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Native Indian Status as a Risk Factor for Injury-related Mortality in Alberta Children

by

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ABSTRACT

OBJECTIVE: The objective of this study was to examine Indian status as a risk factor for mortality from injury among Alberta children, aged 0-19 years. **STUDY DESIGN:** This was an observational population-based epidemiologic study of injury mortality in Alberta children over a 10-year period from 1985-1994. Mortality data obtained from Alberta Vital Statistics (pertaining to all Alberta children) was linked to Alberta First Nations Mortality Database data (pertaining to Indian children) to create Indian and non-Indian comparison groups. Mortality rates and relative risks were calculated for all injuries combined as well as for various subtypes (by intent and mechanism of injury). Patterns over time were also examined. **RESULTS:** After stratifying for age and gender, the relative risk for injury mortality for Indian versus non-Indian children was found to be 4.6 (95% CI: 4.1, 5.2). Indian children were also found to be at increased for death from all intent of injury subtypes: unintentional (RR: 4.0, 95% CI: 3.5, 4.6), suicide (RR: 6.6, 95% CI: 5.2, 8.5), homicide (RR: 5.1, 95% CI: 3.0, 8.5) and intent unknown (RR: 8.3, 95% CI: 4.9, 14.0). Injury mortality rates appeared to decrease over the study period in both Indians and non-Indians. **CONCLUSION:** While death from injury is in decline among Alberta children, Indian children are at significantly increased risk for death from unintentional and intentional injury.

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We live forward, we understand backward.

William James

1 CHAPTER ONE: INTRODUCTION

The aim of this study is to examine Native Indian status as a risk factor for injury-related mortality. This chapter describes the problem under study and the current state of knowledge. Section 1.1 provides definitions for key terms used throughout the thesis. Section 1.2 reviews the modern concept of injury as a consequence of energy interchange. Section 1.3 is an overview of the public health implications of injuries. Section 1.4 discusses the issue of injury specifically in the pediatric age group in North America. Section 1.5 reviews the current state of knowledge regarding native Indian status as a risk factor for injury in a general sense and more specifically in children. Finally, section 1.6 provides a discussion of the rationale for the current study.

1.1 Definitions

For the purposes of this thesis, **injury** is defined as "any specific and identifiable bodily impairment resulting from acute exposure to an external energy source (mechanical, electrical, chemical, thermal or radiant); an injury can also result from a lack of body essentials such as body heat and air".[1] The term "injury" is preferred to "accident" because the latter term implies a random and thus non-preventable event. Viewing injury as the result of transfer of energy points the way to more detailed analyses of injury situations and to potential prevention and control issues. It is useful to further qualify an injury as **intentional** (in which there is demonstrated intent to do harm) or **unintentional** (in which there is no demonstrated intent to do harm).[2]

A **child** is defined here as an individual from birth through nineteen years of age. While many pediatric hospitals would not consider a nineteen year-old eligible for admission, standard vital statistics aggregated age groupings align 19-year old individuals within the 5-year grouping 15-19 years, a practice that is also advocated by the U.S. National Institute of Child Health and Human Development.[3]

A **status Canadian Indian** refers to an aboriginal Canadian who, according to the Indian Act is officially registered or entitled to be registered in the Indian Register maintained at the federal government's Department of Indian Affairs and Northern Development.[4] Individuals are entitled at birth to be registered in the Indian Register if one or both parents is a registered Indian (or is entitled to be registered). Throughout this thesis and in keeping with the Indian Act, the term "Indian," when used in the Canadian context, may be considered synonymous with "status Canadian Indian." All other Canadians are referred to in this thesis as "non-Indians." For the sake of clarity, it should be mentioned that the term "First Nation peoples" is a term that came into common usage in the 1970's to replace the word "Indian" which may people found offensive. While widely used today, this term does not have a legal definition in the Indian Act and as such the term "Indian" is used preferentially throughout this thesis.

1.2 Concept of Injury as a Consequence of Energy Interchange

James J. Gibson and William Haddon Jr. are credited with the modern conceptualization of injury as damage to the body occurring subsequent to transfer of physical energy. Prior to this, injury had generally been thought of in terms of shortcomings of the victims and hence injury prevention strategies largely consisted of educational measures.[5] In 1961, Gibson took a broader view when he stated that man experiences injury in response to the "flux of energies" which surround him - electrical, mechanical, radiant, thermal, and chemical.[6] This concept does not obviate personal responsibility entirely, however, it does assign a greater weight to other factors in the pathway of transmission of "energy" to the victim. Haddon, in a refinement of this concept, considered the various forms of energy listed above as "agents" of injuries and, in addition, he broadened this list of agents to include "negative agents" which interfere with normal body energy exchange. Examples of negative agents of injury include carbon monoxide (asphyxiation), water (drowning), and excessive cold temperature (frostbite).[1,7]

The logical extension of the concept of agents (different forms of energy) responsible for injury is the recognition of "vehicles" by which energy reaches the body.[1] Thus, for example, moving objects are the vehicles of mechanical energy, whereas electric lines are the vehicles of electrical energy. This concept is of practical significance in that many preventive measures are directed at the vehicles of energy.

Another important contribution to the energy interchange concept was made by Hugh De Haven, who observed that there existed thresholds in energy exchange which, if exceeded, will result in injury to the body. Impact conditions (in the case of mechanical energy transfer) or ambient conditions (in the case of other forms of energy transfer), together with injury thresholds will determine the injury outcome when specific quantities of energy are transferred.[8]

The energy interchange model can thus be used to consider the occurrence of injuries within the familiar epidemiologic framework consisting of:

- the host (with a given susceptibility to or threshold for injury) interacting with,
- the agent (energy with the potential to cause injury) delivered by some vehicle and acting in the setting of
- the local environment (the physical or socioeconomic setting) in which the host and the agent come into contact.

In addition to its usefulness in examining specific injury scenarios, this energy interchange model has been applied to hospital and vital statistics record keeping practices. For purposes of recording of injuries, the International Classification of Diseases (ninth edition) provides both "nature of injury" codes (N-codes) and "external cause of injury" codes (E-codes).[9] The N-codes describe the biologic nature of an injury (for example, fracture, closed head injury). The E-codes, on the other hand, detail the mechanism of injury (for example, pedestrian struck by a car, assault with a firearm). E-codes, which are mandatory on death records for all persons whose deaths were injury-related, provide important information about how energy transfer resulted in bodily injury and are therefore often more pertinent to prevention strategies than N-codes.

1.3 Injury as a Public Health Concern

1.3.1 Injury as a Public Health Concern Worldwide

The recently published Global Burden of Disease Study, sponsored by the World Health Organization and the World Bank provides contemporary international data on human health problems.[10-12] In this ambitious study, causes of death and disability were broadly divided into three groups: communicable diseases (including infectious diseases, nutritional disorders and perinatal diseases), noncommunicable diseases (primarily acquired diseases such as cancer and ischemic heart disease), and injury. Injury was responsible for 5.1 million deaths worldwide in 1990, representing 10.1 % of all deaths. While developing countries did demonstrate higher absolute injury-related mortality rates than developed countries, the proportional mortality from injury (among all causes of death) was consistent worldwide. The same study also looked at Disability-Adjusted Life Years (DALYs) as a measure of disease morbidity. This measure is arguably a better indicator of the impact of disease than mortality because it permits consideration of years lost not only to deaths but also to degrees of different disability levels.[13] It was found that injury accounted for 15.2% of DALYs worldwide in 1990; this further underscores the importance of injury on a global basis. Of final note, the Global Burden of Disease Study predicts that by the year 2020, there will be significant reductions in deaths from infectious diseases and perinatal diseases, while there will be an increase in deaths from injury.[14]

1.3.2 Injury as a Public Health Concern in North America

While injuries obviously have significant impact on those affected, the problem is increasingly being recognized as an important public health concern in North America. In Canada, in 1994 alone, there were 13,196 injury-related deaths (8949 unintentional and 4247 intentional), making injuries the fourth leading cause of death after cancer, heart disease and cerebrovascular disease.[15] Furthermore, unlike cancer, cardiovascular disease and cerebrovascular disease, injuries disproportionately strike younger members of the population. Of the above injury-related deaths occurring in 1994, 51% (6740) involved individuals under the age of 45 years, making injury the greatest killer of Canadians under 45. This situation is roughly mirrored in the United States, where in 1995 there were 147,475 injury-related deaths (93,320 unintentional and 54,155 intentional), again positioning injuries as the fourth leading cause of death among all Americans and the leading cause of death amongst Americans under the age of 45.[16] For purposes of rough comparison the crude mortality rates from injury mortality (intentional and unintentional) were 42.2 per 100,000 and 56 per 100,000 for Canada and the United States, respectively.[15,16]

Because the burden of injury mortality falls disproportionately on the young, there is a greater loss of future productive years with injury than with conditions associated with death at older ages. It may thus be argued that injury deaths represent a greater loss to society than other causes of death affecting older individuals.[17] During 1990 in the United States, years of potential life lost before age 65 years (YPLL-65) totaled 12,237,379. Unintentional injuries accounted for the largest proportion of YPLL-65 from all causes (17.5%), followed by malignant neoplasms (15.1%), suicide/homicide (12.2%), diseases of the heart (11.2%), congenital anomalies (5.4%), and human immunodeficiency virus infection including acquired immunodeficiency syndrome (HIV/AIDS) (5.4%).[18]

Mortality represents only the leading edge of a much larger issue, as many times more people suffered from non-fatal injuries. In Canada in 1992, for example, there were almost 290,000 admissions to hospital for treatment of injuries, representing a rate of 1000 admissions per 100,000 population.[19] These admissions accounted for 2.8 million days of hospitalization. The impact of injury morbidity is magnified even further if one considers the days for which normal activity is restricted consequent to injury (activity-loss days). In Canada in 1993 it was estimated that 62% of injuries entailed activity-loss days, amounting to an estimated 60.6 million activity-loss days (table 1-1).[20]

Table 1-1. Activity-loss days because of injuries, by gender and age group*, Canada, 1993.

Age Group	Males		Females		Combined	
	Number ('000)	Rate (per 1,000)	Number ('000)	Rate (per 1,000)	Number ('000)	Rate (per 1,000)
15-24	6,769	3,501	7,100	3,828	13,869	3,661
25-44	13,237	2,904	12,038	2,619	25,275	2,761
45-64	8,806	3,144	5,533	1,940	14,340	2,537
65+	1,146	882	5,935	3,397	7,081	2,324
Total	29,959	2,828	30,606	2,770	60,565	2,798

* Ages 0-14 years not reported.

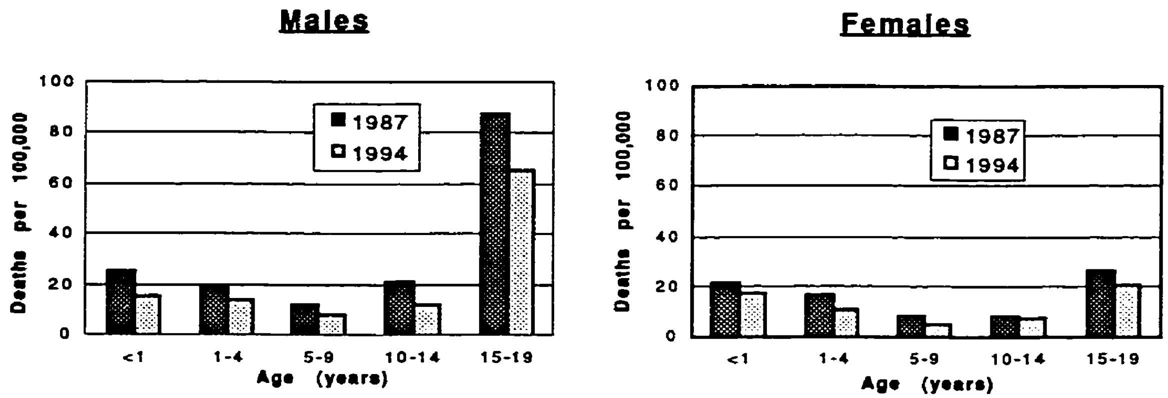
1.4 Injury in Children in North America

1.4.1 Injury Mortality in North American Children

Injuries are the leading cause of childhood mortality in Canada, resulting in more deaths than those combined from cancer, circulatory diseases, infectious diseases, congenital anomalies, and diseases of the nervous system and respiratory system. Specifically, in 1994, in the age group from birth to 19 years, 1059 Canadian children were killed by unintentional injuries (13.4 per 100,000), the most frequent causes being traffic incidents, drowning, burns, asphyxia, falls and poisoning.[15] An additional 387 childhood deaths (4.9 per 100,000) were intentional injuries (suicide and homicide). The combined 1446 injury deaths represent a mortality rate for children 0–19 years of 18.2 deaths per 100,000.

A more detailed examination of these pediatric deaths (figure 1-1) reveals that males of all ages are at greater risk for injury-related death than females, and that teenagers between the ages 15-19 years seem at greater risk than other age groups.[15,21] On a positive note, Figure 1-2 reveals a reduction in injury mortality rates in both genders in each age group from 1987 to 1994. This reflects a trend that has been seen in all ages across North America over the past two decades.[5,20,22,23]

Figure 1-1. Pediatric injury mortality rates, by sex and age group, Canada, 1987 and 1994.



In comparison, in the United States in 1991, there were 21,367 injury-related deaths (intentional and unintentional) of children aged 0 to 19 years, representing a mortality rate of 29.6 deaths per 100,000.[24] Mortality rates for unintentional (20.1 per 100,000) and intentional (9.49 per 100,000) injury deaths, are both in excess of the corresponding Canadian rates. These 1991 figures for the United States do, however, represent a reduction from 1978 when there were 28,905 injury-related deaths of children (40.22 deaths per 100,000).[25] This reduction in injury mortality (26.5% over the 13-year period) has been due to a 34% reduction in deaths from unintentional injury. Unfortunately, there has been a distressing 47% increase in intentional injury deaths.[23]

The reduced mortality from unintentional injury among children has been attributed to improved acute medical care of victims and to greater implementation of prevention strategies.[23] In general, acute trauma care has improved over the past 20 years.[26] The limits of this improvement may soon be reached, however, as many pediatric trauma deaths occur due to severe head injuries, for which medical and surgical care at the present time have limited success.[27] Prevention strategies appear to offer greater promise. In the case of deaths from motor vehicle crashes, prevention strategies have included improvements in vehicle design and occupant packaging, as well as programs aimed at reducing drunk driving. Decreased injury from bicycling is felt to reflect increased helmet use and decreased exposure to traffic. The reduction in pedestrian fatalities over time is attributed to decreased exposure to traffic, with far fewer children walking today, compared with 20 years ago.[28]

1.4.2 Injury Morbidity in North American Children

It has been reported that in Canada, in 1992 alone, 63,000 persons under the age of 20 required hospitalization as a consequence of injury, representing approximately 274,700 days of hospitalization.[19] Thus, for every injury-related death of a Canadian child, there were approximately 44 children admitted to hospital for treatment of injuries. Only diseases of the respiratory system accounted for more hospital admissions (128,792) and days of hospitalization (430,900). Clearly, both injury mortality and morbidity have a major impact on children and their families.

While nonfatal injuries are far more common than fatal injuries, they are much more difficult to accurately document. Hospital separation data, for example, measure only a portion of the injury morbidity toll, with an even larger number of children receiving outpatient attention for injuries. It is difficult to obtain accurate data regarding such visits as they occur in a large variety of outpatient settings. Thus, while injury deaths are recorded in a relatively accurate and complete fashion, surveillance systems for nonfatal injuries are less sophisticated. In Canada, within the past decade, several new injury surveillance databases aimed at documenting pediatric injury morbidity have emerged. Foremost perhaps is the Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP) database which, starting in 1990, began to collect data regarding injured children presenting to the emergency departments of participating hospitals.[22,29] The injuries captured in this database also include those that require hospital admission. Each year the number of participating hospitals has increased. In Alberta, the Alberta Trauma Registry collects data on all trauma patients (children and adults) with an Injury Severity Score greater than 11 admitted to designated trauma hospitals in the province.[29] This database aims at collecting complete (for the province of Alberta) data regarding all injuries of this severity presenting to hospital regardless of whether or not they end in death. While such severe injuries admittedly represent only a subset of all injuries, this type of data collection takes the next step beyond recording injury mortality only.

1.5 Native Indian Status as a Risk Factor for Injury

The focus of this thesis is Native Indian status as a risk factor for injury-related mortality among Canadian children. This section reviews the published literature pertaining to injury in Indians with an emphasis on the Canadian situation.

1.5.1 Government-published Mortality Patterns in Canadian Indians

A recent Health Canada report, entitled "Trends in First Nations Mortality, 1979-1993," examines patterns of mortality in registered Canadian Indians.[30] Indian mortality data from each of the provinces and the Yukon Territory (data were not available for the Northwest Territories) were examined at the Health Canada office in Ottawa.

In general terms, the report found that after age-standardization to the 1991 Canadian population, native Indian mortality rates exceeded the Canadian rates (table 1-2). Between 1980 and 1993, age-standardized mortality (all causes) for Indians declined, however, this was paralleled by a similar decline in the general Canadian population, the result of which is a relatively constant relative risk for Indians versus the general population.

Table 1-2. Age-standardized mortality rates - Indians versus general Canadian population (deaths per 1000 population).

Year	Indian Population	General Canadian Population	Relative Risk
1980	11.9	8.1	1.5
1985	11.0	7.7	1.4
1990	10.4	7.0	1.5
1993	10.8	6.9	1.6

A similar picture is seen when males and females are examined separately (table 1-3). That is, although mortality rates may have dropped slightly over the 1980-93 interval, the relative risks have remained constant.

Table 1-3. Age-standardized mortality rates - Indians versus general Canadian population (deaths per 1000 population), subdivided by gender.

	Females			Males		
Year	**Indian**	**Canadian**	**Relative Risk**	**Indian**	**Canadian**	**Relative Risk**
1980	11.3	7.3	1.5	12.4	8.9	1.4
1985	10.3	6.9	1.5	11.5	8.5	1.4
1990	9.3	6.4	1.5	11.5	7.7	1.5
1993	10.0	6.3	1.6	11.5	7.4	1.6

Injury, circulatory disease, neoplastic disease and respiratory disease, respectively, were the 4 leading causes of death during both the 1979-81 and 1991-93 periods (table 1-4). Rates for all causes of death except neoplasms decreased in the latter time period.

Table 1-4. Crude mortality rates for Canadian Indians by leading causes, 1979-81 versus 1991-93.

Cause of Death	1979-1981 Deaths per 100,000 (rank)	1991-1993 Deaths per 100,000 (rank)
Injury and Poisoning	243 (1)	154 (1)
Circulatory Disease	152 (2)	135 (2)
Neoplasms	55 (3)	76 (3)
Respiratory Disease	46 (4)	43 (4)
Ill-defined Conditions	29 (6)	29 (5)
Digestive Disease	38 (5)	28 (6)
Endocrine Disease	13 (9)	18 (7)
Infectious Disease	14 (8)	10 (8)
Congenital Anomalies	12 (10)	9 (9)
Perinatal Disease	21 (7)	8 (10)

The report provides rankings of leading causes of death for Indians within age subgroups during the period 1991-93; this has been reproduced in table 1-5. Focusing on children, it is seen that injury /poisoning was the leading cause of death amongst Indians aged 1-14 and 15-24.

Table 1-5. Leading causes of death among Canadian Indians by age group, 1991-93.

Rank	Age Group					
	0-1	**1-14**	**15-24**	**25-44**	**45-64**	**65+**
1	Ill-defined	Injury/Poison	Injury/Poison	Injury/Poison	Circulatory	Circulatory
2	Perinatal	Neoplasms	Ill-defined	Circulatory	Neoplasms	Neoplasms
3	Congenital	Congenital	Neoplasms	Neoplasms	Injury/Poison	Respiratory
4	Injury/Poison	Respiratory	Circulatory	Digestive	Digestive	Endocrine
5	Respiratory	Infectious	CNS	Ill-defined	Respiratory	Digestive
6	CNS	Ill-defined	Respiratory	Mental	Endocrine	Injury/Poison

The age-standardized annual mortality rate from injury and poisoning for Indians was calculated as 174 deaths per 100,000 in contrast to 46 deaths per 100,000 for all Canadians; this represents a relative risk of 3.8. Such data were not available for age subgroups and therefore it is not possible to calculate the relative risks pertaining specifically to injury in the pediatric category of Indians; however a break-down of specific injuries amongst Indians of different ages was provided and is summarized in table 1-6.

Table 1-6. Leading causes of death (with rates) in Indian children.

Rank	Ranked Causes of Death by Age Group (deaths per 100,000/year)		
	< 1year	1-14 years	15-24 years
1	Other (43)	Motor Vehicle (14.3)	Suicide (80.7)
2	Fire (15.5)	Drowning (9.6)	Motor Vehicle (62.2)
3	Falls (6.9)	Fire (9.3)	Other (19.9)
4	Motor Vehicle (5.2)	Other (5.9)	Poisoning (10.7)
5	Drowning (3.4)	Suicide (4.2)	Drowning (9.3)
6	Poisoning (1.7)	Firearms (2.0)	Fire (7.4)
7	Firearms (0)	Poisoning (1.4)	Firearms (4.0)
8	Suicide (0)	Falls (0.6)	Falls (1.9)

In summary, this report implicates injury as the leading cause of mortality in Indian children beyond the age of one. Further, it appears that while mortality from injury in Indians of all ages has declined from 1979-83 to 1989-93, its ranking relative to other causes of death has not changed.

Deficiencies in this report include the fact that Indian mortality rates have been standardized to the general Canadian population as a whole rather than compared to the rates of the non-Indian population. As well, data have been aggregated at the national level from data provided by the individual provinces and territories. The authors acknowledge that the completeness and quality of provincial data varies considerably. In particular, data from the Atlantic provinces, Quebec and Ontario are collected only for Indians living on reserves, whereas data were collected for both on- and off-reserve Indians for the rest of the country. Likewise, some communities in Quebec stopped providing data during the latter years of the reporting period and British Columbia failed to provide data for the years 1985 and 1986. These shortcomings potentially dilute the relative risk for injury mortality in registered Indians versus non-Indians towards the null.

1.5.2 Published Literature on Injury in Indian Children in North America

The scientific literature was searched for studies examining Indian status as a risk factor for injury in children (either as a main focus of study or at least as a subgroup analysis). For the purposes of this review, the body of literature resulting from this search was separated by country (Canadian versus American Indians) and by outcome (injury mortality versus injury morbidity). These studies are reviewed in the following subsections.

1.5.2.1 Injury Mortality among Indian Children in Canada

Four published studies address injury mortality in Canadian Indians. The important findings of these studies are summarized in table 1-7.

Table 1-7. Risk of injury mortality among Indian children in Canada.

First Author (reference)	Time Period	Population	Age (years)	Relative Risk	Study Strengths	Study Weaknesses
MacWilliam [31]	1977-82	Indians on reserves across all of Canada	0-14	3.2	1. population based 2. large population	1. old data 2. possible misclassification
Hislop [32]	1953-78	Registered Indians in British Columbia	0-19	Male: 3 Female: 5	1. population based 2. large population 3. controlled for age & sex	1. old data 2. no pediatric subgroups analysis
Young [33]	1972-81	Residents of isolated Indian community in northwestern Ontario	0-4 5-14 15-24	6 2 4	1. detection of deaths and causes very thorough 2. looked at age subgroups	1. old data 2. limited generalizability
Young [34]	1978-86	Indians in the NWT	1-14	~1.5*	1. large population	1. limited data analysis 2. possibility of misclassification

* Relative risk is a conservative estimate based on graphical data presented in the paper.

The first study is entitled "Fatal Accidental Childhood Injuries in Canada" by MacWilliam and colleagues at the Bureau of Chronic Disease Epidemiology at Health and Welfare Canada, Ottawa, Ontario.[31] The purpose of this study was to examine unintentional fatal injuries in Canadian children, looking for trends over time and variation across provinces and between Indians living on reserves and other children. In this cross-sectional survey, the Canada Mortality Data Base, compiled by the Health Division of Statistics Canada, was used to identify all deaths in Canadian children (aged 0 to 14) over the period 1951-1983. Injury deaths were identified using the International Classification of Disease (ICD) codes pertaining to injuries. Injury (all types) as a cause of death was examined as were individual types of injury. Corresponding data were collected separately for deaths in Indian children living on Indian reserves during the period 1977-1982. Age-specific mortality rates were calculated for age groups 0-1, 1-4, 5-9 and 10-14 years. Canadian population data were derived from Statistics Canada census and intercensal estimations, and were used as denominator figures for the calculation of direct age standardized mortality rates (and standardized mortality ratios) using the 1971 Canadian population as the standard.

In addition to comparing injury mortality in Indian children to that in Canadian children in the general population, a large number of other comparisons were made in this study, including variation over time and across provinces. Statistical analyses were not presented for the data regarding Indian mortality rates.

The investigators found that during the period 1977-1982 (when data were available for reserve Indian children) the standardized mortality ratio (SMR) for Indians for all injury deaths was 3.2 relative to the overall Canadian rate (confidence interval not provided). The investigators also stated that, relative to the appropriate provincial injury mortality rates, the risk of injury mortality in Natives aged 1-14 was elevated in each province. Reserves in Manitoba and Saskatchewan had the highest standardized mortality ratios (4.6 and 4.5, respectively). SMR's for specific pediatric age categories were not provided.

The primary strength of this study is the large database available to the investigators, potentially including all deaths occurring in Canada over the study period and reserve Indian deaths over the period 1977-1982. They do not provide information regarding the estimated completeness of this database for either the population in general or the subset of reserve Indians

The large scope of this study represents a weakness in the study in terms of specifically addressing the issue of injury mortality in Indian children. That is, given the number of comparisons being examined (variation over time, province and ethic group), there is considerable potential for the problem of multiple testing with its attendant risk of type I error. The authors appear to recognize this potential problem, as they did not apply statistical testing to all of the subgroups examined. Assuming that the database is quite complete for all Canadian deaths, it remains unclear from the paper how Indians were identified as such in the database and whether this varied from province to province. It also seems possible that some reserve Indian deaths might be misclassified as non-Native deaths (for example, if the death took place off the reserve) resulting in an underestimation of the risk of injury-related death among Indians.

While this study suggests that reserve Indian children are at increased risk for death from injury, it does not consider the risk for Indians living off reserves. Furthermore, as injury mortality rates in the general pediatric population have decreased from 1951 to 1983 it is possible that relative risks for Indians versus non-Indians for the period 1977-82 might not reflect the current situation.

The second study, entitled "Accidental and Intentional Violent Deaths Among British Columbia Native Indians," is a cross-sectional survey examining death from unintentional and intentional injury among Indians in the province of British Columbia.[32] Mortality data were obtained from the Division of Vital Statistics for all deaths occurring in British Columbia from 1953 to 1978. During this period the provincial death registry identified individuals with registered Indian status (both on and off reserves). Injury deaths were identified by the appropriate ICD codes (6th, 7th and 8th revisions, depending on the year of death). Population data for Indians were obtained from Statistics Canada, the Federal Indian Affairs Department and the provincial Division of Vital Statistics for the years 1951, 1956, 1961, 1966, 1971, 1976 and 1981. Population data for the general British Columbia population were obtained from Statistics Canada. These data were in turn used to calculate sex-specific mortality rates standardized to the

1971 Canadian population. Mortality rate ratios (standardized mortality ratios) were then calculated comparing mortality in Natives to that in non-Indians.

A large number of standardized mortality ratios (SMR's) were calculated by the investigators looking at deaths by sex, in different age groups and in different subsets of unintentional and intentional injury. Of relevance to this review, the age-standardized mortality rate for all unintentional injuries in Native Indian children (ages 0-19 years) was 3 times greater than that of the non-Indian population for males and 5 times greater for females. Likewise the SMR for intentional violent deaths was increased in this age group for both males (SMR=6 for suicide, SMR =12 for homicide) and females (SMR=7 for suicide, SMR=4 for homicide). Each of the above estimates was reported to be statistically significant.

The primary strength of this study is its scope, reporting on all injury deaths in status Indians in British Columbia over a 25 year period. Multiple subgroups, however, were examined (over 40) raising the concern of type I error because of multiple testing.

Limitations of the study include the fact that these results are more than 20 years old and may not apply today. Furthermore, without confidence intervals it is difficult to interpret point estimates. Finally, the study does not provide any information about the risk of injury-related mortality among various pediatric age subgroups.

In spite of these limitations, this study demonstrates good internal validity and suggests that both male and female Indian children (0-19 years) are at increased risk of injury-related mortality (intentional and unintentional) relative to non-Indian children. It would seem reasonable to generalize these results to registered Indians in other Canadian provinces during the same time period.

The third study, entitled "Mortality Pattern of Isolated Indians in Northwestern Ontario: a 10-year Review," is a cross-sectional survey looking at mortality rates and causes of death (and specifically injury deaths) among Indians in a northwestern Ontario community (the Sioux Lookout Zone) from 1972 through 1981.[33] All deaths occurring among Indians in this isolated region of scattered Cree-Ojibwa communities were recorded by the regional health authorities and categorized by cause of death (ICD-9 codes, including E-codes for injuries). Deaths occurring outside the zone were "charged back" to the zone. The authors stated that the "isolation of the community, the relative lack of mobility of the population and the fact that health care was the responsibility of a single agency with a comprehensive medical records system made it likely that few deaths escaped registration." Census information and the age/sex composition of the region population were obtained from the Canadian Department of Indian and Northern Affairs, with the age/sex distribution of the 1977 population used to calculate age-specific and age-standardized mortality rates. The corresponding mortality data for the general Canadian population were obtained from Statistics Canada and used in the calculation of standardized mortality ratios (SMR) for Indians.

The annual age-standardized mortality rate in the Sioux Lookout Zone (SLZ) was 11.5 per 1000 compared with a rate of 7.2 for all of Canada. Looking specifically at injuries (intentional and unintentional) as a cause of death for Indians of all ages combined, the standardized mortality ratio for the SLZ was 4.5. In fact, injuries were the leading cause of mortality among SLZ inhabitants, whereas, injuries ranked third for all Canadians. Among the pediatric age subgroups, the SMR's for injury deaths among Indians aged 0-4, 5-14 and 15-24 years were 6, 2 and 4, respectively. Data were not provided for the distribution of specific types of injuries in these pediatric subgroups.

This study looked at Indian children as a subgroup of the larger study population and a large number of subgroups were examined with the attendant possibility of spurious results due to multiple testing. The study's findings, however, are in keeping with the previous cross-sectional studies, demonstrating an increased risk of injury mortality among Indian children. As mentioned above, the population studied here consisted of small isolated communities; thus while one might generalize these findings to other similar Indian communities, it might be difficult to generalize the results to larger communities, communities in close proximity to urban centres or to Indians living in urban settings. Finally, as was the case with the preceding study, these data are from 15-25 years ago and may not reflect the situation today.

The final study, entitled "An Epidemiological Perspective of Injuries in the Northwest Territories," is a cross-sectional survey looking at injury morbidity and mortality in the Northwest Territories (NWT).[34] The authors obtained NWT mortality data, by cause, for the years 1950 to 1987 from the Medical Services Branch of the Department of National Health and Welfare (the federal agency responsible for all health services in the NWT until 1986). During the study period, injury mortality data (by ICD 9 E-codes) for each of the three major ethnic groups (Indians, Inuit and other) in the NWT were available for the years 1978-86. Census data for the region were obtained from Statistics Canada. Mortality rates were calculated and age-standardized by the direct method using the 1971 population of Canada as the standard.

These authors found that the all-cause age-standardized mortality rate for the NWT was greater than the corresponding Canadian rate for all years (1950 through 1987). This rate, however, was declining over time, such that by the 1980's the rate for the NWT was 30% greater than Canadian rate. Likewise, over this period, the age-standardized mortality rate for all injuries was consistently higher than the corresponding national rate. Unfortunately, graphical representation of these data in five-year intervals was supplied, rather than specific age-standardized mortality rate figures. As mentioned above, mortality data for the three major ethnic groups were only available for the period 1978-86, during which time the age-standardized mortality rates for all ethnic groups combined and for all injuries combined were approximately 3 times the Canadian rates for both males and females. Considering all ages combined, injury mortality rates for Indians and Inuit were approximately 1.5 times greater than that of non-Native NWT residents for males and approximately 2 times greater for females. These data were further broken down by age group (0-14, 15-44, 45-64, >65 years). Again, graphical representation of these data was supplied, rather than specific age-standardized mortality rates. In the 0-14 year age subgroup, male Indian and Inuit residents share a mortality rate that is approximately 1.5 times that of non-Natives. The injury mortality rate in female (Inuit and Indian) Natives appears similar to that in non-Natives.

In spite of the volume and breadth of data collected by the investigators for this review, the results presented are distinctly qualitative and not quantitative. In a very general sense the authors conclude that the Indian and Inuit populations in the Northwest Territories have a higher risk of mortality from injury than non-Natives and that this is the case for all age groups. It is difficult to evaluate these conclusions from a stochastic perspective as no statistical testing was applied and specific numbers were not provided for the reader to either calculate standardized mortality ratios or estimate the power of this study to detect differences. Furthermore, the method for determination of ethnic status was not discussed, raising the possibility of misclassification bias. Thus, while they state that one of the study goals was to obtain an "accurate assessment of the extent and magnitude of the problem" of injury in aboriginal people in Canada's northern region, this goal does not appear to have been met.

1.5.2.2 Injury Mortality among Indian Children in the United States

Several articles examining injury mortality in American Indian children were identified. The important findings of these studies are summarized in table 1-8. Perhaps because of its considerably larger population and wide socioeconomic discrepancies from region to region, U.S. studies of injury mortality among Indians generally focus on regions of the country, rather than attempting to describe the picture on a national level.

Table 1-8. Risk of injury mortality among Indian children in the United States.

First Author (reference)	Time Period	Population	Age (years)	Relative Risk (95% CI)	Study Strengths	Study Weaknesses
Olson [35]	1958-82	New Mexico	0-4 5-9 10-14	~1.8* ~2.3* ~1.5*	1. population based 2. large population	1. multiple comparisons 2. limited data analysis 3. possibilty of misclassification of ethnic status 4. old data
Michalek [36]	1955-89	Northeastern New York State	0-24	M: 2.1 (1.3, 3.3) F: 3.1 (1.6, 5.6)	1. accurate identification of Indian status 2. thorough statistical analysis	1. some data remote 2. no analysis of pediatric age subgroups
Cummings [37]	1981-90	Washington State	0-1	2.2 (0.9, 5.8)	1. population based 2. highlights infants 3. recent data	1. small numbers
Campos-Outcalt [38]	1979-88	Victims of fatal motor-vehicle crashes in Arizona	0-4: - pedestrian - occupant 5-14: - pedestrian - occupant 15-24: - pedestrian - occupant	 0.7 (0.0,64.7) 6.4 (1.3, 31.2) 0.8 (0.1, 8.2) 3.1 (0.6, 5.3) 4.8 (1.7, 8.2) 2.5 (1.5, 4.1)	1. population based 2. good statistical analysis	1. small numbers in pediatric subgroups 2. possibility of misclassification of race 3. possibility of misclassification of alcohol involvement

* Relative risk estimates based on graphical data presented in the paper.

The first study, entitled "Injury Mortality in American Indians, Hispanics, and Non-Hispanic White Children in New Mexico, 1958 to 1982," utilized death certificate data for children aged 0-14 years for the years 1958 to 1982.[35] Hispanic ethnicity was determined on the basis of the decedents' surnames, the surnames of the decedents' parents and from specific statements on the death certificate. Non-Hispanic whites were individuals whose race was recorded as white on the death certificate and who did not have a Spanish surname. Indians were identified solely on the basis of information cited on the death certificate. The method used here for identifying Indians was not validated in any way. National census data were used for denominators.

Many comparisons were made by the authors, most of which are reported graphically rather than numerically. In general, it was found that: unintentional deaths accounted for 85% of all injury deaths. Indian children of both sexes had higher injury mortality rates than the children in other ethnic groups. For all age groups Hispanics and non-Hispanic whites experienced similar injury mortality rates.

Specific mortality rates were not provided for all-cause injury mortality by ethnic group, however, from the graphic data provided conservative relative risk estimates (Indians versus non-Indians) can be made for the period 1978-82: 1.8 for ages 0-4 years, 2.3 for ages 5-9 years, and 1.5 for ages 10-14 years. Indians were also found to be at risk for death from the most common injury types - motor vehicle crashes, drowning and fires.

Unfortunately, the analysis included an extremely large number of comparisons mostly presented graphically. It is thus difficult to determine any reliable point estimates of risk. Furthermore, the rather qualitative method of determining exposure (ethnicity) is prone to misclassification of Indian status. That is, unless a comment was specifically made about ethnicity on the death certificate, the decedent would be classified as non-Hispanic white, likely resulting in a bias of the risk for Indian children towards the null.

A second study, entitled "Mortality Patterns Among the Youth of a Northeastern American Indian Cohort," is a retrospective cohort study of mortality among American Indians of the Seneca Nation tribe in New York State born between 1955 and 1989.[36] This cohort, assembled from tribal roll books, consisted of 1550 males and 1483 females. Members were followed until age 25, date of death, or the end of the follow-up period. Information regarding cause of death by ICD causes was collected for members of the cohort and compared with New York State mortality data (exclusive of New York City) to calculate standardized mortality ratios (SMR) for the various causes of death.

The SMR for all-cause mortality for all ages combined (0-24 years) was significantly elevated in Indians at 1.4 (95% CI: 1.1, 1.8). Approximately 42% of these deaths were due to injuries. The SMR's for injury deaths in male and female Indians (ages 0-24 combined) were 2.1 (95% CI: 1.3, 3.3) and 3.2 (95% CI: 1.6, 5.6), respectively. Age subgroups could not be examined in detail because of small numbers.

In summary, the most striking observation of this elegant study is "the continued toll exacted by such preventable causes of death as accidents and injuries". The authors employ accurate methods for identification of the Indian cohort, apply thorough statistical analysis of the data where appropriate and provide useful point estimates of risk in the form of SMR's. Limitations of the study include the fact that some chronologically remote data (as far back as 1955) were used to accumulate large enough numbers in the Indian cohort, yet despite this, the numbers were still not large enough to study specific age subgroups. It seems reasonable to generalize these findings to registered Indian children in Canada over the same time period as the cohort consisted of young Indians living in a variety of rural and urban settings like their Canadian Indian counterparts.

The third study, a population-based case-control study entitled "Infant Injury Death in Washington State, 1981 through 1990," looked specifically at risk factors for injury mortality in children less than 1 year old.[37] Injury deaths (cases) were identified by ICD 9 E-codes on death certificates while controls were a random sample of infants alive during the same period. The investigators looked at a number of potential risk factors including Indian status. After controlling for other variables it was found that the relative risk (odds ratio) for injury death in Indian infants relative to non-Indian infants was 2.2 (95% CI 0.9 to 5.8). The point estimates are, however, limited by small numbers (196 total deaths, 10 of which were Indians) and the large number of variables examined (11 in total).

The final study, entitled "Motor-Vehicle Crash Fatalities among American Indians and Non-Indians in Arizona, 1979 through 1988," looked specifically at the risk for motor vehicle crash fatality among Indians and non-Indians.[38] Death certificates for fatalities from motor-vehicle crashes during the study period were identified from vital statistics data (ICD E-codes E810-E825). Data collected included: age, sex, race, residence, cause of death (by E-codes), and circumstances of the crash. Race (Indian or non-Indian) was determined solely on the basis of information cited on the death certificate. Residence was broadly grouped into urban (2 counties consisting primarily of large metropolitan areas) or rural (the remaining 13 counties, none of which contained a metropolitan area). Results were grouped by age, including the pediatric age categories less than 5 years, 5-14 years and 15-24 years.

During the 10 year study period, there were 6,344 deaths of which 961 were in Indians. In general, the relative risks (Indians versus non-Indians) for all motor-vehicle crash fatalities were increased, regardless of residence (urban/rural) or gender. The data were then stratified by age group and crash circumstances (occupant/pedestrian). For Indian children less than 5 years of age, the relative risk was 6.4 (95% CI: 1.3 to 31.2) for vehicle occupants and 0.7 (95% CI: 0.0 to 64.7) for pedestrians. For children aged 5-14 years, the relative risk was 3.1 (95% CI: 0.6 to 5.3) for occupants and 0.8 (95% CI: 0.1 to 8.2) for pedestrians. Thus, Indian children who were vehicle occupants tended to be at greater risk for death than non-Indians, although statistical significance was not achieved. For individuals aged 15-24 years, the relative risk was 2.5 (95% CI: 1.5 to 4.1) for occupants and 4.8 (95% CI: 1.7 to 8.2) for pedestrians, both statistically significant. Relative risks after stratification by age and sex were not presented probably because of small numbers in the sub-categories. The investigators looked separately at mortality rates for urban versus rural residence status. They found that both Indian and non-Indian rural residents had higher motor vehicle crash mortality rates, however, the relative risks for Indians relative to their respective rural or urban non-Indian counterparts remained the same, suggesting that mortality rates are proportionately increased in rural Indian and non-Indian residents. In general, for all ages combined, it was found that pedestrian fatalities and alcohol use associated with the accident were associated with a higher proportion of the excess mortality seen in Indians than was rural residence.

This study focuses on motor vehicle crash fatalities, which generally account for the largest number of injury deaths in children.[23]. One major strength of the study is that it was a population-based study with good statistical analysis. As well, the authors have attempted to study the contribution of rural residence, alcohol use and pedestrian fatalities to the high Indian motor-vehicle crash mortality rate in Arizona. The study's weakness was that there were relatively small numbers of deaths in the pediatric subgroups, such that although an increased risk was observed, statistical significance was not achieved. Also, there existed the potential for misclassification of Indian status as clarification of ethnicity was based on death certificate information. Finally the classification of alcohol involvement was often based on police judgement, thus introducing the possibility of misclassification bias (differential or non-differential).

1.5.2.3 Injury Morbidity among North American Indian Children

Mortality data underestimate the social, economic and medical burden of injuries on a community.[22] Unfortunately, injury morbidity data are more difficult to collect and may be characterized by a lower degree of accuracy than mortality data. Accordingly, there are fewer published studies looking at morbidity in Indians. Two studies addressing the risk of injury morbidity among North American Indian children were identified and are summarized in table 1-9.

Table 1-9. Summary of available literature examining risk of injury morbidity among North American Indian children and youth.

First Author (reference)	Time Period	Population	Age (years)	Relative Risk	Study strengths	Study Weaknesses
Evers[39, 40]	1974-77	Registered Indians in southwestern Ontario	**0-1:** - office visits - ER visits **1-2:** - office visits ER visits	 1.8 0 2.2 1.5	1. prospective cohort design 2. accurate identification of Indian status	1. multiple testing 2.small study population
Quinlan[41]	1981-92	Patients discharged from Indian Health Service (IHS) hospitals in 11 US IHS regions	0-4 5-14 15-24	1.3 0.7 0.9	1. large study population	1. many Indians misclassified as non-Indians (dilution towards null hypothesis)

The first study, a prospective cohort study is published in two papers, entitled "Morbidity in Canadian Indian and Non-Indian Children in the First Year of Life"[39] and "Morbidity in Canadian Indian and Non-Indian Children in the Second Year."[40] These papers examine the morbidity patterns of a cohort of infants from two family medical centres in southwestern Ontario over the first 2 years of life during the years 1974-77. Among the cohort of 415 infants, 99 were identified as Indian (listed on the Indian Registry), while the remaining 316 were considered non-Indian. The two groups were followed forward over time for the occurrence of "health problem" events, which took the form of office visits, hospital emergency room (ER) visits or admission to hospital. Diagnoses for these health problems were coded according to the International Classification of Health Problems in Primary Care. Incidence rates were calculated based on the number of person-years for each cohort and relative risks were used as the measure of the ratio of risk of a health problem in Indian to the risk in non-Indian. Confidence intervals for the relative risk estimates were not provided in either study.

Indians and non-Indians were noted to be comparable in terms of birth weight, gestational age and sex. Indian mothers were noted to be significantly younger than non-Indian mothers at the time of delivery and the family size was significantly larger in the Indian group. During the study period, 8 of the original 99 Indian children and 78 of the original 316 non-Indian children were no longer patients at either of the two medical centres. The investigators were not aware of any deaths in either group.

During the first year of life, Indians had more than twice the number of office-reported health problems as non-Indian children. Specifically, the relative risk for injury-related office visits (Indians versus non-Indians) was 1.8. The rate of visits to the ER was similar for the two groups (RR=0.9). The vast majority of ER visits were for infectious diseases. No Indian children presented to the ER with injuries, in comparison to 6.4 visits per 100 person-years for non-Indians (RR=0). The rate of hospital admission was increased among the Indians (RR = 4.1), however, the majority of these admissions were for infectious diseases. The relative risk for injury-related admissions was not reported.

During the second year of life, the relative risk (Indians versus non-Indians) for all office-reported health problems was 1.5. Specifically, for injuries the relative risk was 2.2. The relative risk (Indians versus non-Indians) for injury-related visits to emergency departments was 1.5. The relative risk (Indians versus non-Indians) for hospital admission during the second year of life was reported as 2.4, however, these admissions were shown to be primarily for infectious diseases. The relative risk for injury-related hospital admission was not given.

These two studies both suffer from the potential problem of multiple testing as relative risks are calculated for a variety of different health problems in a variety of health care settings (admission to hospital, office visit or visit to the emergency department). Second, the small number of study subjects makes it difficult to accurately assess the risk for injury, which is a relatively rare event in the cohort. Aside from these limitations, this well-conducted and ambitious study does suggest that even at an early age Indian children are at an increased risk for injury compared to non-Indian children. It seems reasonable to infer a similar picture among Indian children having similar access to health care facilities elsewhere in Canada

A second study, from the United States, examined trends in hospitalizations for motor vehicle-related injuries among American Indian children and youth (0-24 years) from 1981-92.[41] This descriptive epidemiologic study looked at discharge data from Indian Health Service (IHS) hospitals in 11 IHS regions across the U.S. Motor vehicle-related injuries were identified by ICD 9 E-codes on discharge data. Discharge rates were calculated using the IHS service population (based on census data) as denominators and adjusted by the direct method using the 1940 population as the standard. The authors found that from 1981 to 1992, the age standardized annual incidence of motor vehicle-related injury hospitalizations decreased by 65%. Declines were seen in all age and sex groups. A comparison of the age-specific motor vehicle-related injury hospitalization rates for IHS patients versus the general US population revealed relative risks of 1.3 (for ages 0-4 years), 0.7 (5-14 years) and 0.9 (15-24 years). The authors noted, however, that the true rate of motor vehicle-related injury hospitalizations in Indians is likely underestimated in their study since only a minority of such patients are admitted to IHS hospitals. The resulting misclassification bias would be expected to dilute the relative risk towards the null hypothesis.

1.6 Rationale for the Current Study

Based on Canadian and American studies, it appears that Indian children are at increased risk for injury mortality. Indian children (all ages) were found to be at between 2 and 4 times greater risk for injury mortality than non-Native children. It would also appear that both reserve and non-reserve Indian children share an increased risk for mortality from injury.

There appears, however, to be a need for more current estimates of the relative risk for injury mortality among Indian children. As well, it remains unclear how this risk varies across different pediatric age groups. Furthermore, while it is known that injury mortality is decreasing over time in the general pediatric population, it is not known whether there is a difference in the rate of change among Indians and non-Indians. Finally, there is a need to examine pediatric Indian injury mortality in greater detail, looking specifically at the mechanism and intent of injury. The latter task could be carried out using the framework as suggested by the Centers for Disease Control and Prevention.[2] This standardized method of presenting injury mortality data has been designed to supplement traditional tabulations of vital statistics mortality data and helps facilitate comparisons of injury mortality across studies, jurisdictions and populations. Such a framework would also help define and characterize injury mortality as a public health concern and aid in identifying target populations at high risk. Such high risk populations could then be the focus of known injury prevention strategies.[42,43]

2 CHAPTER TWO: METHODS

This chapter outlines the methods used to examine the question of whether Indian children in Alberta are at a higher risk of death from injury than non-Indian children. Section 2.1 defines key terms used throughout the study. Sections 2.2 and 2.3 outline the primary and secondary research questions. Sections 2.4 and 2.5 describe the study design and sampling issues. A description of the data sources used in the study is given in section 2,6, including a discussion of data collection and handling. Power calculations for the study are provided in section 2.7. Measurement issues are discussed in section 2.8. Sections 2.9 and 2.10 discuss data cleaning and dataset linkage, respectively. Data analysis is discussed in section 2.11. The study budget is outlined in section 2.12. Ethical issues are discussed in section 2.13. A chapter summary is provided in section 2.14.

In general terms, this was an observational population-based epidemiologic study using historic Alberta Vital Statistics injury mortality data for the years 1985-94. The primary outcome was injury-related mortality. The primary predictor variable was Indian versus non-Indian status. Additional predictor variables of interest were age, gender and calendar year.

2.1 Definitions

For the purposes of this study, **injury** was defined as any specific and identifiable bodily impairment resulting from acute exposure to an external energy source (mechanical, electrical, chemical, thermal or radiation); injury can also result from a lack of body essentials such as heat and air.[1]

A child refers to an individual within the age group extending from birth to the end of the nineteenth year.

In keeping with the Indian Act, the term **Indian** refers to an aboriginal Canadian officially registered in the Indian Register maintained by the federal government.[4]. The term **non-Indian** was applied to all other Canadians. It should be mentioned that the term "First Nation peoples" is a term that came into common usage in the 1970's to replace the word "Indian" which may people found offensive. While widely used today, this term does not have a legal definition in the Indian Act and as such the term "Indian" is used preferentially throughout this thesis.

2.2 Primary Research Question

This study sought to answer the question: is registered Indian status a risk factor for mortality from injury among Alberta children? Specifically, the primary aim of the study was to examine injury mortality rates among Indian and non-Indian children over a 10-year period from 1985 to 1994. The null hypothesis was that mortality rates would be similar for Indians and non-Indians.

2.3 Secondary Research Questions

Secondary goals of the study were, firstly, to examine trends in injury mortality rates for Indian and non-Indian children over the ten-year study period. The null hypothesis was that changes in injury mortality rates over time would be similar for Indians and non-Indians. Second, the relative risks for unintentional and intentional (suicide and homicide) injury mortality in Indians versus non-Indians were examined. Finally relative risks for specific injury causes of death were studied. Again, in each case, the null hypothesis was that Indian status was not a risk factor for these outcomes.

2.4 Study Design

This observational population-based epidemiologic study examined Indian status as a risk factor for injury-related mortality in Alberta children over a 10-year period from January 1, 1985 to December 31, 1994. Indian children represented the "exposed" group and non-Indian Alberta children represented the "unexposed" group. Because the study focused on injury deaths in children aged 0-19 years and spanned an observation period of 10 years, the study population was dynamic in that it gained and lost subjects over the course of the study period.[44]

Data were collected in the form of historic (or retrospective) cause-related mortality data. Such data are routinely collected by provincial and federal governments for vital statistics purposes, and are available as secondary data in an anonymous format to non-governmental investigators. The period from 1985 to 1994 represented the most recent ten-year period for which there existed mortality data for both Indian and non-Indian children.

2.5 Sampling Issues

2.5.1 Target Population

The study sought to make inferences about children (ages 0-19 years) in the province of Alberta who, therefore, comprised the target population of interest. Alberta is a province in Canada with a population in 1991 of 2,545,555 of whom 30% were children.[45]

2.5.2 Sample Selection

The sample for study consisted of all individuals who were between the ages of birth and 19 years at some point during the 10-year study period from January, 1985 to December, 1994. This was, therefore, a population-based census "sample" in the sense that it included all such individuals in the province of Alberta during the 10 year period.[13] As mentioned above, this sample was a dynamic population as it gained and lost subjects over the study period. From this sample, registered Indian children were identified (anonymously) and compared with non-Indian children.

2.6 Data Sources, Collection and Handling

This study made use of secondary data derived from the vital statistics records kept by the Province of Alberta. The term secondary data, as used here, refers to data that have been collected for purposes other than specific research projects.[44] Of particular interest for this study were the vital statistics data pertaining to deaths occurring in Alberta. These data are kept on record in the province's Vital Statistics Information Terminal System maintained by Alberta Registries under the auspices of the provincial government. The data are used for statistical and research purposes by federal and provincial governmental agencies, and may also be made available to non-governmental agencies for research purposes according to the province's Vital Statistics Acts and Regulations.[29]

Vital Statistics data for this study were obtained via two sources, one for Indians and another for the general Alberta population. In the case of deaths of Indian children, data were obtained from the Alberta Medical Services Branch of Health Canada. Alberta Medical Services Branch receives names and identifying information for all deaths of

Alberta registered Indians via two sources. First, each of the Indian health centres in the province are required to report all stillbirths and deaths occurring in their jurisdiction to Medical Services Branch. Second, at the national level, the Department of Indian Affairs and Northern Development (DIAND) is notified of all Indian deaths in order to provide administrative and financial assistance to the family and community. DIAND in turn prepares a list of these deaths for each province's Medical Services Branch on a monthly basis. Alberta Medical Services Branch uses the names and identifying information obtained from these two sources to abstract mortality data from the corresponding death certificates in the province's Vital Statistics Information Terminal System. These data are then compiled in the Alberta Region First Nations Mortality Database for the purposes of internal planning and trend analysis.[29]. Of note, deaths of Alberta Indians occurring outside Alberta are not included in the database since there is no corresponding death certificate in the province's Vital Statistics Information Terminal System; furthermore, deaths of non-Alberta Indians dying in Alberta are not included in the database since notification of their deaths is not sent to Alberta Medical Services Branch (personal communication with M. Perrin, Regional Nurse Epidemiologist, Alberta Region, Medical Services Branch, Health Canada). The latter provisio is expected to dilute the relative risk estimate towards the null hypothesis if anything. The Indian mortality data obtained for this study from the Alberta Region First Nations Mortality Database were in the form of anonymous individual-level data. Each record contained details of the individual's gender, date of birth, date of death, and cause of death (by ICD 9 E-codes).

Mortality data for the general Alberta population were obtained directly from the Province's Vital Statistics Information Terminal System, again in the form of anonymous individual-level data. The Indian mortality deaths were deleted from the general population mortality data in order to generate a "clean" non-Indian comparison data set. In essence, therefore, both the Indian and general population mortality data were ultimately derived from the same source, that is the Alberta Vital Statistics Information Terminal System. It was necessary, however, to access the data via the two sources mentioned above in order to separate Indian deaths from the Alberta general population deaths.

Written requests for data were made to both Alberta Registries and the Alberta Medical Services Branch of Health Canada. In both cases these requests were for anonymous individual-level data for all deaths of children (age 0 through 19 years) occurring in the province during the period 1985-1994, and for whom an ICD 9 E-code for cause of death within the range from E800.0 to E999.9 was assigned. For each death, the data fields requested were: date of birth of the deceased individual, date of death, gender, and cause of death by ICD 9 E-code.

The data from the Alberta Vital Statistics Information Terminal System were requested in the form of an Excel spreadsheet file, with each line representing information pertaining to a single death. The data from the Alberta Region First Nations Mortality Database were also requested in the form of an Excel spreadsheet data file, again with each line representing information pertaining to a single death.

Population data for Indians and non-Indians 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 registered Indians, population data were obtained from the Indian Register annual census for each year during the study period. These population census data sets were obtained as hard copy reports from the Indian Registry and Statistics Canada, respectively. Indian population figures were then subtracted from the non-Indian population figures, thus giving Indian and non-Indian denominator data.

2.7 Power Calculations

The 1991 census population of Alberta was 2,545,555, of whom 779,035 were persons aged 0-19 years.[45] The number of registered Indians living in Alberta (including those registered Indians living on- and off-reserve) in 1993 was 68,872 and, based on the 1993 national age structure of registered Indians, it was estimated that 30,785 were between the ages of 0 and 19 years.[30]. Subtracting the Indian children from the Alberta population figures leaves approximately 748,250 non-Indian children.

Based on these population figures and other assumptions described below, it was possible to calculate the projected power of this study.[46] The rate of mortality from injury (all causes) in 1994 for Canadians aged 0-19 was approximately 19 per 100,000 per year.[15] Assuming this rate was reasonable over the preceding decade, this would translate into approximately 190 deaths per 100,000 over a 10-year period. Thus the mortality rate for the "unexposed" non-Indian population, p_0, for the 10-year study period was estimated at 0.0019. For the purposes of this calculation, a risk ratio of a magnitude of 1.5 (50% increase) was considered "clinically" significant. This corresponds to a mortality rate among "exposed" individuals (Indian children), p_1, of 0.0029 ($p_1 = p_0 \times 1.5 = 0.0019 \times 1.5 = 0.0029$). The ratio of unexposed (non-Indian) to exposed (Indian) children, represented by r, was estimated as $748{,}250 / 30{,}785 \approx 24$. Next, a weighted average of p_1 and p_0 was calculated:

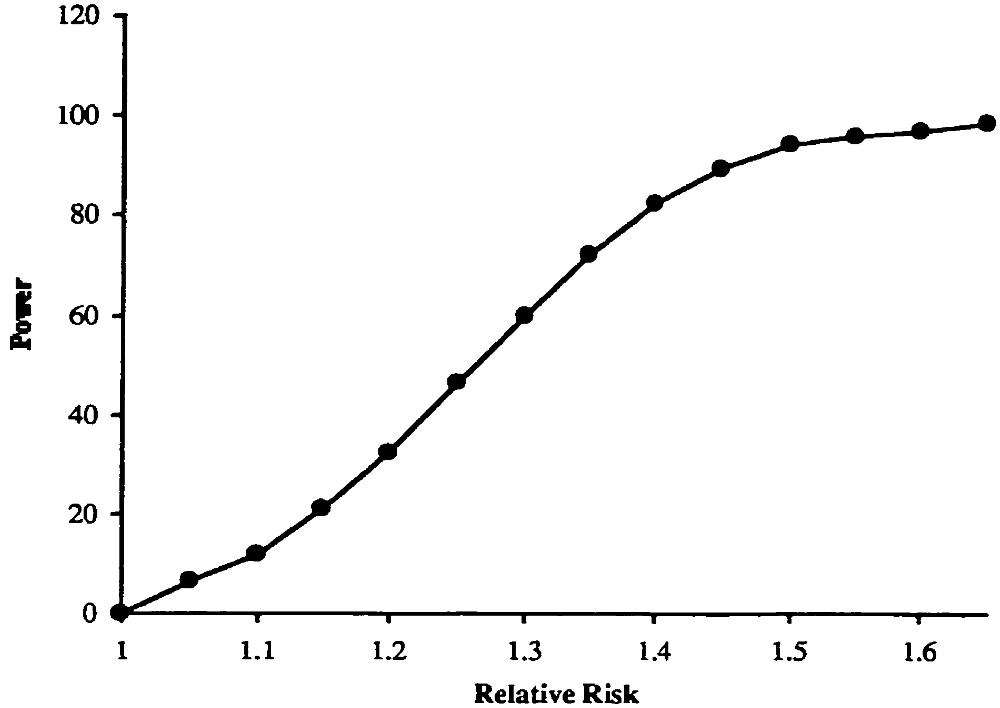
$$\bar{p} = \frac{p_1 + r\,p_0}{1+r}$$
$$= \frac{0.0029 + (24 \times 0.0019)}{1+24}$$
$$= 0.0019$$

Next, the power of the study was calculated, assuming $\alpha = 0.05$:

$$Z_\beta = \left[\frac{n(p_1 - p_0)^2 r}{(r+1)\bar{p}(1-\bar{p})}\right]^{\frac{1}{2}} - Z_{\alpha/2}$$
$$= \left[\frac{30,785(0.0029 - 0.0019)^2 24}{(24+1)(0.0019)(1-0.0019)}\right]^{\frac{1}{2}} - 1.96$$
$$= 3.95 - 1.96$$
$$= 1.99$$

This represented a power of greater than 95% to detect a 50% elevation in risk of injury-related mortality (i.e., RR = 1.5), accepting a 5% risk of type I error. Using the same method and given the above finite sample sizes, a power curve was created to illustrate the power this study had to detect various increases in risk of injury mortality (figure 2-1). It is evident that the smallest increase in risk ratio that can be detected with 80% power and a 5% risk of type I error is approximately 1.4 ($p_1 = 0.0026$).

Figure 2-1. Power to detect various increases in risk for injury mortality among Indian children (relative to non-Indian children).



2.8 Measurement

2.8.1 Independent Variables

The primary independent variable for this study was Indian versus non-Indian status. Indians were those Albertans included in the Indian Register, while non-Indians were all other Albertans. Registered Indians included those residing both on- and off-Indian reserves. It was not possible to distinguish between Indians residing on- and off-reserves.

2.8.2 Dependent Variables

The primary outcome of interest was injury-related mortality, coded in the vital statistics mortality data according to the ninth revision of the World Health Organization's International Classification of Diseases (ICD 9). The ICD 9 is an internationally recognized system for standardized classification of diseases for hospital and vital statistics record keeping.[9,47] Codes for injuries are contained within Chapter 8 of the ICD 9, using two formats: E-codes and N-codes. ICD 9 E-codes describe the "external cause of injury," detailing the mechanism of injury, whether the injury was intentional or unintentional, and, in some instances, the location where the injury took place. These are in contrast to ICD-9 N-codes which describe the nature of the injury and the part of the body injured, but do not explain how the injury took place. Both E-codes and N-codes are mandatory on death records for all persons whose deaths are injury-related, however, the E-codes tend to be more relevant to epidemiologic injury research.[2,48]

The ICD 9 E-codes of interest for this study included both intentional and unintentional injuries, as well as those in which intentionality was not determined. In general, these were the codes from E800.0 through E999.9, with the exceptions of medical/surgical misadventure or complications (E870 - E879) and adverse reactions to drugs (E930 - E949). The codes within this range identify a large variety of specific injury types (a condensed listing of which is found in Appendix A).

2.8.3 Potential Confounding Variables

Confounding variables are those factors that can cause or prevent the outcome of interest, are not intermediate variables in the causal pathway, and are independently associated with the factor under investigation.[13] Potential confounding variables in this study (and for which information was available) included age and gender. That is, there may be differences in the age and sex distributions between Indian and non-Indian populations. These potential differences were dealt with by calculation of age- and gender-specific mortality rates. Stratification by age was into 5-year age groups: 0-4 years, 5-9 years, 10-14 years, and 15-19 years.

2.8.4 Potential Effect Modification

Effect modifiers are factors that modify the effect of the causal factor under study.[13] It was of interest in this study to determine whether injury mortality rates were changing over the 10-year period and, if so, whether this trend affected Indians differently than non-Indians. This issue was addressed by considering time (i.e., year) as a possible effect modifier, looking for interaction between time and Indian/non-Indian status.

2.9 Data Cleaning

The requests for data from the Alberta Vital Statistics Information Terminal System and the Alberta Region First Nations Mortality Database were both comprehensive in the sense that all ICD 9 E-codes (E800.0 through E999.9) were included. As alluded to earlier, some of E-codes were not relevant to the study of death from injury. Specifically these E-codes were: E870-E876, E878-879, and E930-E949 (table 2-1). Individuals whose deaths were attributed to these E-codes were excluded from the datasets.

Table 2-1. Description of excluded ICD 9 E-codes.

E-code	Description
E870.0 - E876.9	Misadventures to patients during surgical or medical care
E878.0 - E879.9	Surgical and medical procedures as the cause of abnormal reaction or later complication, without mention of misadventure at the time of procedure
E930.0 - E949.9	Drugs, medicinal and biological substances causing adverse effects in therapeutic use

2.10 Dataset Linkage

The two data sets were linked probabilistically, with matching on the fields: date of birth, date of death, gender, and ICD-9 E-code for cause of death. After linkage, Indian deaths were in turn separated from the Alberta general population mortality data, yielding one set of data containing records of injury deaths in Indian children and another data set containing records of injury deaths in non-Indian children.

2.11 Data Analysis

2.11.1 Descriptive Analysis

Descriptive analysis of the data sets included assessment of the age and gender structures of the Indian and non-Indian populations. Also, the results of the data linkage were expressed as the percentage of Indian death records matched to death records in the Alberta Vital Statistics data set. The unmatched Indian records were tabulated explicitly.

2.11.2 Data Analysis for the Primary Research Questions

To examine the primary research question of whether Indian children were at a greater risk for injury mortality than non-Indian children, injury-related mortality rates for both groups were calculated for the 10-year period from 1985 to 1994, with stratification by age group and gender. This required initial calculation of sex- and age-specific mortality rates for Indians and non-Indians using the age categories: 0-4, 5-9, 10-14, and 15-19 years. These stratum-specific injury mortality rates were then used to calculate estimates of relative risk for Indians versus non-Indians along with 95% confidence intervals.[46,49] Confidence intervals encompassing 1 were considered to support the null hypothesis of no difference between Indian and non-Indian children, whereas confidence intervals not encompassing 1 were considered as evidence against the null hypothesis.[44] Summary estimates of relative risk with confidence intervals, unconfounded by age and gender, were determined, where appropriate, by calculating a Mantel-Haenszel weighted average of the stratum-specific relative risks.[46, 49] In addition to direct inspection, a Mantel-Haenszel chi-square test of heterogeneity was used to help judge whether stratum-specific were uniform across strata.[46]

These statistical findings were corroborated using Poisson regression analysis in which the outcome (y), death from injury, was considered as count data, with a Poisson distribution.[50, 51] The expected value of y was equal to the mortality rate (λ) multiplied by the period of observation. Using a log-linear model, the relation between the outcome (λ) and the predictor variables (status, age and sex) can be described as follows:

$$\log(\lambda) = \alpha + \beta_{status}\chi_{status} + \beta_{age}\chi_{age} + \beta_{sex}\chi_{sex}$$

2.11.3 Data Analysis for the Secondary Research Questions

As the mortality data were collected over a 10-year period, the possibility existed that injury mortality rates may have changed over time.[17] Furthermore, this change in mortality rate may have differed between Indians and non-Indians. To investigate these possibilities, a Poisson log-linear regression analysis was utilized. In this case, a "main effects" Poisson regression model containing the variables: status (Indian or non-Indian), age, sex and year of death was constructed as follows:

$$\log(\lambda) = \alpha + \beta_{status}\chi_{status} + \beta_{age}\chi_{age} + \beta_{sex}\chi_{sex} + \beta_{year}\chi_{year}$$

In this fashion, the year effect may be examined while controlling for age and gender. To examine the possibility that the year effect may have differed between Indians and non-Indians, an "interaction" model containing the variables: status, age, gender, year plus a status-year interaction term was constructed. Goodness-of-fit testing was used to determine the adequacy of these models in explaining the data. Specifically, a Pearson chi-square statistic was used to evaluate differences between values estimated by the model and observed values.[51]

Likelihood ratio testing was used to compare models of varying complexity. Here, the probability of observing the data when their sampling distribution is determined by the small model is compared to the corresponding probability under the larger model.[46] Thus, the main effects model was compared with the more complex interaction model; a significant difference between these two models would suggest that the rate of change over the 10-year study period differed among Indians and non-Indians.[44] Similarly, likelihood ratio testing was used to compare the main effects model to simpler models.

In addition to all-cause injury mortality, sex- and age-specific mortality rates (along with relative risks for Indians versus non-Indians) were calculated for subgroups of deaths by intent: unintentional, homicide, suicide and undetermined. Finally, mortality rates and relative risks for specific injury causes were tabulated using the conventions proposed by the Centers for Disease Control and Prevention, Atlanta, Georgia.[2] This framework is a product of a collaborative effort in the injury control community in the United States with assistance from the National Center for Injury Prevention and Control and the National Center for Health Statistics of the Centers for Disease Control and Prevention.[52-54]

2.11.4 Statistical Software

The statistical software package "Stata Statistical Software: Release 5," College Station, Texas, U.S.A. was used for all statistical analyses.[55]

2.12 Budget Justification

The primary costs of this study were related to obtaining the data. Data from the Alberta Vital Statistics Information Terminal System were provided at a cost of $895.00, which was based upon the amount of time required to produce the data set. Data from the Alberta Region First Nation Mortality Database were made available free of charge by the Alberta Medical Services Branch of Health Canada.

The funds to cover these expenses were obtained from the Alberta Heritage Foundation for Medical Research. No other outside funding was required for this study.

2.13 Ethical Issues

The goal of this study was to determine whether Indian children in Alberta were at increased risk for death from injury. If this were found to be the case, an obvious next step would be an attempt to understand the reasons for this increased risk with a specific view to developing risk reduction strategies. Such an outcome would be of benefit, not only to the children at risk, but also their families, their communities and indeed all Albertans who collectively share the health care resources provided by the province.

The present study made use of anonymous data regarding the deceased children in that no names or addresses were provided. No attempt was made to contact the families of these children.

The data sets used were the property of the Province of Alberta Registries (in the case of the Vital Statistics Information Terminal System) and the Medical Services Branch of Health Canada (in the case of the Alberta Region First Nations Mortality Database). There was an obligation not to use the data for purposes other than those outlined in the research proposal submitted to these agencies at the time of requesting the data. Furthermore, it was understood that the raw data provided by the above two sources were to be accessed only by the study investigators listed in the research proposal.

Data security was ensured by storage and use of the data files on a single microcomputer in a locked single user office environment at the University of Calgary.

Ethics approval of the research protocol was received from the Conjoint Research Ethics Review Board of the University of Calgary on September 4, 1997, prior to commencement of data collection and analysis.

2.14 Summary

In summary, this study was an observational population-based epidemiologic study seeking to examine the relative risk for injury-related mortality among Indian children in Alberta compared with non-Indian children in the province. The period of study was the 10-year period from 1985 to 1994. The study made use of anonymous individual-level secondary data provided by the province's Vital Statistics department and the province's Medical Services Branch of Health Canada.

3 CHAPTER THREE: RESULTS

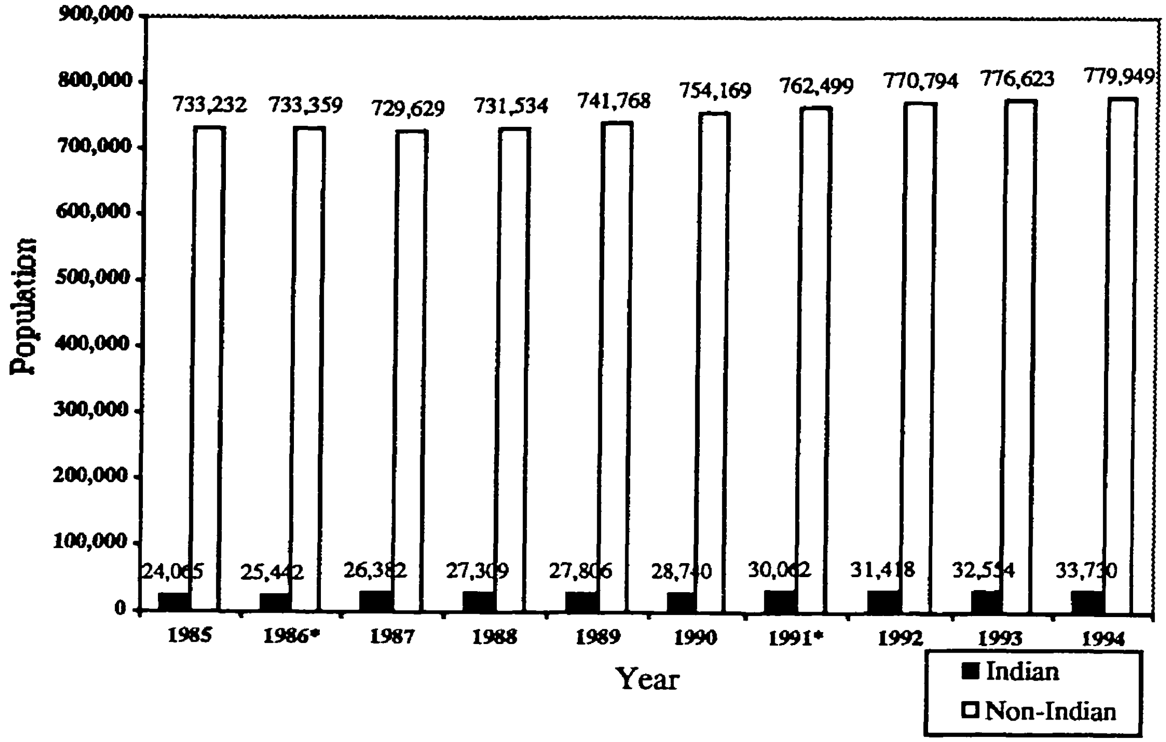
This chapter describes the study results. Section 3.1 discusses the Indian and non-Indian populations examined in the study. Section 3.2 provides results of the data linkage process. Sections 3.3, 3.4 and 3.5 examine Indian status as a risk factor for injury mortality, using stratified analysis initially and then Poisson regression analysis. In section 3.6, the effect of time on injury mortality is assessed. Subgroup analysis by intent of injury and mechanism of injury is described in section 3.7.

3.1 Description of Study Populations

3.1.1 Indians and Non-Indians

Annual population (denominator) data for Indians and non-Indians aged 0 to 19 years are shown in figure 3-1. For Indians, these figures reflect actual numbers on the Indian Register for each year. For non-Indians, these figures represent a combination of census data and intercensal estimates, with numbers of Indians subtracted from the total. As shown in the figure, the population of both Indians and non-Indians increased slightly over the 10 year period (24,065 to 33,730 for Indians and 733,000 to 780,000 for non-Indians). The ratio of non-Indians to Indians, however, has decreased from approximately 30:1 in 1985 to 23:1 in 1994.

Figure 3-1. Population by year for Indian and non-Indian children ages 0-19 years (*census years).



3.1.2 Age Distribution among Indian and Non-Indian Populations

The age distribution among Indians and non-Indians was comparable for the two census years during the study period (table 3-1).

Table 3-1. Age distribution, Indians vs. non-Indians for census years 1986 and 1991.

Age group	1986		1991	
	Indian	Non-Indian	Indian	Non-Indian
0-4 years	6,692 (26%)	201,598 (28%)	7,354 (25%)	204,072 (27%)
5-9 years	6,694 (26%)	180,477 (25%)	8,589 (29%)	201,572 (26%)
10-14 years	6,055 (24%)	169,420 (23%)	7,340 (24%)	181,969 (24%)
15-19 years	6,001 (24%)	181,864 (25%)	6,779 (23%)	174,886 (23%)
Total	25,442	733,359	30,062	762,499

3.1.3 Gender Distribution among Indian and Non-Indian Populations

The gender distribution among Indians and non-Indians was also comparable for the two census years during the study period (table 3-2).

Table 3-2. Populations by gender for the census years 1986 and 1991.

Gender	1986		1991	
	Indian	Non-Indian	Indian	Non-Indian
Female	12,541 (49%)	358,497 (49%)	14,818 (49%)	371,711 (49%)
Male	12,901 (51%)	374,862 (51%)	15,244 (51%)	390,788 (51%)
Total	25,442	733,359	30,062	762,499

3.2 Data Linkage

A search of the Alberta Region First Nations Mortality Database yielded 323 records for injury deaths among Indians aged 0-19 years for the years 1985 through 1994. A similar search of the Alberta Vital Statistics Information Terminal System yielded

2167 records for injury deaths among all Albertans (including Indians) aged 0-19 years for the years 1985-1994. Probabilistic linkage of the two data sets was performed based on the fields: date of death, date of birth, gender and E-code cause of death. Of the 323 deaths in the Indian data set, 319 (99%) were matched with deaths in the Alberta data set. The 4 unmatched Indian records are listed in Table 3-3. In summary, following linkage of the two data sets, then removal of the Indian records from the Alberta vital statistics data set, there were 319 records of Indian deaths and 1848 records of non-Indian deaths.

Table 3-3. Records of Indian deaths not matched to Alberta Vital Statistics records.

Record number*	Age at death	Gender	Cause of death	
			E-code	Description
168	16 years	Male	816.9	Motor vehicle traffic, unspecified
286	16 years	Male	966.0	Homicide, cutting/piercing
208	17 years	Male	910.8	Drowning, unintentional
202	18 years	Female	966.9	Homicide, cutting/piercing

* Note that record numbers have been assigned for purposes of data management and do not represent any official identifier unique to an individual.

3.3 Indian Status as a Risk Factor for Injury Mortality - Crude Rates

Crude mortality rates for Indians and non-Indians were calculated and then used to calculate a relative risk (Indians versus non-Indians). For the Indian population, there were 319 injury deaths among 287,508 person-years of observation, giving a crude injury mortality rate of 111.0 per 100,00 person-years. For non-Indians, there were 1848 injury deaths among 7,513,556 person-years of observation, giving an injury mortality rate of

24.6 per 100,000 person-years. The crude relative risk for injury mortality (Indian versus non-Indian) was, therefore, 4.5 (95% CI: 4.0, 5.1).

3.4 Indian Status as a Risk Factor for Injury Mortality - Stratified Analysis

3.4.1 Stratification by Age

To account for possible confounding effects because of differences in the age distribution of the two populations, stratification by age group was performed (table 3-4). Injury mortality was highest in both Indians and non-Indians in the 15-19 year age group. More importantly, within each age group stratum, Indians had a significantly greater risk for injury mortality.

Table 3-4. Injury mortality rates among Indians and non-Indians, stratified by age.

	Indian			Non-Indian			
Age group (years)	Deaths (1985-94)	Population (1985-94)*	Mortality rate**	Deaths (1985-94)	Population (1985-94)*	Mortality rate	Relative Risk (95% CI)
0-4	62	71,418	86.81	315	2,025,980	15.54	5.6 (4.2, 7.4)
5-9	20	80,115	24.96	169	1,924,719	8.78	2.8 (1.7, 4.5)
10-14	41	70,346	58.28	238	1,784,198	13.34	4.4 (3.1, 6.1)
15-19	196	65,629	298.65	1126	1,778,659	63.31	4.7 (4.0, 5.5)
Total	319	287,508	110.95 (crude)	1848	7,513,556	24.60 (crude)	4.5 (4.0, 5.1) (crude)

* sum of individual yearly populations for the 10 year period
** deaths per 100,000 per year

The Mantel-Haenszel test for heterogeneity was non-significant (p=0.10) and the combined Mantel-Haenszel relative risk (i.e. taking into account the differences between the two populations) was 4.6 (95% CI: 4.1, 5.2).

3.4.2 Stratification by Gender

Stratification by gender was likewise performed (table 3-5).

Table 3-5. Injury mortality rates among Indians and non-Indians, stratified by gender.

	Indian			Non-Indian			
Gender	Deaths (1985-94)	Population (1985-94)*	Mortality rate**	Deaths (1985-94)	Population (1985-94)*	Mortality rate	Relative Risk (95% CI)
Female	102	141,717	71.97	584	3,664,823	15.94	4.5 (3.6, 5.6)
Male	217	145,791	148.84	1264	3,848,733	32.84	4.5 (3.9, 5.2)
Total	319	287,508	110.95 (crude)	1848	7,513,556	24.60 (crude)	4.5 (4.0, 5.1) (crude)

* sum of individual yearly populations for the 10 year period

** deaths per 100,000 per year

The Mantel-Haenszel test for heterogeneity was non-significant (p=0.99) and the combined Mantel-Haenszel relative risk (i.e. taking into account gender differences in the two populations) was 4.5 (95% CI: 4.0, 5.1).

3.4.3 Stratification by Age and Gender

The data, stratified for age and gender, are seen in table 3-6.

Table 3-6. Injury mortality in Indians and non-Indians, stratified by age and gender.

Age group (years)	Sex	Indian			Non-Indian			Relative Risk (95% CI)
		Deaths (1985-94)	Population (1985-94)*	Mortality rate**	Deaths (1985-94)	Population (1985-94)	Mortality rate	
0-4	F	28	34,767	80.54	134	988,627	13.55	5.9 (3.8, 9.0)
	M	34	36,651	92.77	181	1,037,353	17.45	5.3 (3.6, 7.7)
5-9	F	9	39,586	22.74	68	937,095	7.26	3.1 (1.4, 6.3)
	M	11	40,529	27.14	101	987,624	10.23	2.7 (1.3, 5.0)
10-14	F	20	34,912	57.29	89	868,553	10.25	5.6 (3.3, 9.2)
	M	21	35,434	59.27	149	915,645	16.27	3.6 (2.2, 5.8)
15-19	F	45	32,452	138.67	293	870,548	33.66	4.1 (2.9, 5.7)
	M	151	33,177	455.13	833	908,111	91.73	5.0 (4.1, 5.9)
Total		319	287,508	110.95 (crude)	1848	7,513,556	24.60 (crude)	4.5 (4.0, 5.1) (crude)

* sum of individual yearly populations for the 10 year period
** deaths per 100,000 per year

The Mantel-Haenszel test of heterogeneity was not significant (p=0.25) and the confidence intervals overlapped, suggesting uniformity of relative risks across the strata. The combined Mantel-Haenszel relative risk (taking into account age and gender) was 4.6 (4.1, 5.2). Considering females only, Indian children of all ages are again are at significantly greater risk for death from injury than non-Indian children. Considering males only, Indian children of all ages were at significantly greater risk for death from injury than non-Indian children. Of note, the mortality rates among corresponding age strata are similar for non-Indian males and females, except for the 15-19 years group where mortality is much higher for males than females. A similar pattern is seen in Indians.

3.4.4 Sensitivity Analysis

As mentioned above, 4 records in the Indian data set could not be matched with records in the Alberta Vital Statistics data set and were thus excluded from the above stratified analysis. A sensitivity analysis was performed by adding these 4 unmatched records to the appropriate Indian strata and recalculating mortality rates and relative risks (table 3-7).

Table 3-7 Stratification by age and gender after inclusion of unmatched Indian records.

Age Group (years)	Gender	Indian			Non-Indian	Relative Risk (95% CI)
		Deaths	Population	Mortality Rate	Mortality Rate	
0-4	Female	28	34,767	80.54	13.55	5.9 (3.8, 9.0)
	Male	34	36,651	92.77	17.45	5.3 (3.6, 7.7)
5-9	Female	9	39,586	22.74	7.26	3.1 (1.4, 6.3)
	Male	11	40,529	27.14	10.23	2.7 (1.3, 5.0)
10-14	Female	20	34,912	57.29	10.25	5.6 (3.3, 9.2)
	Male	21	35,434	59.27	16.27	3.6 (2.2, 5.8)
15-19	Female	**46**	32,452	**141.75**	33.66	**4.2 (3.0, 5.8)**
	Male	**154**	33,177	**464.18**	91.73	**5.1 (4.2, 6.0)**

The overall crude relative risk was 4.6 (95% CI: 4.0, 5.1). The Mantel-Haenszel test for heterogeneity was non-significant (p=0.24) and the combined Mantel-Haenszel relative risk was 4.7 (95% CI: 4.2, 5.3). The results are essentially the same as those seen in table 3-6.

3.5 Indian Status as a Risk Factor for Injury Mortality - Poisson Analysis

Poisson analysis was used to corroborate the findings of the stratified analysis and also to examine the effect of time (over the 10 study years) on injury mortality in Indians and non-Indians. Poisson regression modeling gave results similar to those obtained with the above stratified analysis. For example, Poisson analysis with status as the sole independent variable gave a relative risk (Indian versus non-Indian) of 4.5 (95% CI: 4.0, 5.1). Likewise, a Poisson regression model with status, age and gender as independent variables gave an adjusted relative risk (Indian versus non-Indian) - taking into account the effect of age and gender - of 4.6 (95% CI: 4.1, 5.2).

3.6 Effect of Time on Injury Mortality (Indians versus Non-Indians)

In addition to determining the relative risk for injury mortality (Indians versus non-Indians) over the 10-year period, it is of interest to determine the trends in mortality rates.

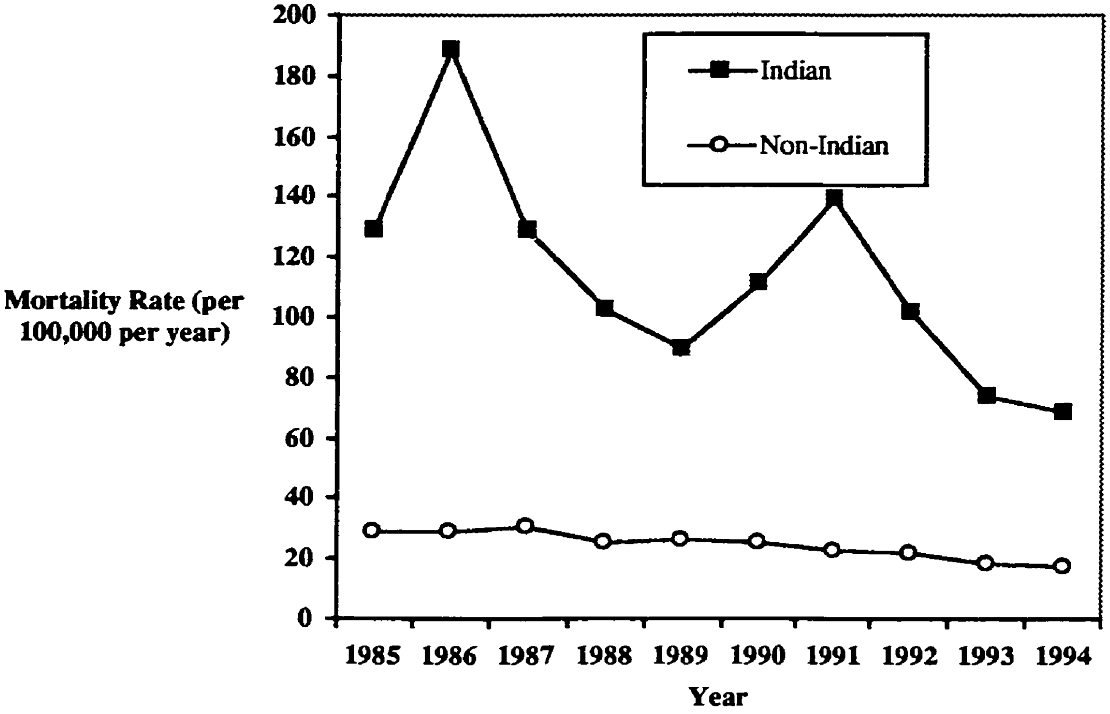
3.6.1 Annual Injury Mortality Rates among Indians and Non-Indians

Annual mortality rates were calculated for Indians and non-Indians and are presented in table 3-8 and figure 3-2. Among both groups there was a declining trend in injury mortality over the 10-year study period, however this was less apparent among Indians.

Table 3-8. Annual injury mortality rates for Indians and non-Indians, 1985-94.

Year	Indian			Non-Indian		
	Deaths	Population	Mortality Rate (per 100,000 per yr)	Deaths	Population	Mortality Rate (per 100,000 per yr)
1985	31	24,065	128.82	214	733,232	29.19
1986	48	25,442	188.66	212	733,359	28.91
1987	34	26,382	128.88	226	729,629	30.97
1988	28	27,309	102.53	185	731,534	25.29
1989	25	27,806	89.91	195	741,768	26.29
1990	32	28,740	111.34	189	754,169	25.06
1991	42	30,062	139.71	173	762,499	22.68
1992	32	31,418	101.85	169	770,794	21.93
1993	24	32,554	73.72	145	776,623	18.67
1994	23	33,730	68.19	140	779,949	17.95
Total	319	287,508	110.95	1848	7,513,556	24.60

Figure 3-2. Annual injury mortality rates for Indians and non-Indians, 1985-94.



3.6.2 Poisson Analysis Modeling - Time-Status Interaction

It was of interest to determine whether injury mortality was changing over the 10 year study period and whether this effect differed among Indians and non-Indians. Poisson regression modeling with a status-year interaction term was used to examine this issue. In the first series of models, year of study was considered as a continuous variable. Model 1 included the variables: status (Indian/non-Indian), age group (4 levels as used in the stratified analysis), gender, year and a status-year interaction term. Model 2 was a main effects model including: status, age group, gender and year. Model 3 included the variables: status, age group and gender only. The content and fit of these models is summarized in (table 3-9). The models were compared to one another by likelihood ratio testing.

Table 3-9. Poisson regression modeling to study the effect of time on injury mortality, considering year as a continuous variable.

Model	Model Variables	Goodness of Fit χ^2 (df)	p value	Model χ^2 (df)	p value
1	•Status •Age group •Gender •Year •Status-year interaction	261.6 (152)	0.00	2190.1(7)	< 0.01
2	•Status •Age group •Gender •Year	262.3 (153)	0.00	2189.4 (6)	< 0.01
3	•Status •Age group •Gender	313.1 (154)	0.00	2138.7 (5)	< 0.01

Models 1 and 2 were compared with a likelihood ratio test, yielding a χ^2 on 1 degree of freedom of 0.68 (p value = 0.41). This suggested no interaction between year and status. Models 2 and 3 were compared with a likelihood ratio test, yielding a χ^2 on 1 degree of freedom of 50.76 (p value = 0.00). This again suggested that the variable year was significant and that injury mortality rates were changing over the 10-year study period. Taken together, this series of models suggested that while mortality rates did change over time, the effect of time did not affect Indians differently than non-Indians.

Identical results were obtained when the variable time was included in the Poisson modeling as a categorical variable. Further, comparison of the two main effects models (time as a continuous variable and categorical variable, respectively) showed that the two models were not significantly different (likelihood ratio test, p=0,30) from one another.

3.6.3 Summary: Effect of Time on Injury Mortality

In summary, there was no evidence for a status-year interaction, suggesting that the rate of change in injury mortality was similar among Indians and non-Indians. It did appear, however, that injury mortality rates were changing over time. The model selected as the most appropriate to describe the risk of injury mortality among Indians versus non-Indians was the main effects model (which included time as a continuous variable, along with the variables age and gender. Examination of this model suggested gradual decline in death from injury over the 10-year study period; the adjusted relative risk for the continuous variable year was equal to 0.95 (95% CI: 0.93, 0.96).

3.7 Subgroup Analysis by Intent and Mechanism of Injury

3.7.1 Injury Mortality Rates by Intent of Injury

The ICD 9 E-codes allow injury deaths to be placed into one of five mutually exclusive intent of injury categories: unintentional, suicide, homicide, intent unknown and other (legal intervention and operations of war). Another category - intentional injury - consists of the sum of the homicide and suicide categories. Mortality rates and relative risks for Indians compared with non-Indians were calculated for each of the five intent of injury categories, initially with all ages combined (table 3-10). Indians were at significantly greater risk than non-Indians for death in each of the intent of injury categories.

Table 3-10. Mortality rates and relative risks (Indians versus non-Indians), by intent of injury (ages 0-19 years) for 1985-1994.

Intent of Injury	Indian		Non-Indian		RR**
	Deaths	Rate*	Deaths	Rate	
Unintentional (E800-E869, E880-E929)	206	71.7	1380	18.4	3.9 (3.4, 4.5)
Suicide (E950-E959)	78	27.1	319	4.2	6.4 (4.9, 8.2)
Homicide (E960-E969)	17	5.9	90	1.2	4.9 (2.8, 8.4)
Intent unknown (E980-E989)	18	6.3	59	0.8	8.0 (4.4, 13.7)
Other (E970-E978, E990-E999)†	0	-	0	-	N/A
All injury deaths (E800-E999)‡	319	111.0	1848	24.6	4.5 (4.0, 5.1)
Population (1985-94)§	287,508		7,513,556		

* Mortality rate per 100,000 per year ** Relative risk (95% confidence interval)

† Includes legal intervention (E970-E978) and operations of war (E990-E999)

‡ Excludes misadventures during surgical/medical care (E870-E876), surgical/medical procedures as the cause of abnormal reaction or complication, without mention of misadventure (E878-E879), and drugs and biologicalsubstances causing adverse effects in therapeutic use (E930-E949)

§ Sum of individual yearly populations for the 10-year period

Relative risks were also calculated after stratification by age and gender (table 3-11). Again, the general trend was one of increased risk for injury mortality for Indians among most of the strata.

Table 3-11. Summary of relative risks (Indians versus non-Indians) by intent of injury, stratified by gender and age group, 1985-94.

Age	Sex	Unintentional (E800-E869, E880-E929)		Intentional* (E950-E969)		Suicide (E950-E959)		Homicide (E960-E969)		Intent unknown (E980-989)	
		RR	CI**	RR	CI	RR	CI	RR	CI	RR	CI
0-4	F	5.7	3.5, 9.1	1.7	0.04, 10.7	N/A	N/A	1.7	0.1,10.7	17.8	4.6, 61.6
	M	5.3	3.5, 7.8	7.1	0.7, 35.5	N/A	N/A	7.1	0.7, 35.5	4.0	0.1, 31.5
5-9	F	3.4	1.5, 7.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	M	2.3	1.0, 4.6	9.7	0.9, 59.5	24.4	0.3,1913	6.1	0.1, 61.6	N/A	N/A
10-14	F	4.1	1.9, 7.8	6.2	1.8, 17.1	10.0	2.3, 34.5	2.5	0.1, 17.5	49.8	7.1, 550
	M	3.6	1.9, 6.1	4.3	1.5, 10.3	4.0	1.2, 10.4	6.5	0.1, 65.3	N/A	N/A
15-19	F	3.5	2.3, 5.2	6.1	3.3, 10.7	8.0	4.2, 14.6	1.3	0.03, 8.4	2.7	0.1, 18.9
	M	4.0	3.1, 5.0	7.0	5.2, 9.2	6.4	4.7, 8.7	12.4	5.3, 27.4	7.7	2.8, 18.2
Crude RR		3.9	3.4, 4.5	6.1	4.8, 7.6	6.4	4.9, 8.2	4.9	2.8, 8.4	8.0	4.4, 13.7
M-H RR		4.0	3.5, 4.6	6.3	5.0, 7.8	6.6	5.2, 8.5	5.1	3.0, 8.5	8.3	4.9, 14.0
M-H test(7 df)		p=0.37		p=0.86		p=0.58		p=0.24		p=0.36	

* The intentional category consists of suicide and homicide combined

** 95% confidence interval

N/A signifies no deaths in either Indians, non-Indians or both in this stratum

3.7.2 Injury Mortality Rates by Intent and Time

The effect of time (considered as a continuous variable) was examined for each injury intent sub-type. In each case a main effects model (including status, age group, gender and year) was compared with an otherwise identical model incorporating a status-year interaction term. In the absence of statistically significant time-status interaction, the main effects model was then compared with a identical model from which year was excluded.

For unintentional injury deaths, Poisson modeling showed no evidence of a status-year interaction (p=0.98). The year variable, however, was significant (p<0.01) indicating that unintentional mortality rates were declining over the 10-year period. The rate of change, however, did not differ between Indians and non-Indians. The adjusted relative risk for year (considered as a continuous variable) was 0.94 (95% CI: 0.92, 0.96).

For suicide deaths, Poisson modeling again showed no evidence of a status-year interaction (p=0.17). Further, the variable year was non-siginificant (p=0.24), suggesting that there was no evidence of significant change in suicide mortality rates over time for either group. The adjusted relative risk for year was 0.98 (95% CI: 0.95, 1.01).

For homicide injury deaths, Poisson modeling showed no significant status-year interaction (p=0.77). Again, the variable year was non-significant (p=0.78), indicating no significant change in the homicide mortality rates over time for either group. The adjusted relative risk for year was 1.01 (95% CI: 0.95, 1.08).

Last, for intent unknown deaths, Poisson regression modeling showed no evidence of a status-year interaction (p=0.56). The variable year, however, was significant (p<0.01), suggesting that intent unknown injury rates were significantly declining over the 10-year period. This decline, however, was similar for Indians and non-Indians. The adjusted relative risk for year was 0.88 (0.81, 0.96).

3.7.3 Injury Mortality by Mechanism and Intent of Injury

The following series of tables compare injury mortality in Indians and non-Indians by specific mechanism and intent of injury, using the conventions proposed by the Centers for Disease Control and Prevention. Initially, all ages are combined (table 3-12), with individual 5-year age subgroups considered subsequently (tables 3-13, 3-14, 3-15, and 3-16). Of note, the "all injury" category in each table excludes misadventures to patients during surgical and medical care (E870-E876), surgical and medical procedures as the cause of abnormal reaction of patient or later complication, without mention of misadventure at the time of procedure (E878-E879), and drugs, medicinal and biological substances causing adverse effects in therapeutic use (E930-E949).

The information detailed in these tables is exploratory in the sense that many categories of injury are examined. This was a population-based study, however, and the Centers for Disease Control and Prevention has recommended that injury mortality be reported in this fashion. Further, such data may generate research questions that are worth pursuing in future investigations.

Table 3-12. Mortality by mechanism and intent of injury, **0-19 years.**

		Indian		Non-Indian		
Cause of Death	**E code**	**Deaths**	**Rate***	**Deaths**	**Rate**	**RR (95% CI)**
Motor vehicle traffic (MVT)						
Unintentional	E810-E819	124	43.1	882	11.7	3.7 (3.0, 4.4)
person injured	*(4th digit codes)*					
Occupant	.0, .1	57	19.8	443	5.9	3.4 (2.5, 4.4)
Motorcyclist	.2, .3	6	2.1	55	0.7	2.9 (1.0, 6.6)
Pedal cyclist	.6	3	1.0	34	0.5	2.3 (0.5, 7.3)
Pedestrian	.7	22	7.7	83	1.1	6.9 (4.1, 11.2)
Unspecified	.9	36	12.5	266	3.5	3.5 (2.4, 5.0)
MVT, all	+ E958.5, E988.5	124	43.1	891	11.9	3.6 (3.0, 4.4)
Pedestrian, other than MVT	E800-E807 (.2), E820-E825 (.7), E826-E829 (.0)	13	4.5	20	0.3	17.0 (7.8, 35.9)
Firearm, all		37	12.9	203	2.7	4.8 (3.3, 6.8)
Unintentional	E922	8	2.8	23	0.3	9.1 (3.5, 21.0)
Suicide	E955 (.0-.4)	27	9.4	153	2.0	4.6 (2.9, 7.0)
Homicide	E965 (.0-.4)	1	0.3	25	0.3	1.0 (0.03, 6.4)
Intent unknown	E985 (.0-.4)	1	0.3	2	0.0	13.1 (0.2, 251)
Drowning						
Unintentional	E830, E832, E910	7	2.4	108	1.4	1.7 (0.7, 3.6)
All	+ E954, E964, E984	8	2.8	113	1.5	1.9 (0.8, 3.8)
Fire/flame						
Unintentional	E890-E899	17	5.9	73	1.0	6.1 (3.4, 10.4)
All	+ E958.1, E968.0, E988.1	17	5.9	76	1.0	5.8 (3.2, 10.0)
Suffocation, all		53	18.4	171	2.3	8.1 (5.8, 11.1)
Unintentional						
Inhalation	E911-E912	2	0.7	22	0.3	2.4 (0.3, 9.7)
Other	E913	6	2.1	52	0.7	3.0 (1.1, 7.0)
Suicide	E953	44	15.3	85	1.1	13.5 (9.2, 19.7)
Homicide	E963	1	0.3	9	0.1	2.9 (0.1, 21.0)
Intent unknown	E983		0.0	3	0.0	
Falls, unintentional	E880-E886, E888	3	1.0	40	0.5	2.0 (0.4, 6.2)
All	+ E957, E968.1, E987	3	1.0	49	0.7	1.6 (0.3, 5.0)
Cutting/piercing						
Homicide	E966	10	3.5	17	0.2	15.4 (6.3, 35.5)
All	+ E920, E956, E986, E974	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	E850-E869	10	3.5	17	0.2	15.4 (6.3, 35.5)
Suicide	E950-E952	6	2.1	70	0.9	2.2 (0.8, 5.1)
Homicide	E962		0.0	5	0.1	
Intent unknown	E980-E982	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	E800-E999	319	111.0	1848	24.6	4.5 (4.0, 5.1)
Population (1985-94)†		287,508		7,513,556		

* Mortality rate per 100,000 per year

† Sum of the indivdual yearly populations for the 10-year period

Table 3-13. Mortality by mechanism and intent of injury, 0-4 years.

		Indian		Non-Indian		
Cause of Death	**E code**	**Deaths**	**Rate***	**Deaths**	**Rate**	**RR (95% CI)**
Motor vehicle traffic (MVT)						
Unintentional	E810-E819	21	29.4	81	4.0	7.4 (4.3, 12.0)
person injured	*(4th digit codes)*					
Occupant	.0, .1	13	18.2	54	2.7	6.8 (3.4, 12.7)
Motorcyclist	.2, .3		0.0		0.0	
Pedal cyclist	.6		0.0		0.0	
Pedestrian	.7	6	8.4	20	1.0	8.5 (2.8, 22.0)
Unspecified	.9	2	2.8	7	0.3	8.1 (0.8, 42.6)
MVT, all	+ E958.5, E988.5	21	29.4	81	4.0	7.4 (4.3, 12.0)
Pedestrian, other than MVT	E800-E807 (.2), E820-E825 (.7), E826-E829 (.0)	6	8.4	9	0.4	18.9 (5.5, 59.5)
Firearm, all			0.0	3	0.1	
Unintentional	E922		0.0	1	0.0	
Suicide	E955 (.0-.4)		0.0		0.0	
Homicide	E965 (.0-.4)		0.0	2	0.1	
Intent unknown	E985 (.0-.4)		0.0		0.0	
Drowning						
Unintentional	E830, E832, E910	6	8.4	51	2.5	3.3 (1.2, 7.8)
All	+ E954, E964, E984	6	8.4	51	2.5	3.3 (1.2, 7.8)
Fire/flame						
Unintentional	E890-E899	6	8.4	43	2.1	4.0 (1.4, 9.3)
All	+ E958.1, E968.0, E988.1	6	8.4	44	2.2	3.9 (1.3, 9.1)
Suffocation, all		6	8.4	50	2.5	3.4 (1.2, 7.9)
Unintentional						
Inhalation	E911-E912	2	2.8	12	0.6	4.7 (0.5, 21.2)
Other	E913	4	5.6	35	1.7	3.2 (0.8, 9.1)
Suicide	E953		0.0		0.0	
Homicide	E963		0.0	2	0.1	
Intent unknown	E983		0.0	1	0.0	
Falls, unintentional	E880-E886, E888	3	4.2	11	0.5	7.7 (1.4, 29.3)
All	+ E957, E968.1, E987	3	4.2	13	0.6	6.5 (1.2, 23.8)
Cutting/piercing						
Homicide	E966		0.0	1	0.0	
All	+ E920, E956, E986, E974		0.0	1	0.0	
Poisoning, all		5	7.0	7	0.3	20.3 (5.1, 74.2)
Unintentional	E850-E869	3	4.2	5	0.2	17.0 (2.6, 87.5)
Suicide	E950-E952		0.0		0.0	
Homicide	E962		0.0		0.0	
Intent unknown	E980-E982	2	2.8	2	0.1	28.4 (2.1, 392)
Other causes, all		9	12.6	55	2.7	4.6 (2.0, 9.5)
Unintentional		2	2.8	27	1.3	2.1 (0.2, 8.4)
Suicide			0.0		0.0	
Homicide		3	4.2	18	0.9	4.7 (0.9, 16.2)
Intent unknown		4	5.6	10	0.5	11.3 (2.6, 39.3)
All injury	E800-E999	62	86.8	315	15.5	5.6 (4.2, 7.4)
Population (1985-94)†		71,418		2,025,980		

* Mortality rate per 100,000 per year

† Sum of the indivdual yearly populations for the 10-year period

Table 3-14. Mortality by mechanism and intent of injury, 5-9 years.

		Indian		Non-Indian		
Cause of Death	**E code**	**Deaths**	**Rate***	**Deaths**	**Rate**	**RR (95% CI)**
Motor vehicle traffic (MVT)						
Unintentional	E810-E819	8	10.0	90	4.7	2.1 (0.9, 4.4)
person injured	*(4th digit codes)*					
Occupant	.0, .1	2	2.5	50	2.6	1.0 (0.1, 3.7)
Motorcyclist	.2, .3		0.0	1	0.1	
Pedal cyclist	.6	2	2.5	11	0.6	4.4 (0.5, 20.0)
Pedestrian	.7	3	3.7	22	1.1	3.2 (0.6, 10.9)
Unspecified	.9	1	1.2	5	0.3	4.8 (0.1, 42.9)
MVT, all	+ E958.5, E988.5	8	10.0	90	4.7	2.1 (0.9, 4.4)
Pedestrian, other than MVT	E800-E807 (.2), E820-E825 (.7), E826-E829 (.0)	1	1.2	4	0.2	6.0 (0.1, 60.7)
Firearm, all		2	2.5	8	0.4	6.0 (0.6, 30.1)
Unintentional	E922	2	2.5	7	0.4	6.9 (0.7, 36.1)
Suicide	E955 (.0-.4)		0.0		0.0	
Homicide	E965 (.0-.4)		0.0	1	0.1	
Intent unknown	E985 (.0-.4)		0.0		0.0	
Drowning						
Unintentional	E830, E832, E910		0.0	12	0.6	
All	+ E954, E964, E984		0.0	12	0.6	
Fire/flame						
Unintentional	E890-E899	4	5.0	9	0.5	10.7 (2.4, 38.3)
All	+ E958.1, E968.0, E988.1	4	5.0	9	0.5	10.7 (2.4, 38.3)
Suffocation, all		3	3.7	12	0.6	6.0 (1.1, 22.3)
Unintentional						
Inhalation	E911-E912		0.0	6	0.3	
Other	E913	1	1.2	3	0.2	8.0 (0.2, 99.7)
Suicide	E953	1	1.2	1	0.1	24.0 (0.3, 1886)
Homicide	E963	1	1.2	2	0.1	12.0 (0.2, 231)
Intent unknown	E983		0.0		0.0	
Falls, unintentional	E880-E886, E888		0.0	2	0.1	
All	+ E957, E968.1, E987		0.0	2	0.1	
Cutting/piercing						
Homicide	E966		0.0	3	0.2	
All	+ E920, E956, E986, E974		0.0	3	0.2	
Poisoning, all		1	1.2	6	0.3	4.0 (0.1, 33.0)
Unintentional	E850-E869	1	1.2	1	0.1	24.0 (0.3, 1886)
Suicide	E950-E952		0.0		0.0	
Homicide	E962		0.0	2	0.1	
Intent unknown	E980-E982		0.0	3	0.2	
Other causes, all		1	1.2	23	1.2	1.0 (0.02, 6.4)
Unintentional		1	1.2	22	1.1	1.1 (0.03, 6.8)
Suicide			0.0		0.0	
Homicide			0.0	1	0.1	
Intent unknown			0.0		0.0	
All injury	E800-E999	20	25.0	169	8.8	2.8 (1.7, 4.5)
Population (1985-94)†		80,115		1,924,719		

* Mortality rate per 100,000 per year

† Sum of the indivdual yearly populations for the 10-year period

Table 3-15. Mortality by mechanism and intent of injury, **10-14 years.**

Cause of Death	E code	Indian Deaths	Indian Rate*	Non-Indian Deaths	Non-Indian Rate	RR (95% CI)
Motor vehicle traffic (MVT)						
Unintentional	E810-E819	18	25.6	104	5.8	4.4 (2.5, 7.3)
person injured	*(4th digit codes)*					
Occupant	.0, .1	9	12.8	61	3.4	3.7 (1.6, 7.6)
Motorcyclist	.2, .3	1	1.4	10	0.6	2.5 (0.1, 17.8)
Pedal cyclist	.6	1	1.4	8	0.4	3.2 (0.1, 23.6)
Pedestrian	.7	1	1.4	14	0.8	1.8 (0.04, 11.9)
Unspecified	.9	6	8.5	11	0.6	13.8 (4.2, 40.8)
MVT, all	+ E958.5, E988.5	18	25.6	104	5.8	4.4 (2.5, 7.3)
Pedestrian, other than MVT	E800-E807 (.2), E820-E825 (.7), E826-E829 (.0)		0.0	2	0.1	
Firearm, all		6	8.5	30	1.7	5.1 (1.7, 12.4)
Unintentional	E922	4	5.7	7	0.4	14.5 (3.1, 57.0)
Suicide	E955 (.0-.4)	1	1.4	16	0.9	1.6 (0.04, 10.2)
Homicide	E965 (.0-.4)	1	1.4	7	0.4	3.6 (0.1, 28.2)
Intent unknown	E985 (.0-.4)		0.0		0.0	
Drowning						
Unintentional	E830, E832, E910	1	1.4	11	0.6	2.3 (0.1, 15.9)
All	+ E954, E964, E984	1	1.4	12	0.7	2.1 (0.05, 14.3)
Fire/flame						
Unintentional	E890-E899		0.0	7	0.4	
All	+ E958.1, E968.0, E988.1		0.0	8	0.4	
Suffocation, all		6	8.5	38	2.1	4.0 (1.4, 9.5)
Unintentional						
Inhalation	E911-E912		0.0	4	0.2	
Other	E913		0.0	9	0.5	
Suicide	E953	6	8.5	23	1.3	6.6 (2.2, 16.7)
Homicide	E963		0.0		0.0	
Intent unknown	E983		0.0	2	0.1	
Falls, unintentional	E880-E886, E888		0.0	3	0.2	
All	+ E957, E968.1, E987		0.0	3	0.2	
Cutting/piercing						
Homicide	E966		0.0	2	0.1	
All	+ E920, E956, E986, E974		0.0	2	0.1	
Poisoning, all		4	5.7	10	0.6	10.1 (2.3, 35.2)
Unintentional	E850-E869		0.0	2	0.1	
Suicide	E950-E952	2	2.8	3	0.2	16.9 (1.4, 148)
Homicide	E962		0.0	3	0.2	
Intent unknown	E980-E982	2	2.8	2	0.1	25.4 (1.8, 350)
Other causes, all		6	8.5	29	1.6	5.2 (1.8, 12.9)
Unintentional		3	4.3	27	1.5	2.8 (0.5, 9.2)
Suicide			0.0		0.0	
Homicide		1	1.4	2	0.1	12.7 (0.2, 244)
Intent unknown		2	2.8		0.0	
All injury	E800-E999	41	58.3	238	13.3	4.4 (3.1, 6.1)
Population (1985-94)†		70,346		1,784,198		

* Mortality rate per 100,000 per year

† Sum of the indivdual yearly populations for the 10-year period

Table 3-16. Mortality by mechanism and intent of injury, **15-19 years.**

		Indian		Non-Indian		
Cause of Death	E code	Deaths	Rate*	Deaths	Rate	RR (95% CI)
Motor vehicle traffic (MVT)						
Unintentional	E810-E819	77	117.3	607	34.1	3.4 (2.7, 4.4)
person injured	*(4th digit codes)*					
Occupant	.0, .1	33	50.3	278	15.6	3.2 (2.2, 4.6)
Motorcyclist	.2, .3	5	7.6	44	2.5	3.1 (1.0, 7.7)
Pedal cyclist	.6		0.0	15	0.8	
Pedestrian	.7	12	18.3	27	1.5	12.0 (5.6, 24.6)
Unspecified	.9	27	41.1	243	13.7	3.0 (1.9, 4.5)
MVT, all	+ E958.5, E988.5	77	117.3	616	34.6	3.4 (2.6, 4.3)
Pedestrian, other than MVT	E800-E807 (.2), E820-E825 (.7), E826-E829 (.0)	6	9.1	5	0.3	32.5 (8.3, 135)
Firearm, all		29	44.2	162	9.1	4.9 (3.1, 7.2)
Unintentional	E922	2	3.0	8	0.4	6.8 (0.7, 34.0)
Suicide	E955 (.0-.4)	26	39.6	137	7.7	5.1 (3.2, 7.9)
Homicide	E965 (.0-.4)		0.0	15	0.8	
Intent unknown	E985 (.0-.4)	1	1.5	2	0.1	13.6 (0.2, 260)
Drowning						
Unintentional	E830, E832, E910		0.0	34	1.9	
All	+ E954, E964, E984	1	1.5	37	2.1	0.7 (0.02, 4.3)
Fire/flame						
Unintentional	E890-E899	7	10.7	14	0.8	13.6 (4.6, 35.9)
All	+ E958.1, E968.0, E988.1	7	10.7	15	0.8	12.6 (4.4, 33.0)
Suffocation, all		38	57.9	71	4.0	14.5 (9.5, 21.8)
Unintentional						
Inhalation	E911-E912		0.0		0.0	
Other	E913	1	1.5	5	0.3	5.4 (0.1, 48.4)
Suicide	E953	37	56.4	61	3.4	16.4 (10.6,25.1)
Homicide	E963		0.0	5	0.3	
Intent unknown	E983		0.0		0.0	
Falls, unintentional	E880-E886, E888		0.0	24	1.3	
All	+ E957, E968.1, E987		0.0	31	1.7	
Cutting/piercing						
Homicide	E966	10	15.2	11	0.6	24.6 (9.4, 63.9)
All	+ E920, E956, E986, E974	12	18.3	15	0.8	21.7 (9.3, 49.6)
Poisoning, all		15	22.9	90	5.1	4.5 (2.4, 7.9)
Unintentional	E850-E869	6	9.1	9	0.5	18.1 (5.3, 56.8)
Suicide	E950-E952	4	6.1	67	3.8	1.6 (0.4, 4.3)
Homicide	E962		0.0		0.0	
Intent unknown	E980-E982	5	7.6	14	0.8	9.7 (2.7, 28.4)
Other causes, all		11	16.8	84	4.7	3.5 (1.7, 6.7)
Unintentional		9	13.7	65	3.7	3.8 (1.6, 7.6)
Suicide			0.0	3	0.2	
Homicide		1	1.5	11	0.6	2.5 (0.1, 17.0)
Intent unknown		1	1.5	5	0.3	5.4 (0.1, 48.4)
All injury	E800-E999	196	298.6	1126	63.3	4.7 (4.0, 5.5)
Population (1985-94)†		65,629		1,778,659		

* Mortality rate per 100,000 per year

† Sum of the indivdual yearly populations for the 10-year period

4 CHAPTER FOUR: DISCUSSION

This chapter reviews the main findings of the study (Section 4.1). Strengths and limitations of the study are discussed in sections 4.2 and 4.3. Generalizability of the study results is discussed in section 4.4. Section 4.5 is an interpretation of the study results. Section 4.6 discusses implications for prevention. Section 4.7 outlines possible directions for future research.

4.1 Summary of Study Findings

4.1.1 Study Population

As expected, Indian children comprised only a small proportion of all Alberta children. Of interest, however, is that this proportion increased from 3.3% in 1985 to 4.3% in 1994. This change is consistent with national demographic data compiled over the same period.[30] The relative increase in the proportion of Indian children (compared with non-Indian children) is attributed to two factors. First, there is a higher birth rate among Indians than non-Indians. The birth rates among Indians and non-Indians in 1985 were 29.8 (per 1000 population) and 14.5, respectively. In 1993, birth rates for Indians and non-Indians were 27.5 and 13.4, respectively. Second, Bill C-31, introduced in 1985, reinstated the status of Indian women who married non-Indians and conferred status to their children and grandchildren.[4,56] It is estimated that, across Canada, 96,000 Bill C-31 registrants were added to the Indian Register from 1985 to 1993.[30] This represents approximately 20% of the names on the Indian register in 1993.

The age distribution among Canadian Indians is known to differ from non-Indians with a higher proportion of individuals under the age of 20 years and a lower proportion of individuals older than 45 years of age. This can be seen in table 4-1 which is based on 1993 Medical Services Branch data.[30]

Table 4-1. Distribution by age of Indians versus all Canadians.

Age Group (years)	Indians (%)	All Canada (%)
0-19	44.7	27.2
20-44	40.5	40.9
45-64	11.2	20.1
65+	3.7	11.7

Within the pediatric age groups (0-19 years), however, the age and gender distribution of Alberta Indians and non-Indians was found in this study to be virtually identical (tables 3-1 and 3-2). The same picture has been reported at the national level.[30]

4.1.2 Data Linkage

A probabilistic linkage of the Indian and non-Indian data sets was performed in order to separate Indian deaths from non-Indian deaths. In this fashion it was possible to match 319 (99%) of the 323 deaths in the Indian data set with deaths in the general Alberta data set. These 4 deaths were excluded from the Indian mortality figures and the calculation of relative risks for Indians versus non-Indians; in theory this would dilute the relative risk estimates toward the null hypothesis. To assess the effect of exclusion of these 4 deaths from the analysis, a sensitivity analysis was performed by recalculating the relative risk after the inclusion of these deaths as Indian deaths. The resulting relative risks were virtually the same and not statistically different from the originally calculated figures.

4.1.3 Indian Status as a Risk Factor for Injury Mortality

The overall relative risk for mortality from all injury types in Indians versus non-Indians, after controlling for age and gender, was 4.6 (95% CI: 4.1, 5.2). This increased relative risk was evident across all age and gender strata (table 3-6). Within each age group, for both Indians and non-Indians, mortality rates for males were greater than females, however, this was most evident in the 15-19 year age group.

Because of the very specific requirements for an individual to be designated as an Indian it seems unlikely that non-Indians would be misclassified as Indians. On the other hand it seems possible that some Indians might be misclassified as non-Indians because the potential lag time required for newborns to be officially registered in the Indian Register. That is, some Indian deaths may have occurred prior to registration, even though such individuals were eligible for Indian status. Also, there may have been some individuals who were eligible for Indian status based on Bill C-31, but who had not taken advantage of this opportunity. The effect of both of the above scenarios would be a differential misclassification bias towards the null hypothesis of no significant difference in injury mortality rates, with a consequent underestimation of the true risk. The extent of this underestimation in this population is uncertain.

4.1.4 Effect of Time on All-Injury Mortality (Indians versus non-Indians)

Other studies of pediatric injury mortality have demonstrated a trend of decreasing mortality rates over the past two decades.[20,57] The present study found a similar trend towards decreasing injury mortality over the 10-year study period. Graphically, this trend was more obvious in non-Indians than Indians, however the apparent variability in Indian rates from year-to-year was likely related to the smaller numbers of Indian deaths (table

3-8, figure 3-2). This was corroborated by statistical analysis, which found no evidence of interaction between status and time (year of study), suggesting that the decline in injury mortality was similar among Indians and non-Indians.

4.1.5 Subgroup Analysis by Intent and Mechanism of Injury

4.1.5.1 Intent of Injury

Injury deaths were classified based on the ICD 9 E-codes into intent of injury categories: unintentional, intentional (subclassified into homicide and suicide) and intent unknown. Indian status was a strong risk factor for all of these injury types. Indian status was a stronger risk factor for intentional death (RR: 6.3, 95% CI: 5.0, 7.8) and intent unknown deaths (RR: 8.3, 95% CI: 4.9, 14.0) than unintentional death (RR: 4.0, 95% CI: 3.5, 4.6). Among intentional deaths, Indian status was a strong risk factor for both suicide (RR: 6.6, 95% CI: 5.2, 8.5) and homicide (RR: 5.1, 95% CI: 3.0, 8.5).

The possibility of misclassification of cause of death based on incorrect assignment of ICD 9 E-codes exists. This would be expected to be a non-differential misclassification bias, however, as they are assigned from information on the death certificate by only a single agency, Alberta Vital Statistics. Further, at the time of coding, those doing the data entry do not have access to information regarding whether the deceased individual has Indian status or not.

There also exists the possibility of misclassification of the cause of death on the death certificate. Available literature regarding this possibility is discussed below. In this study, however, since all injury deaths are included for analysis and Indians were generally found to be at increased risk for all injury subtypes (by intent and by mechanism), it would seem unlikely that significant differential misclassification occurred.

There was no evidence among any of the intent of injury categories for an interaction between time and Indian status. That is, changes in mortality rates over time for the various intent of injury categories did not appear to differ between Indians and non-Indians. Unintentional injury mortality rates were found to be declining significantly in Indians and non-Indians over the 10-year study period. On the other hand, there was no evidence for declining rates of suicide or homicide among either group over the study period.

4.1.5.2 Mechanism of Injury

Mortality rates for various injury types were tabulated according to a framework recommended by the Centers for Disease Control and Prevention.[2] Examination of these tables provides some insight into certain injury types for which Indians appear to be at particularly high risk. This type of data analysis is exploratory in nature, but may be of use in directing future research.

Among children of all ages combined (table 3-12) it appeared that Indians were at increased risk for almost all injury types. Among unintentional deaths, the relative risk for Indians (compared with non-Indians) was particularly high for pedestrian fatalities (traffic-related and non-traffic-related) and poisoning. Among suicide deaths, the risk was especially high for suffocation (hanging).

Within the 0-4 year age subgroup (table 3-13), the risk for motor vehicle traffic fatalities, pedestrian fatalities (both traffic-related and non-traffic-related) and unintentional poisoning deaths was especially high for Indians compared with non-Indians. Among children aged 5-9 years (table 3-14), there was a trend towards increased risk for death from all injury types for Indians compared with non-Indians, however, in many cases statistical significance was not achieved. Among 10-14 year olds (table 3-15), Indians were at a particularly high risk for death from unintentional firearm injury and suicide by suffocation (hanging). Children aged 15-19 years accounted for more deaths than the other age subgroups combined (table 3-16). Among this age group, the relative risk for Indians (compared with non-Indians) was particularly high for death from pedestrian events (both traffic-related and non-traffic-related), fires, suicide by suffocation (hanging), homicide by a piercing object (stabbing) and unintentional poisoning.

4.2 Strengths of Present Study

This study is considered to have several strengths. First, the study time period (1985 to 1994) is more current than other published studies, which date from 1953 to 1986. It is well known that contemporary injury mortality rates are lower than those of twenty years ago.[5,22,23,58] Furthermore, the 10 year span of the study represented a large enough interval that time trends could be examined within the study itself. Finally, during the study time-period all injury deaths were coded using E-codes based on the ninth revision of the International Classification of Diseases (ICD 9). Other studies have spanned time-periods when more than one of the ICD revisions were in use, thus necessitating reconciliation of codes from one revision to another and in turn introducing the possibility of misclassification of cause of death.[46]

Second, this was a population-based study using the entire pediatric population in the province of Alberta as the denominator. In this regards selection bias was minimized. Additionally, the study looked *a priori* at the pediatric population, using well-accepted 5 year age subgroups rather than ad hoc pediatric age subgroups used in the other available studies.[3] Furthermore, the numbers of Indian and non-Indian injury deaths occurring over the study period provided sufficient power to detect subtle differences between Indian and non-Indian mortality rates. Finally, unlike population-based studies attempted at a national level, this study used data solely from Alberta sources, thus eliminating the problem of variable collection of data pertaining to Indian injury deaths. For example, in Alberta, Saskatchewan and Manitoba, data regarding injury deaths are collected for all registered Indians, both on- and off-reserves. In other provinces, data are collected for on-reserve Indians but not off-reserve Indians.

Third, definition and identification of Indians in this study was felt to be objective and accurate. Indian status was defined as inclusion in the Indian Register. The Indian Act is a piece of federal legislation which specifies in great detail the requirements for inclusion on the Indian Register. Registered Indians have certain rights and benefits that are not available to others, including on-reserve housing and exemption from federal and provincial taxes in specific situations. The federal Department of Indian Affairs and Northern Development is required by law to maintain the Indian Register.[4] Other studies have used less objective means of identifying Indian deaths such as comments on the death certificate (which is prone to misclassification bias).

Fourth, the Alberta mortality dataset is felt to be complete as the collection of these vital statistics data (including ICD 9 E-codes for injury deaths) is mandated by law. Death itself is considered a discrete outcome of interest since its occurrence can be established with virtual certainty, however the specific cause of death may be subject to some uncertainty.[46,49] In this study the ICD 9 E-codes for the cause of injury deaths were all assigned by one organization, Alberta Registries, blind to the Indian/non-Indian status of the deceased individual. Most injury mortality studies use the ICD system for reporting injury mortality because international treaty requires national governments to use ICD standards. Furthermore, the CDC and WHO advocate the use of consistent subgroupings of the ICD 9 E-codes in order to allow uniform aggregation of injury deaths by mechanism and intent to: facilitate comparisons across studies, jurisdictions and populations; to help define and characterize injury mortality as a public health problem; and to aid in identifying populations at high risk.[2,59]

Finally, unlike other studies, this study attempted to separate the Indian deaths from the general population deaths. Because individual level data were available for the general population and for Indians, it was possible to perform a probabilistic linkage of the two data sets and in turn identify and extract 99% of the Indian deaths from the general population deaths. Thus two "pure" groups, Indians and non-Indians, were created for study. Other studies have compared injury mortality among Indians to the general population (including Indians), thus potentially diluting the relative risk estimates towards the null hypothesis of no difference. Approximately 4% of Alberta children are registered Indians, however this issue would be of even greater significance in jurisdictions with large Indian populations, such as Saskatchewan and Manitoba where 10% of the population are Indians.[30]

4.3 Limitations of the Study

Several limitations of the present study are recognized, primarily related to the fact that secondary data sources were used. First, both the Indian and non-Indian mortality data were derived from Alberta vital statistics records and consequently, the available data fields were the same for both Indians and non-Indians. The available data fields were limited to: date of birth, date of death, gender, Indian status and cause of death. There was, therefore, no information regarding urban/rural status, reserve/non-reserve status, socioeconomic status, involvement of alcohol, hazard exposure, supervision, pre-existing medical conditions, time and type of transport to medical care and type of medical care given.

Second, there were potential problems with the outcome measure, namely cause of death by ICD 9 E-codes (derived from death certificates). Proper use of E-codes for coding injury-related causes of death permits the correct classification of environmental events, circumstances, and conditions.[59] Validity of death certificate information for injury deaths has been examined by Moyer and colleagues, who studied injury mortality among a randomly selected cohort of US Army Vietnam war veterans over the period 1965-1983.[60] The authors specifically focused on common injury causes of death: motor vehicle crashes, unintentional poisoning, suicide and homicide. They compared agreement of the underlying cause of death as determined from death certificate information with that determined by an independent review of all relevant medical and legal documents by a panel of physicians. Considering the physician panel as the gold standard, sensitivity and specificity were found to be greater than 90% for the broad groupings of motor vehicle crashes, suicides and homicide. Agreement was also excellent for specific categories of suicide and homicide. Agreement was less good for specific categories of motor vehicle crashes. Agreement was poor for deaths from unintentional poisoning, with the death certificate cause of death often coded as "intentionality undetermined", while the medical review panel was often able to determine intentionality.

It could be argued that better information pertaining to cause of death could be derived from medical examiner reports as they often include information from police reports, autopsies and toxicology reports. Dijkhuis and colleagues obtained death certificates for all injury deaths in Iowa for the period 1990-1991 and in turn sought medical examiner reports for these individuals.[61] It was found that the medical examiners reported 69% of all fatal injuries. This percentage varied among different types of injuries: 37% for unintentional falls, 79% of transportation fatalities, 83% of intentional fatalities and 57% of other external causes of death. Deaths of women and the elderly were underreported. The deaths of nonwhite individuals were slightly more likely than whites to be reported by medical examiners. Thus, while medical examiner reports contain more detailed information than vital statistics reports from death certificates, they underreport the actual number of injury deaths in a population and may differentially report on different races. Conversely, the vital statistics data used in this study lack richness yet closely reflect the true number of injury deaths in the Alberta pediatric population.

A final limitation of this study relates to the completeness of the data pertaining to injury deaths among Indians.[30] It is known that some Indians may not have joined the Indian Register by the time of their death, particularly infants. Thus these deaths may be either reported late (after the present study) or not at all. Furthermore, it is felt that not all individuals eligible for restoration of their Indian status according to Bill C-31 have in fact been restored on the Indian Register. The effect of this misclassification would be to underreport the risk of death from injury among Indians.

4.4 Generalizability

This was a contemporary population-based study of injury mortality in the province of Alberta. Indians elsewhere in Canada also fall under the jurisdiction of the Indian Act. As such, it would seem reasonable to generalize these findings to Indian children in general in other provinces in the country. Furthermore, the findings of this study are supported by previous work by other Canadian investigators, discussed in Chapter 1.[31-34] Therefore, it would seem plausible that the age-specific mortality rates observed here would apply to Indian children elsewhere in Canada. It is, however, not possible to make inferences about specific subsets of the Indian population, for example, reserve and non-reserve Indians, as such details were not available in this study.

4.5 Interpretation of the Results

Possible reasons for the increased risk for injury mortality among Indian children compared to non-Indian children include: inaccessibility of many Indian communities, lower socioeconomic status, cultural alienation, greater rates of substance abuse, and reduced awareness of known prevention strategies.

4.5.1 Accessibility of Indian Communities

The remoteness of some Indian communities makes access to medical facilities difficult, potentially resulting in the death of some injury victims before medical intervention was possible.[33,62] It has also been reported that there is an excess of deaths associated with off-road recreational vehicles in Indian children. These vehicles are often the only source of transportation in remote Indian communities and their use by children is often poorly regulated.[63] Others speculate that poorly maintained roads and vehicles, prevalent in many Indian communities, contribute to the greater risk of motor vehicle deaths.[64-67]

The inability to determine place of residence or place of death was a recognized limitation of this study. At the national level it is estimated that 60% of Indians live on reserves while the remaining 40% live off-reserve. For the purposes of resource allocation, the Medical Services Branch of Health Canada has classified Canada's 633

Indian reserves according to their geographic and demographic circumstances into four categories: non-isolated (accessible by road and less than 90 km from physician services), semi-isolated (accessible by road but more than 90 km from physician services), isolated (have scheduled flights and good telephone services, but no road access), and remote (no road access, no scheduled flights, minimal telephone or radio service). Table 4-2 outlines the distribution of reserves across the country and within the province of Alberta. It can be seen that Alberta differs somewhat from the rest of the country, having fewer non-isolated and isolated communities, but more semi-isolated communities.[30]

Table 4-2. Distribution of geo-demographic subtypes of Indian communities: Alberta versus all of Canada.

Type of Community	Distribution of Indian Communities (%)	
	Alberta	Canada
Non-isolated	53%	64%
Semi-isolated	33%	14%
Isolated	7%	19%
Remote	7%	3%
Total	100%	100%

4.5.2 Socioeconomic Status

According to the federal government, as of 1991, Indians as a group had a lower socioeconomic status than the Canadian population as a whole[68]. In particular, Indians had higher unemployment (28%) than the Canadian population (10%) and lower average family income ($10,141 versus $19,188, respectively). In total, 42% of Indians relied on social assistance and 28% had less than a grade 9 education (twice the national figure).

Finally, 11.4% of Indian dwellings have more than one person per room, a figure 8 times that of the general population.

Poor children are at increased risk for injury. A cohort study in Maine over the period 1976 to 1980 found that poor children had a twofold greater risk of injury death than nonpoor children.[69] It was also found that poor children had a fivefold greater rate of death from fires or burns, a fivefold greater risk of homicide, and a fourfold greater risk of drowning than nonpoor children. Several studies have found poor children to be at increased risk for pedestrian injury, compared with nonpoor children.[70-72] Possible explanations for the increased risk of injury in poor children include parenting issues and environmental issues. Poor families are often headed by single parents who may also be young and relatively uneducated.[73] Parents may also have poor knowledge of pediatric development and in turn mismatch the child to a task.[74,75] These parents may also have fewer resources and be less able to watch their children closely. Environmental issues that increase the risk of injury for poor children may include more crowded neighborhoods, inadequate play space, higher traffic volumes and higher vehicular speeds.[73,76]

4.5.3 Cultural Alienation

In addition to poor socioeconomic circumstances, Canadian Indians are said to be suffering from a less tangible condition referred to as "cultural alienation".[30] The Royal Commission on Aboriginal Peoples, sponsored by the Government of Canada in 1995 reported this phenomenon to be related to oppressive experiences such as "loss of identity, loss of control over living conditions, restricted economic opportunity, suppression of beliefs and spirituality, weakening of social institutions, displacement of political institutions, pervasive breakdown of cultural values and diminished esteem, discrimination and institutional racism and their internalized effects, and voluntary or involuntary adoption of elements of an external culture."[77] Possibly as a reflection of this cultural alienation, Indians in Canada have been found to have a higher incidence of mental illness than non-Indians.[78,79] Others have attributed increased rates of sexual abuse, family violence, suicide and homicide among Indians to these complex social issues.[64,80] Unintentional injuries are also said to be more prevalent in families with major social stressors.[81]

4.5.4 Substance Abuse

Abuse of alcohol and drugs have been associated with increased risk for many types of injury mortality, both intentional and unintentional.[73,82] With regards to unintentional injuries, the impact of alcohol on injury has been best studied in vehicular injury. Data from North America show that alcohol is associated with a higher incidence of death from crashes with equivalent vehicular damage.[83] Recent alcohol use has also been associated with an increased risk for other types of unintentional death, including pedestrians struck by motor vehicles, drowning, burns and fires.[84-86] Acute and chronic use of alcohol has been associated with an increased risk for attempted and completed suicide among adolescents.[87]

Several studies from the United States and Canada have reported an increased risk of injury morbidity and mortality associated with alcohol abuse among American Indians compared with non-Indians.[38,64,88-90] Canadian Indians view drug and substance abuse is a serious problem among their adolescents.[80] Greater rates of alcohol and drug abuse in Indian versus non-Indian youth have been documented in both Canada and the United States.[91-93] Precise estimates of the magnitude of the problem are not available. One provincially commissioned report from Saskatchewan in 1986 revealed that the rate of offences that were drug- or alcohol-related was five times higher in Indians than non-Indians; furthermore, the rate of alcohol- or drug-related assault offences among Indians was six times the provincial rate.[94] A precise estimate of the risk for alcohol-related injury mortality in Canadian Indians versus non-Indians is not available.

4.5.5 Reduced Awareness of Known Injury Prevention Strategies

There is evidence to suggest that Indians as a group have a reduced awareness of known injury prevention strategies compared with non-Indians. One American study comparing urban Indians to urban non-Indians found that Indian families were less likely to keep small objects, household products and medicines out of reach of their children and to possess and understand the use of ipecac.[95] A study from Washington state found an increased number of Indian households in which a family member smoked in bed compared with non-Indian households.[96] Another study from Washington State found a greater percentage of Indian households not equipped with a smoke detector compared with non-Indian households.[97] Others have reported that American Indians injured or killed in motor vehicle crashes are less likely to be wearing seatbelts compared with non-Indians.[43,90]

4.6 Implications for Prevention

4.6.1 General Injury Prevention Strategies

Following the lead of other successes in modern public health, the current emphasis in pediatric injury control strategies has been away from individual-centred measures towards community-centred measures[1,98]. Generally, there are three broad approaches to injury prevention: education, environmental modification, and legislation.[99] In practice there is often overlap between the three approaches.

Education measures have traditionally been programs aimed at changing individual decision making by children and their parents. One example would be campaigns to increase bicycle helmet use by children. Education also encompasses the education of professionals and policy makers by measures such as lobbying and advocacy. Education can also be directed at changing beliefs and attitudes of the general public, thus creating imperatives for the government to act, resulting in environmental modification or new legislation.

Environmental modification or engineering involves change in the design of products or of the built environment to reduce the potential for injury. These can be large scale measures such as urban traffic engineering, with measures to redistribute traffic or reduce traffic speed. On a smaller scale, physical barriers such as interior household gates may prevent children from falling down stairs or accessing poisonous substances; innovative designs such as face protectors on hockey helmets may reduce the consequences of head or facial injuries.

Legislation or regulation may be applied to a population to reinforce safety practices. At one extreme, this approach targets a single action that offers passive protection to vulnerable recipients, such as control of flammable sleepwear for children or enforcement of a maximum allowable hot water temperature in apartment buildings. At the other extreme legislative measures can mandate a repetitive activity such as the use of car seat belts or bicycle helmets.

Although intentional injury death (homicide and suicide) may seem to be different from unintentional injuries, injury control experts have increasingly considered intentional and unintentional injuries as parts of a whole for several reasons. First, the mechanism of injury is often the same for both. Second, many "unintentional" injuries, for example, single vehicle motor vehicle crashes, may actually represent suicides. Finally, methods to control unintentional injury, described above, are also effective in the prevention of intentional injury.[73].

4.6.2 Specific Prevention Strategies

Numerous prevention strategies have been shown to be effective in preventing injuries to children. It is convenient to consider these according to the environment in which the consequent injury may occur: road, home, recreation, and work environments.[99,100] Proven prevention strategies for common childhood injuries are summarized in table 4-3.

Table 4-3. Specific injury prevention strategies for children.

Injury	Prevention Strategies
Road Environment	
Pedestrian injuries	• 30 km/h speed zones • traffic management measures • pedestrian right of way education • pedestrian training for 5-8 year olds
Cyclist & motorcyclist injuries	• helmet design, education and legislation
Car occupant injuries	• seatbelt and car seat legislation • vehicle engineering (collapsing steering columns, air bags, interior padding, side impact protection)
Home Environment	
House fires	• smoke alarm education and legislation • elimination of smokers and smokers' materials from inside of homes • bans on hazardous grades of foam in furniture
Falls	• safety gates • removal of baby walkers from homes • window guards for apartments
Scalds	• education and legislation aimed at lowering tap water temperature
Poisoning	• childproof packaging • cabinet locks
General approaches	• home visits by safety inspectors offering safety recommendations
Leisure Environment	
Playground injuries	• playground equipment engineering
Sports injuries	• protective equipment (helmets, mouth guards, eye protection) • rule changes
Drownings	• barrier legislation for domestic pools • swimming lessons
Community-Based Approaches	• community-based programs incorporating elements of: - good local data collection - action committee - interagency collaboration - coordinated development of educational, environmental and legislative measures

4.6.3 Coordinated Injury Prevention Approaches

Many agencies and individuals are involved in child injury prevention. These include levels of government, health services, emergency services, voluntary sectors and academic centres. It has been noted, however, that implemented injury prevention strategies are frequently of poor quality and often ineffective. Furthermore many of the agencies are unable to evaluate the effectiveness of their strategies. Finally, interagency collaboration is often lacking.[101,102] These issues point to the need for national-level agencies which could coordinate funding, expertise, training, implementation, data collection and program evaluation. The National Center for Injury Prevention and Control at the Centers for Disease Control and Prevention in the United States is an example of a national lead agency.

At the local level, community-based coordinated approaches to injury intervention (alluded to in table 4-3) all a broad variety of strategies to be introduced in a particular geographic area.[99] They also reflect a shift in emphasis from individual responsibility to a societal responsibility. Characteristics of successful community-based injury prevention programs include good local data collection, an action committee to lead the program, interagency collaboration, and the development of educational, environmental and legislative approaches specific to the locale. Such programs have already proven to be effective in Sweden and in poor inner city communities in the United States.[103,104]

4.6.4 Injury Prevention Strategies for Indian Children

While specific injury prevention strategies such as those outlined in table 4-3 would likely be useful in reducing injury mortality in Indian children, the implementation of such strategies aimed at the general Canadian population by Indians has been difficult for two reasons. First, the majority of Indians live on reserves, many of which are remote, and have a lower socioeconomic status than the Canadian population as a whole[68]. As such, there is limited transportation and communications access to these people. Second, Indians have traditionally taken a holistic view of health which they view as different from the non-Indian's concept of health. Instead of absence of disease, health is seen to involve physical, social, emotional and spiritual well-being, with a focus not only on the individual but also on the family and the community. The circle is seen as symbolizing health as a balance of the physical, social, emotional and spiritual aspects of the individual's and community's life.[105,106] For these reasons, many within the Canadian Indian community believe the problem must be dealt with using community-based programs specifically targeting Indian communities. This approach would be analogous to the successful implementation of injury prevention strategies in poor inner city communities in the United States mentioned above.

In the United States, the Indian Health Services (IHS) is the federal body responsible for providing health services to American Indians. In the 1980's, in response to high injury rates, the IHS began to develop and implement an injury prevention initiative referred to as the Community Injury Control (CIC) program.[42] While the program is coordinated centrally by IHS, each of the country's twelve service areas also has a designated injury control officer who presides over a CIC committee for each service area. These committees have broad representation, including clinical personnel and representatives from the community. Other important features of the program include a mechanism for collection of data pertaining to injuries in the service areas, appropriate training of personnel, access to injury prevention expertise. There is early evidence that this program has resulted in declines in hospitalization rates for falls, motor vehicle injuries and assaults.

Similar initiatives are beginning to develop in Canada. As suggested above, community-based injury prevention programs are best overseen by a national-level agency that could assist local programs with funding, expertise, training, implementation, data collection and program evaluation. In Canada, Health Canada is the federal agency responsible for helping the people of Canada maintain and improve their health. The Medical Services Branch (MSB) is the arm of Health Canada responsible for providing health services to status Indians and Inuit people.[107] The management and delivery of MSB health services at the local level is provided through regional offices, zone offices and a network of hospitals, nursing stations and health centres across the country. The MSB recognizes injury, intentional and unintentional, as a major cause of morbidity and mortality among Indians. It also recognizes the Indian peoples' desire to define appropriate solutions within their own communities. As such, MSB attempts to help specific Indian communities establish health care priorities based on their own needs. MSB has begun to collect data on mortality from injury among Indians in some provinces and is sharing these data.

It would thus seem that the basic framework for implementation of injury prevention strategies targeting Indians in Canada already exists. Current impediments include the lack of a central national agency dedicated to the coordination of injury control such as the National Center for Injury Prevention and Control at the Centers for Disease Control and Prevention in the United States. Such an organization could facilitate the collection and integration of injury morbidity and mortality data across the country, which would improve on the current piecemeal pattern. Such an agency could also assist MSB in its work at the community level in injury data collection, accessing expertise relating to injury prevention, training of health care personnel, and program evaluation.

4.6.5 Injury Prevention Targets for Indian Children in Alberta

In spite of declining injury mortality in both Indian and non-Indian children in Alberta, it is evident from this study that Indian children had a significantly greater risk of mortality from both intentional and unintentional injury than non-Indian children. Of 319 Indian deaths, 62 (87 deaths per 100,000 per year) occurred in children aged 0-4 years, 20 (25 deaths per 100,000 per year) occurred in children aged 5-9 years, 41 (58 deaths per 100,000 per year) occurred in children aged 10-14 years, and 196 (299 deaths per 100,000 per year) occurred in children aged 15-19 years. Thus, it would appear that older Indian children (aged 10-19 years) and very young Indian children (aged 0-4 years) were at particularly high risk and are thus obvious targets for prevention strategies.

Considering specific injury mechanisms, it is evident from tables 3-12 and 3-10 that among Indian children of all ages, injury mortality rates were highest for motor vehicle traffic deaths (43 deaths per 100,000 per year) and suicide (27 deaths per 100,000 per year). Within each age subgroup (tables 3-13, 3-14, 3-15, and 3-16), motor vehicle traffic deaths were responsible for the highest injury mortality rates among all mechanisms of injury death: 29 deaths per 100,000 per year for 0-4 years, 10 deaths per 100,000 per year for 5-9 years, 26 deaths per 100,000 per year for 10-14 years, and 117 deaths per 100,000 per year for 15-19 years. Other categories with particularly high Indian injury mortality rates included: suicide among 10-14 year old children (13 deaths per 100,000 per year), suicide among 15-19 year old children (102 deaths per 100,000 per year), homicide among 15-19 year old children (16.7 deaths per 100,000 per year), and death from fire/flames among 15-19 year old children (11 deaths per 100,000 per year).

As mentioned above, Indians themselves favour community-based strategies aimed at improving health status. Also as discussed above, such community-based programs benefit from a national-level lead agency such as the National Center for Injury Prevention in the United States. Such an agency, if it existed in Canada, could assist the Medical Services Branch in implementation of injury prevention strategies for Indian children. Specific targets for injury prevention measures in Alberta Indian children include: motor vehicle traffic deaths among children of all ages, suicide in children aged 10-19 years, and homicide in children aged 15-19 years.

Measures potentially capable of reducing motor vehicle traffic deaths include better education about the proper use of seatbelts, car seats and helmets, as well as better enforcement of existing legislation, especially in remote communities. Likewise education and enforcement of laws pertaining to driving while under the influence of alcohol would likely be of considerable benefit.

Reduction in suicide and homicide is a more difficult issue. There is a need to better understand the problems underlying these deaths. Substance abuse and cultural alienation likely play a role and but their exact roles remain unclear. Thus further research into these issues is necessary. Once again, community-based programs would be most helpful in studying these problems and introducing prevention strategies.

4.7 Future Directions

Many questions pertaining to injury in Indian children remain unanswered. For example, there is a need to understand the effect of certain potential confounders on injury mortality in Indian children. Specific confounders of interest include: location of residence (on-reserve versus off-reserve, and rural versus urban status) and socioeconomic status. As well, the role of possible effect modifiers needs to be clarified. These include: medical risk factors, substance abuse, time of day of the injury, recreation patterns, level of supervision, access to medical facilities, and type of treatment administered. It seems likely that Indian status is in fact a proxy for other more specific injury risk factors and this relationship needs to be better understood.

Future studies should target those age groups and injury mechanisms with the highest injury mortality rates, for example motor vehicle traffic deaths among all pediatric ages, suicide in the 10-19 year age group, and all-injury death in the 0-4 year and 15-19 year groups. It is necessary to examine the relative prevalence of known injury prevention strategies among Indian and non-Indian and their families. As well, a case-control design might be useful to compare the presence or absence of known injury risk factors in injured versus non-injured children.

As with injuries in children in general, much more seems to be known about Indian injury mortality than injury morbidity and as such there is a great need to examine the risk for injury morbidity among Indian children versus non-Indians. With the increasing participation by Canadian Hospitals in various pediatric health databases, such as the Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP), it may be possible to design studies looking at specific risk factors for injury morbidity in Indian children.[108]

5 CHAPTER FIVE: CONCLUSIONS

This population-based study examined Indian status as a risk factor for mortality from injury among Alberta children, aged 0-19 years, over the 10-year period 1985-1994. In general, Indian children were found to be at 4.6 times greater risk for death from injury than non-Indian children. When intent of injury subtypes were examined, Indians were at much greater risk for death from unintentional injuries, suicide, homicide and injuries where intent was uncertain. Indians in all age subgroups (0-4 years, 5-9 years, 10-14 years and 15-19 years) and of both genders were found to be at increased risk of injury death compared with non-Indians.

Among all Alberta children, injury mortality was found to be declining over the 10-year study period. The rate of decline was similar for both Indians and non-Indians, the result being that Indians remain at a proportionately greater risk than non-Indians.

Exploratory analysis of numerous mechanism of injury subtypes, in the manner recommended by the Centers for Disease Control and Prevention, again revealed Indian children to be at greater risk for death than non-Indians in virtually all areas.

Death from injury remains a significant public health concern in North America. This study and others like it suggest that Indian children are at particularly high risk. In Alberta, where approximately 4% of all children are Indians, attention must be focused on understanding this problem so that steps to intervene may be taken.

REFERENCES

1. Haddon W, Jr. Advances in the epidemiology of injuries as a basis for public policy. Public Health Rep 1980;95(5):411-21.

2. Centers for Disease Control and Prevention. Recommended framework for presenting injury mortality data. MMWR Morb Mortal Wkly Rep 1997;46(RR-14):1-30.

3. Christoffel KK, Scheidt PC, Agran PF, Kraus JF, McLoughlin E, Paulson JA. Standard definitions for childhood injury research: excerpts of a conference report. Pediatrics 1992;89(6):1027-34.

4. Government of Canada. Indian Act. Ottawa: The Government of Canada; 1996. Cat. No. YX76-I5/1996.

5. National Committee for Injury Prevention and Control. Injury prevention: meeting the challenge.New York: Oxford University Press, 1989

6. Gibson JJ. The contribution of experimental psychology to the formulation of the problem of safety: a brief for basic research. In: Behavioural approaches to accident research. New York: New York Association for the Aid of Crippled Children, 1961: 77-89.

7. Haddon W, Jr. A note concerning accident theory and research with special reference to motor vehicle accidents. Ann NY Acad Sci 1963;107:635-46.

8. De Haven H. Mechanical analysis of falls from heights of fifty to one hundred and fifty feet. War Med 1942;2:586-96.

9. Commission on Professional and Hospital Activities. The International Classification of Diseases, Ninth Revision, Clinical Modification.Ann Arbor: Commission on Professional and Hospital Activities, 1986

10. Murray C, Lopez A. Mortality by cause for eight regions of the world: global burden of disease study. Lancet 1997;349(9061):1269-1276.

11. Murray C, Lopez A. Regional patterns of disability-free life expectency and disability-adjusted life expectency: global burden of disease study. Lancet 1997;349(9062):1347-1353.

12. Murray C, Lopez A. Global mortality, disability, and the contribution of risk factors: global burden of disease study. Lancet 1997;349(9063):1436-1442.

13. Last JM, Abramson JH, Friedman GD, Porta M, Spasoff RA, Thuriaux M, eds. A dictionary of epidemiology. 3rd ed. New York: Oxford University Press, 1995:180.

14. Murray C, Lopez A. Alternative projections of mortality and disability by cause 1990-2020: global burden of disease study. Lancet 1997;349(9064):1498-1504.

15. Statistics Canada. Mortality - summary list of causes, 1994. Ottawa: Statistics Canada; 1996. Cat. no. 84-209-XPB.

16. National Center for Health Statistics. Report of final mortality statistics, 1995. Hyattsville, Maryland: US Department of Health and Human Services, Public Health Service, Centers for Disease Control; 1997. Publication (PHS) 97-1120.

17. Gordis L. Epidemiology.Philadelphia: W.B. Saunders Company, 1996:277.

18. Centers for Disease Control. Years of potential life lost before age 65--United States, 1990 and 1991. MMWR Morb Mortal Wkly Rep 1993;42(13):251-3.

19. Statistics Canada. Hospital morbidity, 1992-93. Ottawa: Statistics Canada; 1995. Cat. no. 82-216.

20. Miller WJ. Accidents in Canada, 1988 and 1993. Ottawa: Statistics Canada, Health Statistics Division; 1995. Vol 7(2):7-16 (Cat. no. 82-003).

21. Statistics Canada. Mortality - summary list of causes, 1987. Ottawa: Statistics Canada; 1989. Cat. no. 82-003S.

22. Macarthur C, Pless IB. Unintentional injury mortality in Canada. Pediatrics 1990;86(6 Pt 2):1073-7.

23. Rivara FP, Grossman DC. Prevention of traumatic deaths to children in the United States: how far have we come and where do we need to go? Pediatrics 1996;97(6):791-7.

24. National Center for Health Statistics. Compressed mortality data. Washington: US Government Printing Office; 1991.

25. National Center for Health Statistics. Vital statistics of the United States, 1978. Washington: US Government Printing Office; 1982. PHS 83-1101.

26. Durch JS, Lohr KN. Emergency medical services for children.Washington, D.C.: National Academy Press, 1993

27. Mayer T, Walker M, Johnson D, Matlak M. Causes of morbidity and mortality in severe pediatric trauma. JAMA 1981;245(7):719-21.

28. Hillman M, Adams J, Whitelegg J. One false move: a study of children's independent mobility. London: Policy Studies Institute; 1991.

29. Injury Prevention Centre. Directory of Alberta Injury Data Sources. (2nd ed.) Edmonton: 1997

30. Health Canada. Trends in first nations mortality, 1979-1993. Ottawa: Health Canada; 1996. Cat. no. 34-79/1993E.

31. MacWilliam L, Mao Y, Nicholls E, Wigle DT. Fatal accidental childhood injuries in Canada. Can J Public Health 1987;78(2):129-35.

32. Hislop TG, Threlfall WJ, Gallagher RP, Band PR. Accidental and intentional violent deaths among British Columbia native Indians. Can J Public Health 1987;78(4):271-4.

33. Young TK. Mortality pattern of isolated Indians in northwestern Ontario: a 10-year review. Public Health Rep 1983;98(5):467-75.

34. Young TK, Moffatt MEK, O'Neil JD. An epidemiological perspective of injury in the Northwest Territories. Arct Med Res 1992;51(Suppl. 7):27-36.

35. Olson LM, Becker TM, Wiggins CL, Key CR, Samet JM. Injury mortality in American Indian, Hispanic, and non-Hispanic white children in New Mexico, 1958-1982. Soc Sci Med 1990;30(4):479-86.

36. Michalek AM, Mahoney MC, Buck G, Snyder R. Mortality patterns among the youth of a northeastern American Indian cohort. Public Health Rep 1993;108(3):403-7.

37. Cummings P, Theis MK, Mueller BA, Rivara FP. Infant injury death in Washington State, 1981 through 1990. Arch Pediatr Adolesc Med 1994;148(10):1021-6.

38. Campos-Outcalt D, Prybylski D, Watkins AJ, Rothfus G, Dellapenna A. Motor-vehicle crash fatalities among American Indians and non-Indians in Arizona, 1979 through 1988. Am J Public Health 1997;87(2):282-85.

39. Evers SE, Rand CE. Morbidity in Canadian Indian and non-Indian children in the first year of life. Can Med Assoc J 1982;126:249-52.

40. Evers SE, Rand CE. Morbidity in Canadian Indian and non-Indian children in the second year. Can J Public Health 1983;74:191-94.

41. Quinlan KP, Wallace LJD, Furner SE, Brewer RD, Bolen J, Schieber RA. Motor vehicle related injuries among American Indian and Alaskan youth, 1981-92: analysis of a national hospital discharge database. Inj Prev 1998;4:276-279.

42. Robertson LS. Community injury control programs of the Indian Health Service: an early assessment. Public Health Rep 1986;101(6):632-7.

43. Centers for Disease Control. Safety-belt use and motor-vehicle-related injuries--Navajo Nation, 1988-1991. MMWR Morb Mortal Wkly Rep 1992;41(38):705-8.

44. Kleinbaum DG, Kupper LL, Morgenstern H. Epidemiologic research.New York: Van Nostrand Rheinhold, 1982

45. Statistics Canada. 1991 Census. Ottawa: Statistics Canada; 1992. Cat. No. 95-372.

46. Kelsey JL, Whittemore AS, Evans AS, Thomson WD. Methods in observational epidemiology. (2nd ed.) New York: Oxford University Press, 1996:432. (Kelsey JL, Marmot MG, Stolley PD, Vessey MP, eds. Monographs in epidemiology and biostatistics; vol 26).

47. Baker SP. Injury classification and the international classification of diseases codes. Accident Anal Prev 1982;14(3):199-201.

48. Centers for Disease Control. Update: External cause-of-injury coding in hospital discharge data - United States, 1994. MMWR Morb Mortal Wkly Rep 1994;43(25):465-7.

49. Hennekens CH, Buring JE, Mayrent SL. Epidemiology in Medicine.Boston: Little, Brown and Company, 1987:383.

50. Rosner BA. Fundamentals of biostatistics. (4th ed.) Belmont: Duxbury Press, 1995:682.

51. Selvin S. Practical biostatistical methods.Belmont: Duxbury Press, 1995

52. Fingerhut LA, Annest JA, Baker SP, Kochanek KD, McLoughlin E. Injury mortality among children and teenagers in the United States, 1993. Inj Prev 1996;2:93-4.

53. McLoughlin E, Fingerhut LA, Weiss H, Annest JL. A proposed mechanism/intent matrix for presenting E-coded data. Atlanta, GA: National Center for Injury Prevention and Control; 1995.

54. Berenholz G. Draft recommendations report of standard E-code groupings. Lexington, MA: Berenholz Consulting Associates; 1995.

55. StataCorp. Stata Statistical Software, Version 5.0. Stata Corporation, College Station, TX, 1997.

56. Indian and Northern Affairs Canada. The Indan Act past and present: a manual on registration and entitlement legislation. Ottawa: Government of Canada; 1991. R32110/1991.

57. Rivara FP. Pediatric injury control in 1999: where do we go from here? Pediatrics 1999;103(4):883-8.

58. Centers for Disease Control. Mortality patterns - United States, 1992. MMWR Morb Mortal Wkly Rep 1994;43(49):916-20.

59. Christoffel KK. Definition and classification of childhood injuries. Acta Paediatr Jpn 1993;35:166-70.

60. Moyer LA, Boyle CA, Pollack DA. Validity of death certificates for injury-related causes of death. Am J Epidemiol 1989;130(5):1024-32.

61. Dijkhuis H, Zwerling C, Parrish G, Bennett T, Kemper HCG. Medical examiner data in injury surveillance: a comparison with death certificates. Am J Epidemiol 1994;139(6):637-43.

62. Baggish DA, Kimball CP. The problem of transportation to medical facilities on an Indian reservation. Med. Care 1973;6:502-508.

63. Postl BD, Moffatt MEK, Black GB, Cameron CB. Injuries and deaths associated with off-road recreational vehicles among children in Manitoba. Can Med Assoc J 1987;137:297-300.

64. Jarvis GK, Boldt M. Death styles among Canada's Indians. Soc Sci Med 1982;16(14):1345-52.

65. Schmitt N, Hole LW, Barclay WS. Accidental deaths among British Columbia Indians. Can Med Assoc J 1966;94(5):228-34.

66. Baker SP, Whitfield MA, O'Neill B. Geographic variations in mortality from motor-vehicle crashes. N Eng J Med 1987;316(22):1384-1387.

67. Porvaznik J, Jensen GH. Motor vehicle accidents and emergency medical services on Indian reservations. Mil Med 1988;153(9):453-456.

68. Department of Indian Affairs and Northern Development. Comparison of social conditions of registered Indians to the general Canadian population. Ottawa: Government of Canada; 1995.

69. Nersesian WS, Petit MR, Shaper R, Lemieux D, Naor E. Childhood death and poverty: a study of all childhood deaths in Maine, 1976 to 1980. Pediatrics 1985;75(1):41-50.

70. Rivara FP, Barber M. Sociodemographic determinants of childhood pedestrian injuries. Pediatrics 1985;76:375-381.

71. Pless IB, Verrault R, Arsenault L, Frappier JY, Stulginskas J. The epidemiology of road accidents in childhood. Am J Public Health 1987;77:358-360.

72. Pless IB, Peckham CS, Power C. Predicting traffic injuries in childhood: a cohort analysis. J Pediatr 1989;115:932-938.

73. Grossman DC, Rivara FP. Injury control in childhood. Pediatr Clin North Am 1992;39(3):471-85.

74. Rivara FP, Howard D. Parental knowledge of child development and injury risks. J Dev Behav Pediatr 1982;3:103-105.

75. Rivara FP. Developmental and behavioral issues in childhood injury prevention. J Dev Behav Pediatr 1995;16(5):362-70.

76. Mueller BA, Rivara FP, Lii SM, Weiss NS. Environmental factors and the risk for childhood pedestrian-motor vehicle collision occurrence. Am J Epidemiol 1990;132(3):550-560.

77. Royal Commission on Aboriginal Peoples. Choosing Life: Special Report on Suicide among Aboriginal People. Ottawa: Minister of Supply and Services Canada; 1995.

78. Roy C, Chaudhuri A, Irvine D. The prevalence of mental disorders among Saskatchewan Indians. J Cross-Cultural Psychol 1970;1:383-392.

79. Statistical Data Technical Working Group. Statistical Profile on Native Mental Health, Background Report #1. Ottawa: Medical Services Branch, Health and Welfare Canada; 1991.

80. Feather J, Irvine J, Belanger B, et al. Promoting social health in northern Saskatchewan. Can J Public Health 1993;84(4):250-3.

81. Berger LR, Kitzes J. Injuries to children in a Native American community. Pediatrics 1989;84(1):152-6.

82. Meyer AA. Death and disability from injury: a global challenge. J Trauma 1998;44(1):1-12.

83. Waller P, Stewart JR, Hansen AR, Stutts JC, Popkin CL, Rodgman EA. The potentiating effects of alcohol on driver injury. JAMA 1986;256(11):1461-1466.

84. Centers for Disease Control. Motor-vehicle-related deaths involving intoxicated pedestrians - United States, 1982-1992. MMWR Morb Mortal Wkly Rep 1994;43(14):249-253.

85. Howland J, Hingson R. Alcohol as a risk factor for drowning: a review of the literature (1950-1985). Accid Anal Prev 1988;20(1):19-25.

86. Chernichko L, Saunders LD, Tough S. Unintentional house fire deaths in Alberta 1985-1990: a population study. Can J Public Health 1993;84(5):317-20.

87. Fowler RC, Rich CL, Young D. San Diego Suicide Study. II. Substance abuse in young adolescents. Arch Gen Psychiatry 1986;43(10):962-965.

88. Sugarman JR, Smith EM. Alcohol-related hospitalizations - Indian Health Service and Tribal hospitals, United States, May, 1992. MMWR Morbid Mortal Wkly Rep 1992;41(41):757-760.

89. Sugarman JR, Grossman DC. Trauma among American Indians in an urban county. Public Health Rep 1996;111(4):321-7.

90. Grossman DC, Sugarman JR, Fox C, Moran J. Motor vehicle crash injury risk factors among American Indians. Accid Anal Prev 1997;29(3):313-319.

91. Beauvais F, Oetting ER, Wolf W, Edwards RW. American Indian youth and drugs, 1976-1987: A continuing problem. Am J Public Health 1989;79(5):634-36.

92. Gfellner BM, Hundleby JD. Patterns of drug use among native and white adolescents: 1990-1993. Can J Public Health 1995;86(2):95-7.

93. Single E, Maclennan A, MacNeil P. Horizons 1994: Alcohol and drug abuse in Canada. Ottawa: Studies Unit, Health Promotion Directorate, Health Canada, and Canadian Centre on Drug Abuse; 1994. Cat. no. H39-307/1994E.

94. Saskatchewan Alcohol and Drug Abuse Commission. Legal Offences in Saskatchewan: The Alcohol and Drug Connection. Regina: Saskatchewan Alcohol and Drug Abuse Commission; 1988.

95. Hsu JS, Williams SD. Injury prevention awareness in an urban Native American population. Am J Public Health 1991;81(11):1466-8.

96. Mobley C, Sugarman JR, Deam C, Giles L. Prevalence of risk factors for residential fire and burn injuries in an American Indian community. Public Health Rep 1994;109(5):702-5.

97. Kimball EH, Goldberg HI, Oberle MW. Western Washington Native American Behavioral Risk Factor Survey: Final Report. Seattle: Public Health Service, Indian Health Service; 1989.

98. Barry PZ. Individual versus community orientation in the prevention of injuries. Prev Med 1975;4:47-56.

99. Towner E, Ward H. Prevention of injuries to children and young adults: the way ahead for the UK. Inj Prev 1998;4(4 Suppl):S17-25.

100. Dowswell T, Towner EML, Simpson G, Jarvis SN. Preventing childhood unintentional injuries - what works? A literature review. Inj Prev 1996;2:140-149.

101. Towner E, Carter Y, Hayes M. Implementation of injury prevention for children and young. Inj Prev 1998;4(suppl):S26-33.

102. Micik S, Miclette M. Injury prevention in the community: a systems approach. Pediatr Clin North Am 1985;32(1):251-65.

103. Timpka T, K. L, Schelp L, Ahlgren M. Community-based injury prevention: effects on health care utilization. Int J Epidemiol 1999;28(3):502-508.

104. Schwarz DF, Grisso JA, Miles C, Holmes JH, Sutton RL. An injury prevention program in an urban African-American community. Am J Public Health 1993;83(5):675-80.

105. Bopp J, Bopp M, Brown L, Lane P. The Sacred Tree.Lethbridge: Four Worlds Development Press, 1985

106. Medical Services Branch. Community Based Programs: 1998-99 Annual Review. Ottawa: Health Canada; 1999.

107. Medical Services Branch. Medical Services Branch: Mission and Vision. Ottawa: Health Canada; 1999.

108. Injury Prevention Centre. Compendium of Canadian data sources for childhood injury prevention.Edmonton: 1994

Appendix A: Condensed Listing of ICD 9 E-codes

(reproduced from: Injury Prevention Centre. Alberta injury data report. Edmonton: 1996.)

E-code Table

UNINTENTIONAL INJURIES

Cause	Abbreviation	Description	E-code
Air Pressure Changes	air press.	Unintentional injuries due to high or low air pressure or changes in air pressure.	E902. E902.0-E902.9
Cutting and Piercing	cut/pierce	Unintentional injuries caused by cutting or piercing instruments or objects, including powered tools, appliances, knives and other implements.	E920. E920.0-E920.9
Drowning	drowning	Unintentional drowning or submersion in a bath, while boating, swimming, or participating in water sports.	E830, E832, E910, E830.0-E830.9, E832.0-E832.9, E910.0-E910.9
Electricity	electricity	Unintentional injuries caused by electric current.	E925. E925.0-E925.9
Excessive Cold	ex. cold	Unintentional injuries due to excessive cold.	E901. E901.0-E901.9
Excessive Heat	ex. heat	Unintentional injuries due to excessive heat.	E900. E900.0-E900.9
Explosion of a Pressure Vessel	expl. press. vessel	Unintentional injuries due to the explosion of pressure vessels such as boilers or gas cylinders.	E921. E921.0-E921.9
Explosive Materials	explosives	Unintentional injuries caused by fireworks, blasting materials, explosive gases or other specified or unspecified explosive materials.	E923. E923.0-E923.9
Exposure and Neglect	exp/neglect	Unintentional injuries due to abandonment or neglect, lack of food, lack of water or exposure not elsewhere classifiable.	E904. E904.0-E904.9
Falls	falls	Falls, including falls on stairs, while running, slipping, diving into a swimming pool and falling from playground equipment. Excludes falls on same level from a collision and pushing or shoving by or with another person in sports.	E880-E886, E888, E880.0-E884.9, E886.9
Fire	fire	Unintentional injuries caused by fire, flames or smoke.	E890-E899. E890.0-E898.1
Firearms	firearms	Unintentional firearm injuries excluding air rifles and BB-guns.	E922. E922.0-E922.9
Fracture	fracture	Unintentional injuries involving fracture with cause unspecified.	E887

E-code Table continued

UNINTENTIONAL INJURIES

Cause	Abbreviation	Description	E-code
Machinery	machinery	Unintentional injuries caused by machinery in operation, such as agricultural machines, lifting machines or woodworking machines.	E919, E919.0-E919.9
Motor Vehicle-related	mv	Unintentional injuries caused by motor vehicle-related incidents (both traffic and non-traffic). Includes any collision or non-collision incident involving a motor vehicle such as a car, truck, van, bicycle, motor cycle, snowmobile or other off-road motor vehicle or a pedestrian.	E810-E825, E810.0-E825.9
Natural Disasters	nat. disasters	Unintentional injuries due to storms, lightening, earthquakes, volcanoes and floods resulting from storms	E907-E909
Non-venomous Animals	non-ven. animals	Other unintentional injuries due to animals such as a dog bite, or a bite from a non-venomous animal.	E906, E906.0-E906.9
Other Transportation-Related	oth. trans	Unintentional injuries involving aircraft, water craft, railway or other non-motorized road vehicles.	E800-E807, E826-E829, E831, E833-E848, E800.0-E807.9, E826.0-E829.9, E831.0-E831.9, E833.0-E848.9
Overexertion and Strenuous Movements	overexertion	Overexertion and strenuous movements due to excessive physical exercise, lifting, pulling, pushing or other recreational activities.	E927, E927.0-E927.9
Radiation	radiation	Unintentional injuries due to exposure to radiation.	E926, E926.0-E926.9
Scalds and Burns	scalds	Unintentional injuries caused by hot liquids or vapors (including steam), caustic or corrosive substances.	E924, E924.0-E924.9
Sports-Related (Falls & Collisions)	sports	Unintentional injuries caused by falls on the same level from a collisions, pushing or shoving by or with another person in sports or being knocked down or struck in sports.	E886.0, E917.0
Struck by Objects/ People	struck by obj	Unintentional injuries caused by falls on same level from a collision, pushing or shoving by or with another person or being caught between objects. Excludes being knocked down by or during sports.	E916-E918, E917.1-E917.9

E-code Table continued

UNINTENTIONAL INJURIES

Cause	Abbreviation	Description	E-code
Suffocation/Foreign Body in Natural Opening	**suffoc'n**	Smothering or choking (including inhalation or ingestion of food or other object, and mechanical suffocation) or foreign body entering the eye, nose, ear or other orifice.	E911-E915, E913.0-E913.9
Travel and Motion	**travel/motion**	Unintentional injuries due to travel and motion	E903
Unintentional Poisoning	**poison**	Unintentional poisonings by drugs or biological substances	E850-E869, E850.0-E869.9
Unspecified Environmental Causes	**unsp. enviro**	Unintentional injuries caused by other and unspecified environmental causes.	E928, E928.0-E928.9
Venomous Animals and Plants	**ven. animals**	Unintentional injuries due to venomous snakes, lizards, spiders, insects or plants.	E905, E905.0-E905.9

INTENTIONAL INJURIES

Cause	Abbreviation	Description	E-code
Assault (hospitalization data only)	**assault**	Intentional injury involving firearms, explosives, drowning, cutting, piercing or other specified or unspecified means.	E960, E960.0-E969.9
Homicide (death data only)	**homicide**	Homicide is an intentional injury involving firearms, explosives, drowning, cutting, piercing or other specified or unspecified means which results in death.	E960-E969, E960.0-E969.9
Legal Intervention	**legal interv'n**	Intentional injury involving firearms, explosives, gas, blunt objects, cutting, piercing or other specified or unspecified means as legal intervention.	E970-E978
Self-inflicted Injuries (hospitalization data only)	**self-inflicted**	Intentional injuries to one's self involving poisoning, gases, suffocation, strangulation, submersion, firearms, cutting, piercing, jumping, or other specified or unspecified means.	E950-E959, E950.0-E959.9
Suicide (death data only)	**suicide**	Suicide is an intentional injury to one's self involving poisoning, suffocation, strangulation, drowning, firearms, cutting, piercing, jumping or other specified or unspecified means which results in death.	E950-E959, E950.0-E959.9
War Operations	**war ops**	Injury due to war operations including explosives, weapons, aircraft, or other forms of unconventional warfare.	E990-E999, E990.0-E997.9

INJURIES OF UNDETERMINED INTENT & OTHER INJURIES

Cause	Abbreviation	Description	E-code
Adverse Reaction to Drugs and Medicinal Substances*	adv. react. (drugs)	Drugs, medications and biological substances causing adverse effects in therapeutic use.	E930-E949, E930.0-E949.9
Late Effects of Injury	late effects	Late effects of unintentional and intentional injuries.	E929, E929.0-E929.9
Medical/ Surgical Misadventures and Complications*	med. misadv	Misadventures to patients during surgical or medical care. Also includes surgical and medical procedures as the cause of abnormal reaction of patient or later complications.	E870-E879, E870.0-E879.9
Other Injuries of Undetermined Intent	other undet. intent	Other injuries involving submersion, hanging, firearms, explosives, falling or other unspecified means where the cause of injury is of undetermined intent (i.e., undetermined whether "accidentally" or purposely inflicted).	E983-E988, E983.0-E988.9
Other Injuries Unspecified	other inj. (unspec.)	Other injuries due to external causes not specified.	E988.9
Poisoning of Undetermined Intent	poison (undet.)	Injury resulting from poisoning involving gases, solid or liquid substances, where it is undetermined whether the injury was intended or not intended.	E980-E982, E980.0-E982.9