environment related to MVCs.

It is important to consider that context and perspectives may not be consistent across different communities. For instance, whereas some populations may benefit from first employing educational interventions, a study conducted with an indigenous population in New Zealand indicated that individuals recognized the risks of impaired driving.[37] A collaborative approach is desirable and respectful when communicating with specific groups to conduct needs assessments, target specific risk factors and develop interventions that could potentially be effective for that group. Unfortunately, few culturally appropriated injury prevention and intervention programs exist in Canada.[38] Overall, understanding and incorporating the variations between different Aboriginal populations within Canada in regard to cultural differences, political policies and availability

of precrash- and crash-related risk factors (e.g., access to alcohol) should be a research priority.

We examined the grey literature in this review to help eliminate publication bias, and this was particularly useful in identifying trends across provinces. However, grey literature can often lack detail and methodological rigour compared with studies published in peer-reviewed journals. Some methodological issues are also pervasive throughout published research studies in this area.[2] Incomplete and inaccurate data are a major concern and likely underestimate the extent of the problem. Misclassification of ethnicity can occur, and culturally appropriate methods of collecting data are needed.[39] Moreover, improving surveillance efforts at a national and provincial level is important, because there is no current surveillance system for tracking injury patterns among Aboriginal people in Canada.[38]

A further consideration is that some studies compared ethnic groups, whereas others examined geographical regions. The use of ethnicity allows for examination of cultural or contextual factors specific to the group that may be missed when examining geographical regions; however, certain environmental factors (e.g., rural v. urban and on-reserve v. off-reserve differences) can only be identified when examining geographical regions. Future research may benefit from examining both the region and the ethnic group, which calls for precise classifications of study groups.

CONCLUSION

Unintentional injury and death caused by MVCs is an important, preventable issue among Canadian Aboriginal people and presents a major public health concern. Rates of MVC-related death, hospital admission and injury are twice as high among Aboriginal populations than the general Canadian population, and consistent trends in crash-related risk factors are apparent across Canada. These findings not only demonstrate an important issue in Aboriginal health and safety, but also clarify specific research priorities. Although national and provincial research exists, more rigorous research methods and studies examining the social environment would further advance our understanding of this problem. A framework for conducting MVC research involving Aboriginal populations could potentially aid in eliminating some of the methodological challenges faced by previous researchers and help in the development of effective programs and policy for prevention.

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