Injury Mortality Rates in Native and Non-Native Children: A Population-Based Study

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SYNOPSIS

Objectives. To examine injury mortality rates in Native and non-Native children in the province of Alberta, Canada, over a 10-year period, temporal trends in injury mortality rates (Native vs. non-Native), as well as relative risks of injury mortality (Native vs. non-Native) by injury mechanism and intent, were calculated.

Methods. An observational, population-based study design was used. Mortality data were obtained from provincial vital statistics, with injury deaths identified using external injury codes (E-codes). The relative risk (RR) of injury mortality (Native vs. non-Native) along with 95% confidence intervals (CIs) were calculated. Stratified analyses and Poisson regression modeling were used to calculate adjusted relative risk.

Results. Injury mortality rates declined over the study period, with no difference in the rate of decline between Native and non-Native children. The adjusted relative risk for all-cause injury death (Native vs. non-Native) was 4.6 (95% CI 4.1 to 5.2). The adjusted relative risks (Native vs. non-Native) by injury intent categories were: unintentional injuries, 4.0 (95% CI 3.5 to 4.6); suicide, 6.6 (95% CI 5.2 to 8.5); and homicide, 5.1 (95% CI 3.0 to 8.5). Injury mortality rates were consistently higher for Native children across all injury mechanism categories. The largest relative risks (Native vs. non-Native) were pedestrian injury (RR=17.0), accidental poisoning (RR=15.4), homicide by piercing objects (RR=15.4), and suicide by hanging (RR=13.5).

Conclusion. The burden of injury mortality is significantly greater in Native children compared with non-Native children. Therefore, injury prevention strategies that target both intentional and unintentional injuries are needed.

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Injury is the leading cause of death and disability among children in North America.[1,2] Studies in the United States and Canada have suggested that the injury mortality rate among Native Indian children is two to four times higher than for non-Native children.[3–12] Methodologic limitations of these studies, however, have included potential misclassification of Native Indian status, limited information on pediatric age groups, examination of specific types of injury only, and limited examination of temporal trends.

The Alberta Medical Services Branch of Health Canada collects data on all Native Indian deaths in the province of Alberta through detailed review of provincial Vital Statistics records. Therefore, the availability of population-based data on Native and non-Native childhood injury deaths over a 10-year period provided an opportunity to overcome some limitations of previous studies on the topic.

The objectives of this study were to examine temporal trends in injury mortality rates in Native and non-Native children and to calculate injury mortality relative risks (RR) (Native vs. non-Native) by injury mechanism and intent.

METHODS

Study design

An observational, population-based study design was used to examine injury mortality rates in Native and non-Native children (aged 0–19 years) in the province of Alberta, Canada, over the 10-year period from January 1, 1985, to December 31, 1994. For the purposes of this study, a Native Indian refers to a status Indian. A status Indian is a person of aboriginal heritage recognized under the Indian Act as "a person who, pursuant to this Act, is registered as an Indian or is entitled to be registered as an Indian."[13,14] Status Indians are, in turn, entitled to certain rights and benefits under the law. Currently, individuals are eligible for status if at least one grandparent has or is eligible for status. This would preclude status for a child whose mother obtained status by marrying a status male, but whose father is a non-status male. In Alberta, approximately 70% of registered Indian children (aged 0–19 years) live on reserves while 30% live off reserves mostly in urban centers.[15] In this study, it was not possible to distinguish between those living on reserves vs. those living off reserves.

Data sources

Vital Statistics records were used to identify all childhood injury deaths in the province of Alberta. Injury deaths (both unintentional and intentional) were identified using the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) external injury codes (E-codes).[16] All deaths coded as ICD-9 E800.0 through E999.9 were selected, excluding E870–E879 (misadventures to patients during surgical and medical care) and E930–E949 (drugs, medicinal, and biological substances causing adverse effects in therapeutic use). Data on age, sex, and year of death were available on all fatalities. Vital Statistics records, however, do not contain a variable for Native Indian status. Data on injury deaths in Native Indian children were obtained from the Alberta Medical Services Branch of Health Canada. This government agency identifies all Native Indian deaths in the province of Alberta through detailed review of provincial Vital Statistics records.

Data linkage

Native Indian childhood injury deaths from Alberta Medical Services were linked to the provincial dataset of all childhood injury deaths using probabilistic linkage, with matching on date of birth, date of death, sex, and ICD-9 E-code. Data linkage was performed with Microsoft® Excel software. Following linkage, all Native Indian injury deaths in the provincial mortality dataset were flagged and removed, resulting in two population-based databases of childhood injury deaths (Native and non-Native) for analysis.

Native and non-Native populations

Estimates of the provincial pediatric population (by age and sex) over the study period were required to serve as denominators in the calculation of mortality rates. For the general population of Alberta children, these data were obtained from Statistics Canada in the form of census data for the census years 1986 and 1991, along with intercensal estimates for the remaining years during the 10-year study period (also available from Statistics Canada). In the case of Indians, population data were obtained from the Indian Register annual census for each year during the study period. These population census datasets were obtained as hard copy reports from the Indian Registry and Statistics Canada. Indian population figures were then subtracted from the non-Indian population figures, thus giving separate Indian and non-Indian denominator data.

Analyses

Annual, all-cause injury mortality rates for Native and non-Native children over the 10-year study period were calculated. Temporal trends in injury mortality for Native and non-Native children were examined by

calculating year-by-year rates, controlling for age and sex using Poisson multivariate regression analysis.[17]

Native and non-Native injury mortality rates (all cause, all years) were calculated by age (five-year age groups) and gender. Rates reported were mean annual rates. Stratum-specific relative risks (Native vs. non-Native) were estimated, along with 95% confidence intervals (CIs). The homogeneity of the stratum-specific relative risks was assessed using a Mantel-Haenszel chi-square test.[17] Summary estimates of relative risk (with confidence intervals) unconfounded by age and gender were calculated, where appropriate, by calculating a Mantel-Haenszel weighted mean of the stratum-specific relative risks (direct standardization).

Age- and gender-specific injury mortality rates and relative risks (Native vs. non-Native) were also calculated by injury intent (unintentional, homicide, suicide, and intent unknown) and by specific injury mechanism. The latter analysis used the framework developed by the Centers for Disease Control and Prevention (CDC) for subclassifying injuries by mechanism and intent.[18]

Statistical analyses were performed using Stata software.[19]

Ethics

Ethical approval for the study was obtained from the Conjoint Ethics Review Board of the University of Calgary. Subsequently, written application for procurement of mortality data was made to the Alberta Region Medical Services Branch of Health Canada (for Native mortality data) and to the Alberta Registries (for general population mortality data).

RESULTS

Injury deaths

Provincial Vital Statistics data identified 2,167 records of injury deaths in children aged 0–19 years in Alberta from 1985 to 1994, whereas the Alberta Medical Services Branch identified 323 records of injury deaths among Native children over the same time period. In total, 319 (99%) Native injury deaths were probabilistically linked to Provincial Vital Statistics records. Therefore, 319 Native injury deaths were compared with 1,848 non-Native injury deaths.

Native and non-Native populations

Both Native and non-Native pediatric populations (aged 0–19 years) increased over the 10-year period (24,065 to 33,730 for Natives and 733,000 to 780,000 for non-Natives). However, there were no significant differences regarding the age and gender distribution of children in the two groups.

Temporal trends in injury mortality

Annual injury mortality rates for Native and non-Native children are shown in the Figure. For both groups, mortality rates significantly declined ($p<0.01$) over the 10-year period. The annual injury mortality rate for Natives decreased from 129/100,000 in 1985 to 68/100,000 in 1994 (47% decline), whereas for non-Natives, injury mortality rates declined from 29/100,000 to 18/100,000 (38% decline) over the same time period. Poisson regression modeling showed no difference in the relative rates of decline in injury mortality between Natives and non-Natives ($p=0.41$). On average, mortality rates declined by approximately 5% per year.

The observed decline in injury deaths over the 10-year study period was further examined by injury intent subgroups (data not shown). There were statistically significant declines in both unintentional and intent unknown injury mortality rates over this time interval, with no difference in the rates of change between Natives and non-Natives. On the other hand, no change in suicide or homicide rates was observed over the study period in either Natives or non-Natives. Subgroup analysis by age group and injury mechanism was not possible due to small numbers.

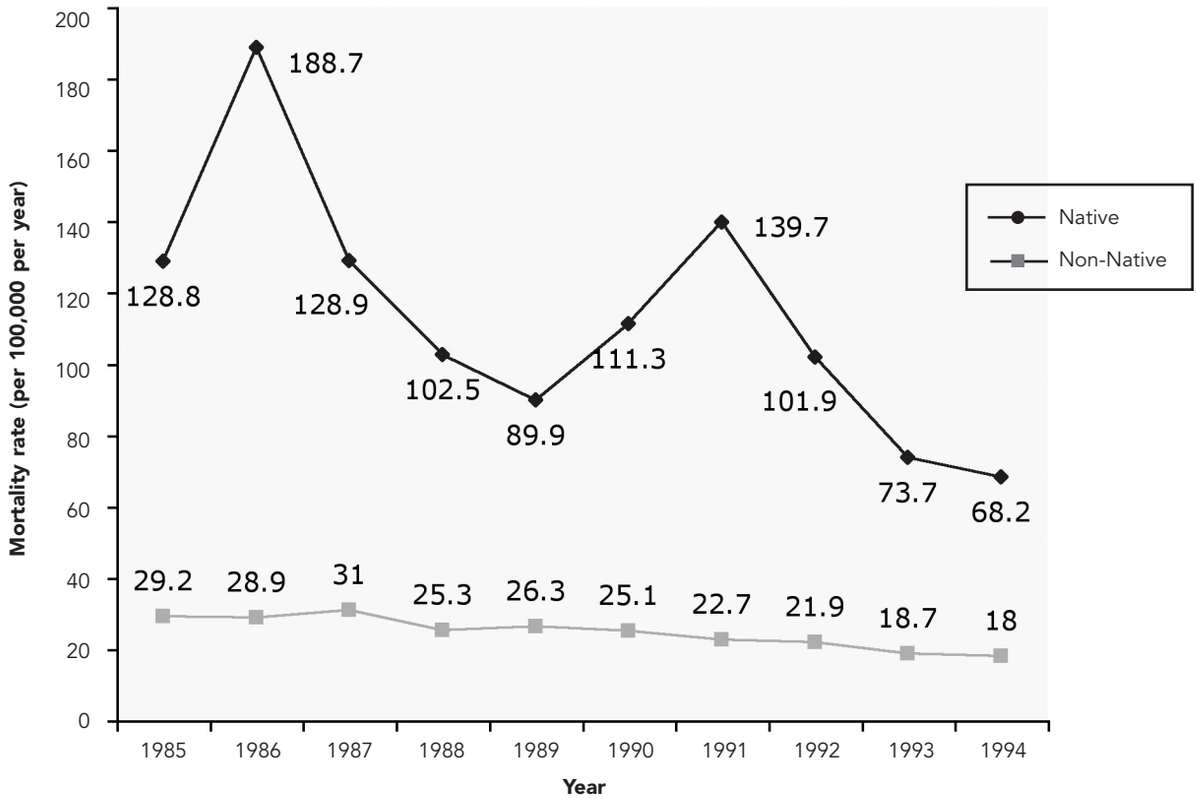
Injury mortality by age and gender

Injury mortality rates for the entire study period, by age and gender, along with relative risk (Native vs. non-Native) are shown in Table 1. For both Natives and non-Natives, male and female injury mortality rates were similar across age groups, except for adolescents (aged 15–19 years). In this age group, male rates were significantly higher than female rates for both Natives and non-Natives. Within each age group and gender stratum, Native injury mortality rates were significantly higher than non-Native rates. Injury mortality relative risk (Native vs. non-Native) ranged from 2.7 to 5.9; however, a Mantel-Haenszel test of heterogeneity across strata was not significant ($p=0.25$). A Mantel-Haenszel summary relative risk of injury mortality (Native vs. non-Native), adjusting for age and gender, was equal to 4.6 (95% CI 4.1 to 5.2).

Injury mortality by intent of injury

All Native and non-Native injury deaths were assigned to one of four mutually exclusive categories: unintentional (E800–E869, E880–E929), suicide (E950–E959), homicide (E960–E969), or intent unknown (E980–E989). For unintentional injuries, the summary relative risk of mortality (Native vs. non-Native) was 4.0 (95% CI 3.5 to 4.6). For suicide, the summary relative risk (Native vs. non-Native) was 6.6 (95% CI 5.2 to 8.5). For homicide,

Figure. Annual injury mortality rates in Native and non-Native children (aged 0–19 years) in Alberta, 1985–1994



the summary relative risk (Native vs. non-Native) was 5.1 (95% CI 3.0 to 8.5). And for intent unknown, the summary relative risk (Native vs. non-Native) was 8.3 (95% CI 4.9 to 14.0).

Injury mortality by mechanism of injury

Table 2 describes injury mortality rates for Native and non-Native children for the entire study period, by mechanism and intent, using the framework devel-

Table 1. Injury mortality rates in Native and non-Native children in Alberta, 1985–1994

		Native			*Non-Native*			
Age (years)	*Sex*	*Deaths*	*Population*	*Rate*[a]	*Deaths*	*Population*	*Rate*[a]	*RR (95% CI)*
0–4	Female	28	34,767	80.54	134	988,627	13.55	5.9 (3.8, 9.0)
	Male	34	36,651	92.77	181	1,037,353	17.45	5.3 (3.6, 7.7)
5–9	Female	9	39,586	22.74	68	937,095	7.26	3.1 (1.4, 6.3)
	Male	11	40,529	27.14	101	987,624	10.23	2.7 (1.3, 5.0)
10–14	Female	20	34,912	57.29	89	868,553	10.25	5.6 (3.3, 9.2)
	Male	21	35,434	59.27	149	915,645	16.27	3.6 (2.2, 5.8)
15–19	Female	45	32,452	138.67	293	870,548	33.66	4.1 (2.9, 5.7)
	Male	151	33,177	455.13	833	908,111	91.73	5.0 (4.1, 5.9)
Total		319	287,508	110.95	1848	7,513,556	24.60	4.5 (4.0, 5.1)
								4.6[b] (4.1, 5.2)

[a]Injury mortality rate per 100,000 per year

[b]Adjusted relative risk

RR = relative risk (Native vs. non-Native)

CI = confidence interval

Table 2. Injury mortality rates in Native and non-Native children in Alberta, 1985–1994, by mechanism and intent of injury

	Native		*Non-Native*		
Cause of death	*Deaths*	*Rate*[a]	*Deaths*	*Rate*[a]	*RR (95% CI)*
Motor vehicle traffic (MVT)					
Unintentional	124	43.1	882	11.7	3.7 (3.0, 4.4)
Occupant	57	19.8	443	5.9	3.4 (2.5, 4.4)
Motorcyclist	6	2.1	55	0.7	2.9 (1.0, 6.6)
Pedal cyclist	3	1.0	34	0.5	2.3 (0.5, 7.3)
Pedestrian	22	7.7	83	1.1	6.9 (4.1, 11.2)
Unspecified	36	12.5	266	3.5	3.5 (2.4, 5.0)
MVT, all	124	43.1	891	11.9	3.6 (3.0, 4.4)
Pedestrian, other than MVT	13	4.5	20	0.3	17.0 (7.8, 35.9)
Firearm					
Unintentional	8	2.8	23	0.3	9.1 (3.5, 21.0)
Suicide	27	9.4	153	2.0	4.6 (2.9, 7.0)
Homicide	1	0.3	25	0.3	1.0 (0.03, 6.4)
Intent unknown	1	0.3	2	0.0	13.1 (0.2, 251)
All	37	12.9	203	2.7	4.8 (3.3, 6.8)
Drowning					
Unintentional	7	2.4	108	1.4	1.7 (0.7, 3.6)
All	8	2.8	113	1.5	1.9 (0.8, 3.8)
Fire/flame					
Unintentional	17	5.9	73	1.0	6.1 (3.4, 10.4)
All	17	5.9	76	1.0	5.8 (3.2, 10)
Suffocation					
Unintentional					
Inhalation	2	0.7	22	0.3	2.4 (0.3, 9.7)
Other	6	2.1	52	0.7	3.0 (1.1, 7)
Suicide	44	15.3	85	1.1	13.5 (9.2, 19.7)
Homicide	1	0.3	9	0.1	2.9 (0.1, 21)
Intent unknown		0.0	3	0.0	
All	53	18.4	171	2.3	8.1 (5.8, 11.1)
Falls, unintentional	3	1.0	40	0.5	2.0 (0.4, 6.2)
All	3	1.0	49	0.7	1.6 (0.3, 5.0)
Cutting/piercing					13.1 (1.2, 91.2)
Homicide	10	3.5	17	0.2	15.4 (6.3, 35.5)
Other	2	.7	4	.1	
All	12	4.2	21	0.3	14.9 (6.7, 31.8)
Poisoning, all	25	8.7	113	1.5	5.8 (3.6, 9.0)
Unintentional	10	3.5	17	0.2	15.4 (6.3, 35.5)
Suicide	6	2.1	70	0.9	2.2 (0.8, 5.1)
Homicide		0.0	5	0.1	
Intent unknown	9	3.1	21	0.3	11.2 (4.5, 25.5)
Other causes, all	27	9.4	191	2.5	3.7 (2.4, 5.5)
Unintentional	15	5.2	141	1.9	2.8 (1.5, 4.7)
Suicide		0.0	3	0.0	
Homicide	5	1.7	32	0.4	4.1 (1.2, 10.6)
Intent unknown	7	2.4	15	0.2	12.2 (4.2, 31.8)
All injury	319	111.0	1848	24.6	4.5 (4.0, 5.1)
Population (1985–1994)[b]	287,508		7,513,556		

[a]Injury mortality rate per 100,000 per year

[b]Sum of the yearly populations over the 10-year period

RR = relative risk (Native vs. non-Native)

CI = confidence interval

oped by CDC.[18] Native injury mortality rates were consistently higher than non-Native rates across all injury mechanism categories. The largest relative risks (Native vs. non-Native) were seen for pedestrian injury (RR=17.0), accidental poisoning (RR=15.4), homicide by piercing objects (RR=15.4), and suicide by hanging (RR=13.5).

Table 3 presents the top five injury mortality mechanisms and associated mortality rates for each age subgroup.

DISCUSSION

This study showed that Native children in Alberta, Canada, have a fivefold increased risk of death from injury compared with non-Native children in the province. An increased mortality risk (Native vs. non-Native) was noted across all categories of injury intent and mechanism, in particular, pedestrian injury, accidental poisoning, homicide by piercing objects, and suicide by hanging. Last, injury mortality rates declined over the study period for both Native and non-Native children, with no difference in the rate of decline between the two groups.

This study had several strengths. First, the study was population-based, with Provincial Vital Statistics data used to provide information on injury deaths for both Native and non-Native children. Vital Statistics coders were unaware of Native status at the time of coding. Therefore, differential misclassification of cause of injury death by status was considered unlikely. Other investigators have reported high sensitivity (>90%) and specificity (>98% for ICD 9 E-codes derived from death certificates, for broad groupings such as motor vehicle crashes, homicide, and suicide.[20] Multivariable Poisson regression analysis was used to take into account the effects of potential confounding variables (age and gender).

The main limitation of the study related to the use of administrative databases. Important factors, such as living on or off reserve, socioeconomic status, involvement of alcohol, hazard exposure, supervision, preexisting medical conditions, time and type of transport to medical care, and type of medical care given were not captured in Vital Statistics records. In addition, there is a delay in data entry into the Alberta First Nations Mortality Database and, as such, the time period examined is not current.

The results of this study confirm and extend the findings of previous studies.[3–10] In particular, several studies in other jurisdictions in Canada prior to 1982 revealed that injury mortality rates for Native children were two to six times higher than for non-Natives.[3–5] A recent CDC report examined injury mortality rates

Table 3. Top five injury mechanisms for each age subgroup

		Native		*Non-Native*	
Age		*Mechanism*	*Rate*[a]	*Mechanism*	*Rate*[a]
0–4	1	Unintentional motor vehicle	29.4	Unintentional motor vehicle	4.0
	2	Pedestrian	8.4	Unintentional drowning	2.5
	3	Unintentional drowning	8.4	Unintentional suffocation	2.3
	4	Unintentional flame/fire	8.4	Homicide	1.1
	5	Unintentional suffocation	8.4	Unintentional fall	0.5
5–9	1	Unintentional motor vehicle	10.0	Unintentional motor vehicle	4.7
	2	Unintentional flame/fire	4.0	Unintentional drowning	0.6
	3	Unintentional firearm	2.5	Unintentional flame/fire	0.5
	4	Unintentional suffocation	1.2	Homicide	0.5
	5	Pedestrian	1.2	Unintentional firearm	0.4
10–14	1	Unintentional motor vehicle	25.6	Unintentional motor vehicle	5.8
	2	Suicide	12.8	Suicide	2.4
	3	Unintentional firearm	5.7	Homicide	0.8
	4	Homicide	2.8	Unintentional suffocation	0.7
	5	Unintentional drowning	1.4	Unintentional drowning	0.7
15–19	1	Unintentional motor vehicle	117	Unintentional motor vehicle	34.1
	2	Suicide	102	Suicide	15.1
	3	Homicide	16.8	Unintentional drowning	1.9
	4	Unintentional flame/fire	10.7	Unintentional falls	1.3
	5	Unintentional poisoning	9.1	Unintentional flame/fire	0.8

[a]Injury mortality rate per 100,000 per year

among American Indian and Alaska Native children for the period from 1989 to 1998.[12] Native rates were compared with those for the general pediatric population in the United States. The all-cause injury mortality rate for American Indian and Alaska Native children was two times higher than for the general population. The relative risk was thought to be underestimated given the likelihood of significant misclassification of ethnicity on state death certificates.

The reasons for the excess injury mortality in Native children (compared with non-Native children) are numerous and complex. Based on national data, Canadian Natives have a lower socioeconomic status compared with the general population, as reflected in higher unemployment, lower mean family income, greater reliance on social assistance, less education, and higher-density living arrangements. The inverse correlation between socioeconomic status and injury risk in children is well established.[21,22] Beyond socioeconomic deprivation, Native populations in Canada are also thought to experience cultural alienation,[23] which is related to oppressive experiences such as loss of identity, restricted economic opportunity, suppression of beliefs and spirituality, discrimination, and racism. Such major social stressors may contribute to the increased rates of unintentional injury, suicide, and homicide in Native populations.[24–26]

Other investigators have reported increased injury morbidity and mortality associated with alcohol and drug abuse among Natives compared with non-Natives.[26–29] It has been estimated that more than 75% of suicides and homicides among American Indians involve alcohol.[30] Canadian Natives acknowledge that substance abuse is a serious problem in the Native adolescent population.[25]

An excess of deaths associated with off-road recreational vehicles in Native children has also been reported.[31] These vehicles are often an important means of transportation on the reserve, and their use by children is often poorly regulated. Other authors have speculated that poorly maintained roads and vehicles contribute to the greater risk of motor vehicle deaths in Native communities.[26,32] The remoteness of Native communities may also make timely access to medical facilities difficult.[3,33] Last, awareness of (or compliance with) injury prevention strategies may be less common in Native populations compared with non-Natives.[34,35]

The relative risk for intent unknown deaths was noticeably higher than the relative risk for other intent categories. While the reasons for this statistic are unknown, others have reported that deaths in which intent is considered unknown have characteristics similar to homicide deaths.[36] If that were the case in this study, the effect of such misclassification of homicide deaths as intent unknown deaths would be to bias the homicide relative risk (Native vs. non-Native) toward the null.

Almost 20 years ago, in response to the high injury rates in the Native population in the United States, Indian Health Services (IHS) developed an injury prevention initiative now referred to as the IHS Injury Prevention Program.[36] This program provides expertise and support to communities or tribes interested in implementing injury prevention strategies in their jurisdiction. There is evidence that this program has reduced injury morbidity and mortality in some communities.[37–40]

Similar initiatives are underway in Canada. At the federal level, the Medical Services Branch within Health Canada is responsible for providing health services to the Native population. Delivery of health services is organized around a network of regional offices and health centers across the country, and priority setting at the local level is encouraged. Injury mortality data are already being collected at the local and national level. Therefore, the basic framework for implementing injury prevention initiatives in the Native population already exists. A major current impediment, however, is the lack of a central national agency dedicated to the coordination of injury control, such as the National Center for Injury Prevention and Control in the United States. Such an agency could assist local efforts in data collection, training, priority setting, implementation, and evaluation of injury prevention interventions.

The present study does not examine injury morbidity in Native children. A related study from the same geographic area examined the incidence of severe injury, both fatal and nonfatal, in Native adults. Again, Natives were found to be at increased relative risk for such injury than the general population (RR=3.7, 95% CI 3.0 to 4.6).[41] It would thus seem that Natives in this geographic area are at a similarly greater risk for both injury morbidity and mortality.

CONCLUSION

In conclusion, injury is a significant public health issue in the Native population. Both unintentional and intentional injury mortality rates in Native children are several times higher than the rates in non-Native children. National and local initiatives to identify and quantify the modifiable risk factors for injury mortality in Native children are required, as are the development and implementation of injury prevention strategies to reduce the burden of unintentional and intentional injury mortality in this vulnerable population.

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