Snowmobile-related deaths in Ontario: a 5-year review

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Objectives: To investigate the demographic characteristics and circumstances surrounding fatal snowmobile accidents in Ontario, to examine the risk factors and to observe any fatality trends over the study period.
Design: Case series.
Patients: All 131 people who died accidentally while operating a snowmobile in Ontario from 1985–86 to 1989–90. Records were obtained from the chief coroner's office; registration data were obtained from the Ministry of Transportation.
Results: Although the absolute number of deaths increased each year, owing to a rapid increase in the number of registered snowmobiles, the risk of death from snowmobile accidents remained relatively constant. Deaths occurred most frequently in northeastern Ontario. Youths and men predominated among the victims. Fatal accidents occurred more often on lakes (in 66% of the cases in which this information was known) than on roads (in 26%) or trails (in 8%). Weekend fatalities predominated, and deaths occurred most often during times of suboptimal lighting (from 4 pm to 8 am). The driver was killed in 84% of the cases in which the person's role was known. Alcohol use before death was implicated in 69% of the cases, the level exceeding the Ontario legal limit in 59%.
Conclusion: Snowmobile-related deaths result from factors that are generally avoidable. Strategies need to be instituted to reduce the rate of these events.

Objectifs : Analyser les caractéristiques démographiques des accidents mortels de motoneige en Ontario et les circonstances qui les entourent, afin d'étudier les facteurs de risque et d'observer toute tendance des accidents mortels au cours de la période d'étude.
Conception : Étude de cas.
Patients : Les 131 victimes d'accident mortel de motoneige en Ontario entre 1985–1986 et 1989–1990. On a obtenu des dossiers du bureau du coroner en chef et des données sur les immatriculations du ministère des Transports.
Résultats : Même si le nombre absolu des victimes a augmenté chaque année, à cause de l'augmentation rapide du nombre de motoneiges immatriculées, le risque d'accident mortel de motoneige est demeuré relativement stable. Les victimes ont été plus nombreuses dans le nord-est de l'Ontario. Les victimes étaient surtout des jeunes et des hommes. Les accidents mortels se sont produits plus souvent sur des lacs (dans 66 % des cas où ces renseignements étaient connus) que sur des routes (26 %) ou des pistes (8 %). Les accidents mortels se sont produits surtout en fin de semaine et principalement en période d'éclairage médiocre (de 16 h à 8 h). Le conducteur est mort dans 84 % des cas

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où l'on connaissait le rôle de la victime. Il y a eu consommation d'alcool dans 69 % des cas et l'alcoolémie a dépassé la limite légale de l'Ontario dans 59 % des cas.
Conclusion : Les accidents mortels de motoneige sont attribuables à des facteurs en général évitables. Il faut établir des stratégies pour réduire le taux de ces accidents.

Snowmobiling is popular in Ontario, over 320 000 vehicles having been registered with the Ontario Ministry of Transportation during 1989–90 (Safety Coordination Development Office, Ministry of Transportation: personal communication, 1990). Although originally used for transportation over generally impassable terrain for work purposes, most snowmobiles are currently bought for recreational use. Parallelling the growing popularity of this activity has been the number of injuries and deaths in areas frequented by snowmobile enthusiasts.[1-14]

In northern Ontario, where snowmobile use is common, an increasing incidence of serious trauma resulting in hospital admission or death during the period 1985–90 has been documented.[1] As a result of that study several factors predisposing to this type of trauma have been suggested: substance abuse, nighttime driving, excessive speed and driver error.[1] However, there are controversies surrounding snowmobile-related injury that remain unresolved, mainly because of the inherent biases in trauma research and the weak designs of previous studies.[15-17] In addition, most of the research was conducted many years ago, before the advent of today's powerful machines. A renewed effort to define the role of predisposing factors more clearly has resulted from these controversies and the recent increase in traumatic events in some regions.

Surprisingly, there is a paucity of information regarding the factors contributing to fatal snowmobile accidents. Although some studies mentioned deaths[1-3,5,7,13] only one specifically examined the issue.[7] However, that study was conducted in Sweden in the 1970s and included a small number of cases. Evidence for the contribution of such factors as suboptimal lighting and alcohol use is weak and often conflicting. For example, estimates for alcohol use vary from 13%[3] to 80%.[7]

Fatal snowmobile accidents need to be examined with the use of better methods and data reflecting the current patterns of use in Ontario. This idea is supported by the increased number of snowmobile-related deaths in a recent Ontario study[1] and a coroner's inquest into such deaths in Ontario conducted during the fall of 1990.[18] Although guidelines and recommendations for this sport are justified on the basis of past figures, research to support such advice is lacking.

We conducted a study of snowmobile-related deaths in Ontario during the winters of 1985–86 to 1989–90 to (a) investigate the demographic characteristics and circumstances surrounding the events, (b) examine the association of risk factors and (c) examine any fatality trends over the study period.

Methods

The Coroner's Act stipulates that all trauma-related and sudden, unexplained deaths in Ontario's eight regions must be reported to the provincial chief coroner in Toronto.[19] These deaths are registered with a code designating the type of vehicle and place of death; this system was developed by the chief coroner's office. A computer list of all snowmobile-related deaths from 1985 to 1990 was generated. Complete capture was assumed because the coroner's office codes all snowmobile-related deaths, regardless of the cause. For the purposes of this study the snowmobile season began in November of each year and ended the following April.

All accidental and traumatic deaths occurring while the victim was operating a snowmobile were eligible for inclusion. Cases in which no obvious signs of trauma were identified and those in which the person died of other causes (e.g., myocardial infarction, sudden cardiac death, hypothermia unrelated to drowning, cerebrovascular accident and suicide) were excluded. Final decisions were made on the basis of the summary provided by the regional coroner involved in each case. Drowning deaths during snowmobile use were included, since it was postulated that the contributory factors were similar to those of other snowmobile-related deaths.

A data entry form was completed by a researcher (C.J.) who was unaware of the study objectives. The blood alcohol level, the urine alcohol level and the "alcohol-implicated" history (alcohol use before death as reported to police by friends or relatives in contact with the victim) were abstracted from the police and pathology reports. Other demographic data and information on the circumstances surrounding the accident were collected.

The snowmobiles were examined superficially for mechanical malfunction; a formal extensive mechanical assessment was not completed.

Data were entered onto a Vax 8530 computer (Digital Inc., Boston) with the use of the Entrypoint-90 software program (Datalex, San Francisco). Analyses were completed with the SPSS-X software package (SPSS Inc., Chicago). Proportions, means and odds ratios (ORs) with 95% confidence intervals (CIs) were determined. Multiple statistical

tests on the same data set inflated the overall α level, and therefore a Bonferroni correction[20] was applied to the analysis.

Results

The computer records identified 149 snowmobile-related deaths; all of the charts were recovered from the coroner's office. Eighteen cases were excluded because of myocardial infarction or sudden cardiac death (14), hypothermia unrelated to drowning (2), cerebrovascular accident (1) and suicide (1). The excluded group comprised middle-aged men (mean age 54.2 [SD 11.0] years), 75% of whom had the accident on the weekend. The yearly frequency of events in the excluded group showed a distribution similar to that in the main group.

Table 1 provides a summary of the annual figures for snowmobile-related deaths during the study period. There was an increasing number of registered vehicles.

Fig. 1 illustrates the distribution of deaths in Ontario's eight regions; 87% occurred in the most northern and least-populated regions. The largest number of deaths occurred in the northeastern region, which includes the cities of North Bay, Timmins and Sudbury.

Table 2 shows the demographic features of the study group and the circumstances surrounding the deaths. There was a predominance of youths and men. The mean age of the victims was 29.9 (standard deviation 12.4) years. In 83% of the cases in which the time was known the accident occurred during times of suboptimal lighting (between 4 pm and 8 am). In 84% of the cases in which the person's role was known the driver was involved. In 81% of the cases the patient was dead on arrival at the emergency department. Single-vehicle accidents were common.

For the period immediately before the accident alcohol was implicated in the police report or in the pathology report in 91 (69%) of the cases. A detectable blood alcohol level was identified in 90 (69%); the level varied from 2.0 to 77.0 (mean 33.3 [SD 15.6] mmol/L). In 77 (59%) of the cases the level exceeded what is considered to be safe for the operation of a motorized vehicle in Ontario (17 mmol/L). More victims than expected were found to have a blood alcohol level above the legal limit after 4 pm and before 8 am (χ^2 = 10.23, 2 degrees of freedom; p = 0.006).

Factors thought to be associated with alcohol use and snowmobile-related trauma were further examined. A blood alcohol level in excess of the legal limit was significantly associated with an age of more than 30 years (OR 8.5, 95% CI 2.46 to 89.0). The other risk factor associated with an excessive blood alcohol level was being the driver rather than the passenger (OR 5.2, 95% CI 2.1 to 16.4). Factors that were not found to contribute to alcohol use were the ownership status of the snowmobile and whether the traumatic event was witnessed.

Drowning was reported as the cause of death in 44 (36%) of the cases (Table 2). Examination of this

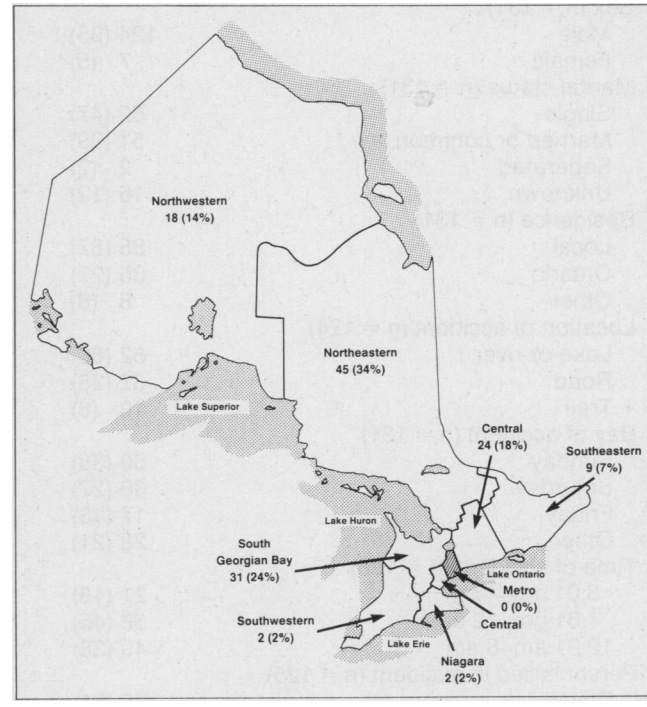

Fig. 1: Distribution of 131 snowmobile-related deaths in Ontario from 1985–86 to 1989–90 by region in which accident occurred.

Table 1: Number of deaths and registered snowmobiles and rate of death per 100 000 registered snowmobiles in Ontario from 1985–86 to 1989–90

Study season	No. of deaths	No. of registered vehicles	Rate of death per 100 000 registered vehicles
1989–90	24	320 000	7.5
1988–89	34	309 373	11.0
1987–88	28	285 744	9.8
1986–87	26	263 681	9.9
1985–86	19	237 806	8.0

subgroup revealed that alcohol was implicated as often as in the other types of death (OR 0.66, 95% CI 0.32 to 1.0). Also, the prevalence of a blood alcohol level in excess of the legal limit was no greater among the drowning victims than among the other subjects (OR 1.0, 95% CI 0.48 to 3.49). Those who drowned were slightly older (32.2 v. 28.7 years); however, this was neither clinically nor statistically significant.

Discussion

Our findings reveal that snowmobile-related deaths are a serious problem in Ontario. The absolute fatality figures were highest in 1988–89; however, the rate per 100 000 registered vehicles increased less dramatically than the absolute numbers would indicate (Table 1).

Table 2: Characteristics of the 131 people who died in snowmobile accidents and the circumstances surrounding the event

Characteristic	No. (and %) of patients
Sex (n = 131)	
Male	124 (95)
Female	7 (5)
Marital status (n = 131)	
Single	62 (47)
Married or common law	51 (39)
Separated	2 (2)
Unknown	16 (12)
Residence (n = 131)	
Local	88 (67)
Ontario	35 (27)
Other	8 (6)
Location of accident (n = 124)	
Lake or river	82 (66)
Road	32 (26)
Trail	10 (8)
Day of accident (n = 131)	
Sunday	50 (38)
Saturday	36 (27)
Friday	17 (13)
Other	28 (21)
Time of accident (n = 128)	
8:01 am–4 pm	21 (16)
4:01 pm–12 am	58 (45)
12:01 am–8 am	49 (38)
Person killed in accident (n = 125)	
Driver	105 (84)
Passenger	18 (14)
Pedestrian	2 (2)
Cause of death (n = 122)	
Collision with fixed object	66 (54)
Drowning	44 (36)
Impact from being thrown	12 (10)
No. of deaths per accident (n = 129)	
One	93 (72)
More than one	36 (28)
Outcome (n = 131)	
Dead on arrival	106 (81)
Died in emergency department	7 (5)
Died in hospital within 48 h after admission	14 (11)
Died in hospital beyond 48 h after admission	4 (3)

Some studies of snowmobile-related injury have documented the number of injuries or deaths but failed to concern themselves with the rates.[1-3,5,7,13] This is a particular problem when the number of vehicles rapidly increases, as has been the case in Ontario recently. One could argue that despite this increase the risk of death has remained stable, between 8 and 11 deaths per 100 000 registered vehicles. Data from Wisconsin suggest that after a peak in the 1970s the rate has also remained stable (between 4.4 and 9.8 deaths per 100 000 registered vehicles).[13] Although our figures do not indicate a crisis, the association between death and a variety of avoidable risk factors suggests that a policy of complacency would be unwise.

One of the most problematic and controversial topics in research is causation.[15,16] There are now accepted criteria to evaluate the evidence for causation; however, the final decision on many factors or agents is often complicated and subject to debate. This is perhaps most clearly illustrated when sound methods (as in a clinical trial) cannot be applied to the research question and when multiple factors are implicated. Examination of the risk factors involved in traumatic accidental events is an example of this problem.

Consequently, analysis of risk factors in fatal events must be approached in a multifactorial fashion. There are a number of injury models to study how events occur, and uniformity has not yet been obtained.[21] In snowmobile-related deaths it is convenient to categorize factors that contribute to the cause into those related to the operator, the environment and the vehicle.[21,22] We examined each of these areas, but the most complete information was provided for the operator and the environment.

Operator

Examination of the demographics of this population highlighted the predominance of youths and men (Table 2). Children were infrequently involved in fatal events; however, studies from Manitoba[11] and northern Ontario[1] have indicated that snowmobile-related injuries are common among those under 16 years of age. In addition, our results indicated that women were fatally injured more frequently than expected as nondrivers and less frequently than expected as drivers. Anyone considering passenger status on a snowmobile must take these figures very seriously. The finding that 33% of the deaths involved people who were not local residents or who

lived outside of Ontario illustrates the importance of tourism in snowmobiling. Our findings support the evidence of an association between alcohol and snowmobile-related deaths. Regardless of the method of measurement (implicated by history or measured in the blood) alcohol use before the accident was documented in over 69% of the cases. An excessive blood alcohol level (in 59% of the cases) was associated with driver status and higher age. However, the blood alcohol level was not related to ownership, since both owners and nonowners had frequently consumed alcohol before the accident.

Environment

The environment can provide challenges to the snowmobile enthusiast, particularly when the sun is down. Studies have suggested that serious nonfatal injuries are more common during times of suboptimal lighting (after 4 pm and before 8 am).[1,7,8] The fact that 82% of the deaths in our study occurred during those hours supports the evidence for a similar pattern in fatal snowmobile-related trauma. In addition, it is at times of suboptimal lighting when alcohol use is at its highest.

The surfaces on which snowmobiles travel contribute to accidents. A large number of deaths occurred on frozen water surfaces, which may explain in part the large number of drownings. However, the proportion of nondrowning deaths on these surfaces was important. High speeds attained on open surfaces such as lakes and unexpectedly uneven terrain (e.g., ice ridges) were probably contributory factors; the speed documented at the accident scene by police was excessive (greater than 50 km/h) in 75 (57%) of the cases. Unfortunately these data are open to bias, since the police did not actually measure the speed before the accident. Collision with fixed objects (e.g., fences, trees, cars and other snowmobiles), submersion in water as a result of weakened or absent ice and being thrown from a vehicle after suddenly changing direction were leading causes of death.

Vehicle

Little evidence was uncovered to suggest that machine error played a major role in the deaths. Isolated reports of minor vehicle malfunction were insufficient to explain any of the events. More extensive evaluation of vehicles involved in fatal accidents is needed to be able to fully exonerate them.[21]

Drowning

Snowmobiling is the leading cause of winter drowning in Ontario.[23] In a case series in California[24] drowning resulting from motor vehicle accidents was associated with alcohol use before the event. The snowmobile-related drownings in our study support these findings. Since the demographic characteristics and histories were similar for the people who drowned and for those who died from other causes, there was no evidence to support the theory that drowning and nondrowning deaths represent different groups.

Conclusions

Snowmobile-related deaths represent a significant problem in Ontario. The importance of snowmobile accidents is highlighted when nonfatal injuries are considered. It has been shown that fatal accidents account for only 1% to 5% of all snowmobile-related trauma and that less than 20% of all injuries result in hospital admission.[1,5,13,21] Nevertheless, the remaining 75% to 80% of accidents can lead to significant disability and health care costs. These figures translate into a major health problem for the communities where snowmobiling is popular.

Despite the optimism generated by the relatively constant rate of death there are risk factors that appear to be avoidable in most cases. Our research strongly implicated driver error, suboptimal lighting and alcohol impairment as contributing factors; vehicle speed may also have been a factor, but this area needs further study. Such factors are directly controlled by the operator; thus the driver is at the centre of prevention strategies. Development and implementation of interventions designed to reduce the number of snowmobile-related injuries are needed.

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Paris
Agence 2M2, Dr Marie-Pierre Delafontaine, 7, rue Bastienne, 95160 Montmorency, France; téléphone 011-33-1-39-64-88-83

Mar. 30-Apr. 2, 1992: Intermedica 1992
Paris
B. Soubiran, 78, ave. Kleber, F-75116 Paris, France

Mar. 30-Apr. 3, 1992: 8th World Conference on Tobacco OR Health — Building a Tobacco-Free World (cosponsors include the Canadian Cancer Society and the American Medical Association)
Sheraton Buenos Aires Hotel, Buenos Aires, Argentina
Secretariat, American Cancer Society, 1599 Clifton Rd. NE, Atlanta, GA 30329-4251; (404) 329-7638, fax (404) 325-2217

Mar. 30-Apr. 3, 1992: International Symposium on Diabetes and Pregnancy
Tel-Aviv, Israel
Conference coordinator, Kenes USA, 903-271 Madison Ave., New York, NY 10016; (212) 986-8300

Apr. 1-2, 1992: 5th Annual Conference on Education in Aging and Health — Interdisciplinary Education Revisited
Holiday Inn, Kingston, Ont.
Educational Centre for Aging and Health, Rm. 1M7, Faculty of Health Sciences, McMaster University Health Sciences Centre, 1200 Main St. W, Hamilton, ON L8N 3Z5; (416) 525-9140, ext. 2977

Apr. 3-5, 1992: 3rd International Conference on Geriatric Nephrology and Urology
Royal York Hotel, Toronto
Dr. D.G. Oreopoulos, Toronto Hospital (Western Division), 399 Bathurst St., Toronto, ON M5T 2S8; (416) 364-9974, fax (416) 360-8127

Apr. 3-6, 1992: Sports and Cardiovascular Nutritionists (SCAN) (a practice group of the American Dietetic Association) 9th Annual Symposium — Winning Strategies in Sports Nutrition
Westin Hotel, Indianapolis
Annette Warpeha, 3M-233 E 69th St., New York, NY 10021; (212) 772-0901

Apr. 4, 1992: Acute Care Medicine Course
Ramada Inn, Burnside Industrial Park, Dartmouth, NS
Ms. Diane Smith, education coordinator, Dartmouth General Hospital, 325 Pleasant St., Dartmouth, NS B2Y 4G8; (902) 465-8518

Apr. 4-8, 1992: European Society for Dermatological Research Annual Meeting
London
Congress Secretariat, Hautklinik der Stadt, Krankenanstalten, PO Box 23, 6800 Mannheim 1, Germany

Apr. 5-9, 1992: International Congress — Management of Infection
Amsterdam
Conference coordinator, Gardiner Caldwell Communications Ltd., Old Ribbon Road, Pittstreet, Macclesfield, Cheshire SK11 7PT, England

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