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## Injuries Associated with Snowmobiles, Alaska, 1993–1994

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### S Y N O P S I S

**Objective.** To characterize the nature and burden of snowmobile injuries in Alaska by examining injury deaths and hospitalizations associated with snowmobiles and comparing these with injury deaths and hospitalizations associated with on-road motor vehicles.

**Methods.** The authors used vital statistics, medical examiner, Department of Public Safety, and Department of Transportation records to identify snowmobile injury deaths, and used vital statistics mortality files to identify on-road motor vehicle injury deaths. The Alaska Trauma Registry provided data on hospitalizations. The number of vehicles in use in 1993–1994 was estimated from snowmobile sales and on-road motor vehicle registrations.

**Results.** For 1993–1994, injury death and hospitalization rates were greater for snowmobiles than for on-road motor vehicles. In northern Alaska, snowmobile injuries outnumbered on-road motor vehicle injuries. A total of 26 snowmobile injury deaths were reported; 7 decedents drowned after breaking through ice and 8 were ejected from vehicles. More than half (58%) of the snowmobile injury deaths involved a natural object such as a boulder, ravine, or river. Of the 17 decedents for whom blood alcohol concentrations were available, 11 (65%) had blood alcohol concentrations  $\geq$  100 mg/dL.

**Conclusions.** Natural obstacles and alcohol intoxication contribute to the high risk of injury death associated with snowmobile use. Injury control strategies, including trail development and improvement, should be evaluated.

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**S**nowmobile use in the United States has been increasing.<sup>1,2</sup> Annual snowmobile sales in this country doubled between 1992 and 1997 (Personal communication, Edward Klim, International Snowmobile Manufacturers Association, 1997). Numerous studies have described snowmobile injuries in the United States,<sup>1-5</sup> Canada,<sup>6</sup> Sweden,<sup>7</sup> and Finland.<sup>8</sup> Alcohol involvement, lack of helmet use, and excessive speed have been shown to be associated with snowmobile injuries.<sup>1-10</sup>

Efforts in the United States to control on-road motor vehicle injuries have benefited from well-funded interventions based on the findings of a large body of research. In contrast, snowmobile injury control strategies have been hampered by poor estimates of exposure<sup>2,3,8</sup> and by a lack of resources. Although this gulf in attention and resources is warranted in areas of the country where snowmobiles are seldom or never used, there are areas of this and other countries where more attention to snowmobile injuries is needed.

We sought to characterize the nature and burden of snowmobile injuries in one such area, the state of Alaska, by examining injury deaths and hospitalizations associated with snowmobiles and comparing these with injury deaths and hospitalizations associated with on-road motor vehicles.

## METHODS

We obtained snowmobile injury mortality rates by state for 1990–1994 using CDC Wonder, an interactive database that calculates mortality rates from National Center for Health Statistics mortality files. These rates per 100,000 population were for deaths coded E820, according to the International Classification of Diseases, Ninth Revision (ICD-9). To achieve more precise estimates, we obtained the number of snowmobile injury deaths (ICD-9 code E820) for 1990 through 1994 from the vital statistics bureaus of the five states with the highest rates. We then calculated mortality rates for these five states using population estimates derived from the 1990 Census.<sup>11</sup>

**Snowmobiles in use.** We estimated the number of snowmobiles in use in Alaska during 1993–1994 from new snowmobile sales rather than registration data, because point-of-sale snowmobile registration was not mandatory in Alaska.

To derive estimates of snowmobiles in use, we first estimated the vehicle life of snowmobiles in Alaska, extrapolating from several data sources. We contacted two Alaska snowmobile dealers, who estimated the vehicle life to be five years. National estimates of snowmobile vehicle life

range from nine to eleven years, with a shorter vehicle life estimated for snowmobiles in Alaska (Personal communication, Edward Klim, International Snowmobile Manufacturers Association, 1997). We also determined from Alaska Department of Transportation files that 86% of the snowmobiles involved in crashes were less than nine years old (median 2 years; mean 4.2 years). Based on these available data, we estimated the vehicle life of snowmobiles in Alaska to be eight years.

We obtained snowmobile sales figures from the Anchorage Economic Development Corporation; the first year for which these figures were available was 1993. We assumed that yearly snowmobile sales in Alaska during the preceding seven years, 1986 through 1992, were equivalent to the mean of annual snowmobile sales for 1993 and 1994. To estimate the number of snowmobiles in use in Alaska at any time during 1993–1994, we multiplied 1993–1994 mean annual sales by 8.

**On-road motor vehicles in use.** For the number of on-road motor vehicles in use in Alaska in 1993–1994, we averaged the total number of motor vehicles registered in 1993 and 1994 with the Alaska Division of Motor Vehicles, excluding three classes of registrations: snowmobiles, trailers, and commercial trailers.

**Snowmobile miles driven.** We calculated miles driven per snowmobile per year in Alaska by multiplying 1040 miles, an estimate of average annual miles driven per snowmobiler in the United States during 1995–1996 (Personal communication, Edward Klim, International Snowmobile Manufacturers Association, 1997), by 1.5, to adjust for the likelihood of greater miles driven in Alaska because of a longer snowmobile season.

**On-road vehicle miles driven.** We obtained estimates of annual miles driven for on-road motor vehicles in Alaska during 1993 and 1994 from the Alaska Department of Transportation.

**Injury mortality and hospitalization rates.** In calculating injury mortality and hospitalization rates, we used as denominators “race”-specific and region-specific population estimates for 1993 and 1994 obtained from the Alaska Department of Labor. The regions were based on those used in the Alaska Behavioral Risk Factor Survey.<sup>12</sup>

**Mortality.** We reviewed Alaska vital statistics, medical examiner, Department of Transportation, and Department of Public Safety records to identify and characterize snowmobile injury deaths. We defined a snowmobile injury

death as a death of an Alaska resident with an ICD-9 code of E820 in vital statistics mortality files or a traffic-related death of a snowmobile driver or passenger listed in Department of Transportation records.

We used Alaska vital statistics mortality files to identify on-road motor vehicle injury deaths, defined as deaths among Alaska residents with an ICD-9 code of E810 through E819, excluding the traffic-related deaths of snowmobile drivers or passengers (identified by date of incident, age, and location).

We calculated "race"- and region-specific mortality rates for snowmobile and on-road motor vehicle injuries. Medical examiner records provided data on helmet use, injury circumstances, and blood alcohol concentrations. Department of Public Safety records also provided data on helmet use and injury circumstances.

**Hospitalizations.** The Alaska Trauma Registry provided data on snowmobile and on-road motor vehicle injury hospitalizations of at least 24 hours duration. We defined a snowmobile injury hospitalization as a hospitalization of an Alaska resident listed in the Trauma Registry with an ICD-9 code of E820. We defined an on-road motor vehicle injury hospitalization as a hospitalization of an Alaska resident listed in the Trauma Registry with an ICD-9 code of E810 through E819.

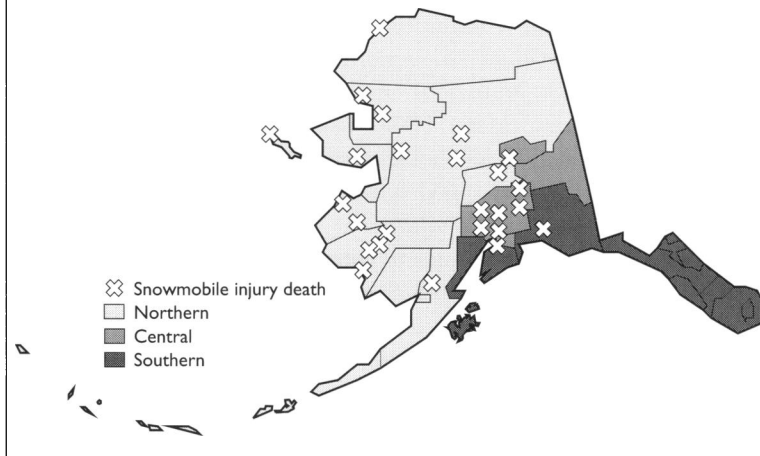
Injury severity scores (ISS) for these hospitalizations had been determined by the Alaska Trauma Registry in the standard fashion by using the sum of the squares of the three highest Abbreviated Injury Scores (AIS) in each body region, with AIS calculated from ICD-9 codes using the computerized method described by MacKenzie.<sup>13</sup>

**RESULTS**

Alaska, with a snowmobile injury mortality rate of 2.2 per 100,000 population for 1990–1994, had the highest rate among U.S. states. (See Table 1.) Wisconsin, Minnesota, North Dakota, and Maine, in that order, had the next highest rates. Collectively, the remaining 45 states had 232 snowmobile injury deaths during 1990–1994.

**Vehicle use.** In Alaska, mean annual snowmobile sales for 1993 and 1994 were 6000 snowmobiles, and we estimated that 48,000 snowmobiles were in use during that period. An estimated 75 million miles per year were driven in snowmobiles in Alaska in 1993–1994 (1.5 x 10<sup>4</sup> miles per snowmobiler per year x 48,000 snowmobiles).

**Figure. Snowmobile injury deaths by region, Alaska, 1993–1994**



A total of 515,904 on-road motor vehicles were registered in 1993, and a total of 532,176 in 1994. On-road motor vehicles were driven an estimated 4034 million miles per year in Alaska in 1993–1994.

**Injury mortality.** For 1993–1994, we identified 26 snowmobile injury deaths in Alaska, for a rate of 27 deaths per 100,000 snowmobiles per year, compared with 176 on-road motor vehicle injury deaths, for a rate of 17 deaths per 100,000 on-road motor vehicles per year. Those who died of snowmobile injuries included 22 operators, three passengers, and one pedestrian. We calculated a rate of 17 snowmobile injury deaths per 100 million miles driven, compared with two on-road motor vehicle injury deaths per 100 million miles driven. The median age of snowmobile injury death victims was 29 years, compared with 30 years for on-road motor vehicle injury death victims. The age range was narrower for victims of snowmobile injury death (10–61 years) than for on-road motor vehicle injury death victims (0–92 years). Snowmobile injury death victims

**Table 1. US states with the highest snowmobile injury mortality rates, 1990–1994**

| State                  | Deaths<br>1990–1994 | Mortality rate |
|------------------------|---------------------|----------------|
| Alaska . . . . .       | 63                  | 2.2            |
| Wisconsin . . . . .    | 86                  | 0.3            |
| Minnesota . . . . .    | 76                  | 0.3            |
| North Dakota . . . . . | 7                   | 0.2            |
| Maine . . . . .        | 15                  | 0.2            |

Mortality rate = deaths per 100,000 population per year

were more likely to be male (96%) and Alaska Native (56%) than were on-road motor vehicle injury death victims (66% male and 19% Alaska Native). Alaska Natives had a higher snowmobile injury death rate, 7.8 per 100,000 population, than did non-Alaska Natives, 1.1 per 100,000 population. The northern region of the state, which has the lowest population density of the regions, had more snowmobile injury deaths than other regions (see Table 1 and Figure), and the northern region had the highest rate of snowmobile injury deaths per 100,000 population (Table 2). The number of injuries associated with snowmobiles surpassed the number of injuries associated with on-road motor vehicles in this region.

Among the 17 snowmobile injury deaths for which medical examiner data on blood alcohol concentration (BAC) were available, 11 decedents (65%) had a BAC of 100 milligrams per deciliter (mg/dL) or higher. Two snowmobile injury death victims with BACs lower than 100 mg/dL had elevated levels of other psychoactive substances in their blood. Ejection from the vehicle ( $n = 8$ ) and drowning ( $n = 7$ ) were the most common mechanisms of snowmobile injury death. Collision with an on-road motor vehicle ( $n = 3$ ), hypothermia ( $n = 2$ ), and collision with another snowmobile ( $n = 2$ ) each caused more than one death. Two of the three hypothermia deaths associated with snowmobiles involved BACs higher than 180 mg/dL, and the third person who died of hypothermia, for whom no BAC was recorded, was reported by observers to have been intoxicated at the start of the trip. Fifteen (58%) deaths involved a natural object such as a boulder, ravine, or river. Among 17 deaths for which helmet use was recorded, only six decedents were wearing helmets.

**Hospitalizations.** In Alaska during 1993–1994, there were 238 snowmobile injury hospitalizations, for a rate of

248 hospitalizations per 100,000 snowmobiles, compared with 1137 on-road motor vehicle-related hospitalizations, or 108 hospitalizations per 100,000 on-road motor vehicles in use. The rate of hospitalizations associated with snowmobile injuries was higher in northern Alaska than in other regions of the state (Table 2). Snowmobile and on-road motor vehicle injury hospitalizations differed by type of injuries. Lower extremity fractures were more common among snowmobile injury victims (90/238, 38%) than among those hospitalized with on-road motor vehicle injuries (262/1137, 23%) ( $P < 0.0001$ ). Skull fractures and closed head trauma were less common among snowmobile injury victims (46/238, 19%) than among those hospitalized with on-road motor vehicle injuries (401/1137, 35%) ( $P < 0.0001$ ). The mean injury severity score for snowmobile injury hospitalizations (7.6) was less than that for on-road motor vehicle injury hospitalizations (9.4,  $P < 0.0001$ ).

DISCUSSION

In Alaska, snowmobiles are used for basic transportation, recreation, and work. In 1993–1994, annual injury death and hospitalization rates per 100,000 vehicles were greater for snowmobiles than for on-road motor vehicles. In absolute numbers, snowmobile injury deaths and hospitalizations were more common than on-road motor vehicle injury deaths and hospitalizations in northern Alaska. Alaska Natives were at greater risk of snowmobile injury death than non-Alaska Natives. Alcohol intoxication, lack of helmet use, and natural obstacles contributed to the risk of death and hospitalization associated with snowmobile use in Alaska.

Alaska had an annual snowmobile injury mortality rate of 27 deaths per 100,000 vehicles in 1993–1994. This rate was greater than others reported in the literature, including

**Table 2. Deaths and hospitalizations associated with snowmobile and on-road motor vehicle injuries, by region, Alaska, 1993–1994**

| Region             | Snowmobiles |      |                  |      | On-road motor vehicles |      |                   |       |
|--------------------|-------------|------|------------------|------|------------------------|------|-------------------|-------|
|                    | Deaths      |      | Hospitalizations |      | Deaths                 |      | Hospitalizations  |       |
|                    | Number      | Rate | Number           | Rate | Number                 | Rate | Number            | Rate  |
| Northern . . . . . | 16          | 11.2 | 136              | 96.9 | 15                     | 10.7 | 59                | 42.1  |
| Central . . . . .  | 9           | 1.2  | 88               | 11.3 | 121                    | 15.6 | 755               | 97.2  |
| Southern . . . . . | 1           | 0.3  | 14               | 4.9  | 40                     | 13.9 | 317               | 109.9 |
| Total . . . . .    | 26          | 2.2  | 238              | 19.7 | 176                    | 14.6 | 1137 <sup>a</sup> | 94.3  |

NOTE: Rates are per 100,000 population per year.

<sup>a</sup>Includes six hospitalizations for which town or city of residence was not recorded

14.8 per 100,000 vehicles per year in Wisconsin in 1990–1992<sup>4</sup> and a range of 8 to 11 per 100,000 vehicles per year in Ontario in 1985–1990.<sup>6</sup> However, Alaska's annual snowmobile injury hospitalization rate of 248 per 100,000 vehicles during 1993–1994 was lower than the non-fatal snowmobile injury rate of 1155 per 100,000 vehicles (which included both outpatient visits and hospitalizations) reported for Lapland for 1990.<sup>8</sup>

Annual snowmobile injury rates per vehicle tend to underestimate the magnitude of risk in comparison with on-road motor vehicle injury rates because snowmobiles are not used year-round while on-road motor vehicles typically are. With an average six-month snowmobile season each year in Alaska, the expected annual rate of snowmobile injury death per vehicle would be twice as great (54 per 100,000 vehicles) if snowmobiles were operated year-round. When rates by miles driven are calculated for injuries associated with each vehicle, the rate ratio becomes even greater and approaches a more accurate measure of the relative risk of injury associated with snowmobile use. Snowmobile injury rates per miles driven would have remained greater than those for on-road motor vehicle injuries even if the miles driven per snowmobile and on-road vehicle were equivalent.

This study had several limitations. First, our estimate of the number of snowmobiles in use may be inaccurate. The life expectancy of snowmobiles in Alaska is not well known; however, we were unlikely to have underestimated snowmobiles in use because we assumed earlier year sales were the same as sales during 1993–1994 despite a rising trend in national sales. Miles driven per snowmobile are also difficult to estimate.

Despite these limitations, the results should direct increased attention to injuries associated with snowmobiles. In northern Alaska, where snowmobiles are used for basic transportation, injuries are the leading cause of death<sup>12</sup> and in 1993–1994, the number of snowmobile injuries exceeded the number of on-road motor vehicle injuries.

Injury control strategies need to keep pace with the growth of snowmobile use in the 1990s. Just as the emerging problem of injuries associated with all-terrain vehicles was described<sup>14,15</sup> and addressed in the 1980s, an opportunity exists now to intervene with respect to snowmobile injuries. Surveys of drivers would help determine the relative use of snowmobiles for occupational and recreational purposes. Trail development and improvement should be evaluated as a snowmobile injury control strategy. Vehicle modifications could potentially reduce the likelihood of lower extremity injuries. Driving and riding under the influence of alcohol needs to be targeted on a number of levels, including snowmobiler education. Helmets should be worn by all snowmobilers, and innovative programs to increase helmet use should be developed. Mandatory snowmobile registration at the point of sale and snowmobile driver licensure would provide additional data on users and might avert some injuries. Unfortunately, enforcement of mandatory helmet use and driver licensure among snowmobilers would be difficult in remote areas.

In conclusion, we recommend that more resources be directed to the control of snowmobile injuries in the northern United States and circumpolar regions of the world.

The authors thank Michael Beller, MD MPH, and Ronald L. Moolenaar, MD, for their constructive review of the manuscript; Elizabeth Funk, MD MPH, for helpful advice; and Jeanne Della-Maggiore for preparation of the manuscript.

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