

Drownings in Minnesota, 1980–85: A Population-Based Study

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Abstract: We conducted a population-based study of drownings in Minnesota from 1980 through 1985. Five hundred and forty-one drownings (2.1 per 100,000 person-years) were identified from death certificates and from incident reports filed with the Minnesota Department of Natural Resources. Most drownings (334, 62 percent) occurred during summer months (May–August) and involved boating (42 percent) and swimming (35 percent) events. However, 62 drownings (11 percent) occurred during winter months (December–February) and primarily involved snowmobiles and motor vehicles (71 percent) breaking through ice on lakes and waterways. The risk

of drowning, estimated by the ratio of drownings to number of water-related activities, was highest during March and April, when the ice on lakes and waterway surfaces is melting, and during October and November, when lake and waterway surfaces are starting to freeze. Drowning rates were highest for males (3.7 per 100,000 person-years), persons 15 to 25 years of age (3.3 per 100,000 person-years), and children less than 5 years of age (2.5 per 100,000 person-years). These data can be used to target prevention strategies, particularly in northern climates. (*Am J Public Health* 1990; 80:1071–1074.)

Introduction

Drowning is the third most common cause of fatal, unintentional injury in the United States; among children and young adults it is the second most common cause.¹ In 1984, drowning accounted for 4,444 deaths nationwide.* Yet detailed epidemiologic data are lacking for outdoor and recreational drownings in northern climates, where surface water is frozen for several months of the year.²

Minnesota is known as “The Land of 10,000 Lakes.” Water covers 7,353 square miles or 9.2 percent of the state’s surface area. Lakes and waterways provide the 4.2 million people who live in Minnesota with numerous recreational opportunities throughout the year, including swimming and boating in the summer and ice-fishing in the winter. The lakes and waterways are usually frozen from December through March.

We conducted a population-based study of drownings in Minnesota, with an emphasis on outdoor and recreational drownings. In addition to characterizing drowning victims, we examined data by season-specific activities associated with drowning.

Methods

A case of drowning was defined as an unintentional death due to submersion in water, that occurred to a Minnesota resident during 1980 through 1985. Deaths involving motor vehicles operated in or on a body of water were considered to be drownings. However, deaths involving motor vehicles that ran off the road into water were considered to be motor vehicle fatalities.

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*Division of Vital Statistics, National Center for Health Statistics (NCHS), Hyattsville, MD, (unpublished data).

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Data on drownings were obtained from two sources: death certificates maintained by the Minnesota Center for Health Statistics, and fatal injury reports filed with the Minnesota Department of Natural Resources. All death certificates in Minnesota are assigned an ICD-9 cause of death code by a certified nosologist. Death certificates assigned an ICD-9 code for drowning were reviewed. This included both boating (E830-E832) and non-boating fatalities (E910).

Law enforcement officials are required to investigate and file a report with the Department of Natural Resources on all fatal injuries that occur on Minnesota lakes and waterways (Minnesota Statute 361.24). These officials often use coroner reports in preparing their reports. These reports were reviewed, and information was obtained on the age and sex of the victim; the date, time, and location of the incident; the victim’s activity at the time of drowning; the probable cause of the drowning; and history of alcohol use. Death certificates and Department of Natural Resources reports were manually matched by name, age, and address.

Drowning rates were calculated for the general population of Minnesota residents using population data extrapolated from the 1980 census. To estimate rates of outdoor and recreational drownings for the specific population-at-risk, we calculated the ratio of drownings to the estimated number of water-related activities. The annual number of water-related activities in which Minnesota residents participated was extrapolated from a random telephone survey of 6,000 households conducted by the Department of Natural Resources during a 12-month period, beginning in September 1985.** Each week, a sample of households was contacted and asked to report the age and sex of household members and the number of water-related activities in which each member had participated during the preceding week. (Information was collected on a number of activities, but not on hours of activity.) In addition, we reviewed records that the Department of Natural Resources has maintained since 1944 on the number of drowning deaths that have occurred in Minnesota.

Data were analyzed using standard univariate methods.³ Years of potential life lost prior to age 65 were calculated.⁴

**Minnesota Center for Survey Research, University of Minnesota. A continuous survey of participation and expenditures in outdoor recreation by Minnesota residents—Year end summary report, February 1987, (unpublished document).

Results

Five hundred and forty-one drownings occurred to Minnesota residents during 1980 through 1985; 458 drownings (85 percent) were identified from death certificate review (ICD-9 codes E830-32 and E910) and 83 drownings (15 percent) were identified only from Department of Natural Resources reports (death certificates were retrieved for these drownings). These 83 deaths were coded as follows: 35 (42 percent) were assigned the ICD-9 code for drownings which reflects accidental or purposely inflicted cause undetermined (E984); 32 (39 percent) were assigned the code for motor vehicle fatalities (E820-25); and 16 (19 percent) were assigned other ICD-9 codes including cardiac arrests, diving accidents, falls and hypothermia.

Four hundred and ninety-one drownings (91 percent) occurred in Minnesota and 50 (9 percent) occurred out-of-state. Forty-three (86 percent) of the out-of-state drownings occurred in the states immediately adjacent to Minnesota or in areas with northern climates (Montana, Alaska, and Canada). The seasonal distribution for the out-of-state drownings was similar to the distribution of drownings which occurred in Minnesota. Five hundred drownings (92 percent) occurred outdoors or were related to recreation and 41 drownings (8 percent) occurred in bathtubs. Department of Natural Resources reports were completed on 404 (90 percent) of the 450 outdoor and recreational drownings that occurred in Minnesota.

Death Certificate Review

The 541 drownings identified represent an overall mean annual incidence of 2.1 drownings per 100,000 person-years. The annual incidence declined over the study period from 2.5 per 100,000 person-years in 1980 to 1.9 per 100,000 person-years in 1985. This finding is consistent with a decreasing trend in the annual incidence of drowning observed in Minnesota since 1944. The drownings that occurred during the study period represent 17,853 years of potential life lost before age 65 (33 years lost for each death).

The majority of drownings (334, 62 percent) occurred during the summer months, May through August, when outdoor and recreational activities peak (Figure 1). However, 62 drownings (11 percent) occurred during the winter months, December through February, when lakes and waterways are frozen, and water-related activities are low. The risk of drowning, estimated by the ratio of drownings to number of

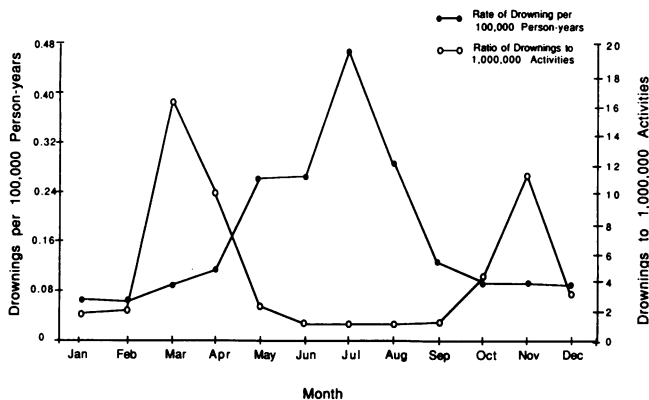


FIGURE 1—Mean Incidence of Drowning by Month, Minnesota, 1980 through 1985

water-related activities, was highest during spring and fall months (Figure 1).

Overall, 447 drownings (83 percent) occurred in males (Figure 2). The mean annual incidence for males was 5.3 times higher than that for females (3.7 versus 0.7 per 100,000 person-years, respectively). Incidence rates were highest for persons 15 to 30 years of age and for persons less than 5 years of age (3.3 and 2.5 per 100,000 person-years, respectively). For the age group 15 to 30 years, 91 percent of drownings occurred in males. For this age group, the rate for males was 10 times higher than the rate for females (5.2 versus 0.5 per 100,000 person-years, respectively). The ratio of number of drownings to number of water-related activities for males was 3.3 times higher than the ratio for females (13.7 versus 4.2 per 1,000,000 activities, respectively).

The drowning rate for persons 15 to 49 years of age decreased significantly over the six-year study period ($p < 0.001$, chi-square test for trend). However, rates for persons less than 15 years of age and for persons greater than or equal to 50 years of age did not show a similar decrease ($p = 0.22$, and 0.82 , respectively, chi-square test for trend).

Department of Natural Resources (DNR) Incident Report Review

DNR report forms were completed for 404 of the outdoor and recreational events. Of these, 382 (95 percent) occurred in a lake, pond, river, or stream, and 18 (4 percent) occurred in a swimming pool.

Table 1 shows the type of activity in which victims were engaged at the time of drowning. Swimming and boating were the most common activities during the summer, driving a vehicle on ice was the most common activity during the winter, while boating and falling from a bank into a body of water were common activities during the fall and spring.

Type of activity also varied by age group. For all ages combined, 66 drownings (16 percent) were due to falling from land, pool-side, or through ice into a body of water. However, for the 29 drownings that occurred in children <5 years of age, 22 (76 percent) were due to falling into a natural body of water or through ice, and three (10 percent) were due to falling into swimming pools. For the 21 drownings that occurred in persons ≥ 60 years of age, all were due to falling into water from land, pool-side, or through ice.

One hundred and thirty-five of the 404 drownings (33 percent) involved boating incidents. Table 2 shows the probable cause of boating-related drownings and the use of a

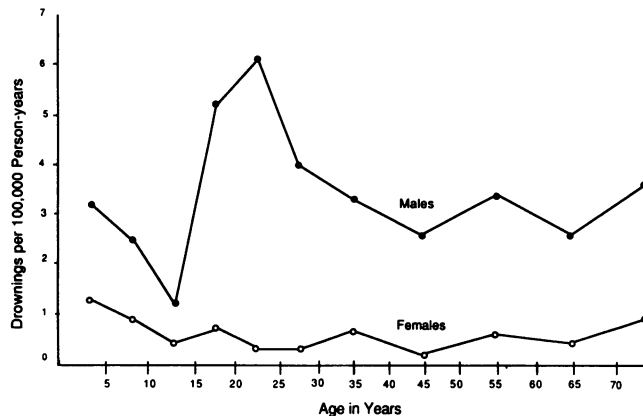


FIGURE 2—Mean Incidence of Drowning by Gender and Age Group, Minnesota, 1980 through 1985

TABLE 1—Type of Activity Reported at the Time of Drowning by Season, Minnesota, 1980 through 1985

Activity	Summer (May– Sept) No. (%)	Fall (Oct– Nov) No. (%)	Winter (Dec– Feb) No. (%)	Spring (Mar– Apr) No. (%)
Swimming/Wading	120 (42)	—	1 (2)	3 (8)
Boating	100 (35)	23 (60)	1 (2)	11 (28)
Fall from bank	30 (10)	7 (18)	—	11 (28)
Inner-tubing	10 (3)	—	—	—
Diving	7 (2)	—	—	—
Vehicle on ice	—	4 (11)	29 (71)	7 (18)
Walking on ice	—	4 (11)	10 (25)	4 (10)
Rescue attempt	2 (1)	—	—	—
Other	2 (1)	—	—	3 (8)
Unknown	15 (5)	—	—	—
Total (N = 404)	286 (100)	38 (100)	41 (100)	39 (100)

TABLE 2—Boating-Related Drownings by Cause and Use of Personal Flotation Device, Minnesota, 1980 through 1985

Cause	No.	(%)
Capsize/Sink	66	(49)
Fall Overboard	38	(28)
Collision—Boat/ Dock	16	(12)
Other/Unknown	15	(11)
Total	135	(100)
Use of PFD*		
Used	13	(10)
Available/Not Used	66	(49)
Not available	54	(40)
Unknown	2	(1)
Total	135	(100)

*Personal flotation device

personal flotation device. Only 13 drownings (10 percent) occurred while such a device was being used.

History of alcohol use was noted on 242 reports (60 percent); three (6 percent) of 54 persons less than 15 years of age and 109 (58 percent) of 188 persons more than 15 years of age were reported as having consumed alcohol at the time of the event.

Discussion

The mean annual incidence of drowning in Minnesota during 1980 through 1985 (2.1 per 100,000 person-years) was lower than the 1984 incidence of drowning nationally (2.3 per 100,000 person-years),⁵ and lower than the incidence in Georgia from 1981 through 1983 (3.2 per 100,000 person-years),⁶ New Mexico from 1975 through 1980 (4.3 per 100,000 person-years),⁷ North Carolina from 1980 through 1984 (3.2 per 100,000 person-years),⁸ and Los Angeles County from 1976 through 1984 (2.4 per 100,000 person-years).⁹ This probably reflects the fact that the peak season when people are participating in outdoor water activities is shorter in Minnesota where lakes and waterways are usually frozen for several months of the year.

We believe that a population-based incidence rate provides an accurate estimate of the risk of drowning and can be compared to population-based rates in other states. Yet, population-based rates assume that every resident in the state is at equal risk of drowning. The ratio of drownings to the number of water-related activities provides an estimate of the

risk of drowning for the specific population that participates in water-related activities. The importance of this estimate is illustrated by the seasonal trends in drowning rates.

Previous investigators have noted that the incidence of drowning has marked seasonal variation.^{1,10} In Minnesota, as in other states, most drownings occurred during the summer. However, if the risk of drowning is estimated by the ratio of drownings to number of water-related activities, the risk was highest during the spring and fall months, when the ice on the lakes is starting to freeze or thaw and likely to be unsafe. In addition, a submersion incident may be more likely to result in a fatality during the non-summer months due to the increased risk of hypothermia. Thus, this increased risk is probably specific to areas where surface water freezes during the winter.

Investigators in Hawaii and California found that the majority of drownings in these areas occurred in swimming pools.^{9,11,12} However, we found that 95 percent of drownings in Minnesota occurred in lakes and waterways and only 4 percent occurred in swimming pools. Even in children less than 5 years of age, only three drownings occurred as a result of falling into swimming pools. Minnesota residents may use swimming pools less than residents of more southern climates because most people have access to natural bodies of water and because of the relatively short season in which people can swim outdoors. Therefore, prevention measures such as requiring all swimming pools to be fenced in, which have proved to be effective in other areas,¹³ may have only limited impact in areas similar to Minnesota.

Our data showed that males, children, and young adults had the highest rates of drowning, a finding consistent with several past studies.^{6–12,14–16} Comparing population-based rates, the incidence in males was 5.3 times the incidence in females. However, if the risk of drowning is estimated by the ratio of drownings to the number of water-related activities, the risk for males was only 3.3 times the risk for females. Thus, some of the excess risk seen in males may be due to increased time spent participating in water-related activities.

Behavioral factors which may put people at increased risk of drowning include alcohol consumption^{16–19} and the nonuse of a personal flotation device. Although more than half of the Minnesota Department of Natural Resources reports completed for persons over 15 years of age listed alcohol consumption as contributing to the drowning, we do not know the number of people consuming alcohol that did not drown. Also, although only 10 percent of boat-related drownings occurred while a flotation device was being used, we do not know how many people who were wearing such devices did not drown, or how many drownings were avoided by people wearing such devices. Therefore, although our data suggest that alcohol consumption and the nonuse of a flotation device may increase the risk of drowning, we are unable to evaluate the exact contribution of these possible risk factors.

Although the overall rate of drowning in Minnesota decreased during the study period, only the rate in persons 15 to 49 years of age showed a significant decline. Risk-taking behavior may have contributed more to drownings in this age group than in other age groups, and may have been more amenable to current intervention strategies. The decrease in the incidence of drowning deaths may also have been a result of improved medical treatment. However, we were unable to evaluate this due to the lack of data on near-drownings.

To design, implement and evaluate injury intervention strategies, accurate surveillance data on injuries are needed.

Previous investigators have questioned the accuracy and usefulness of death certificates for obtaining selected mortality statistics.²⁰ In our study, 15 percent of the drownings were identified from the Department of Natural Resources reports and would have been missed if we had relied solely on death certificate review. We did not include death certificates assigned ICD-9 code E-984 in our initial review because we wanted to exclude suicides and homicides from the study. However, by examining information from the Department of Natural Resources reports, we were able to include those deaths which were unintentional. In addition, one-third of the drownings identified from the Department of Natural Resources reports had been assigned an ICD-9 code for a motor vehicle fatality. We chose to include only those deaths in which the vehicle was operated on an ice-covered body of water and exclude those in which the vehicle had run off a road into water, assuming that different risk factors may have been involved. Such information on the circumstances surrounding the events was available from the Department of Natural Resources reports but was lacking on most death certificates. This information is vital to understanding the causes of drowning and can be used to target further prevention strategies.

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REFERENCES

1. Baker S, O'Neill B, Karpt RS: The Injury Fact Book. Lexington: Lexington Books, 1984.
2. Committee on Trauma Research: Injury in America: A Continuing Public Health Problem. Washington, DC: National Academy Press, 1985.
3. Nie NH, Hull CH, Jenkins JG, Steinbrenner K, Bent DH: Statistical package for the social sciences (2nd Ed). New York: McGraw-Hill Book Company, 1975.
4. Centers for Disease Control: Premature mortality in the United States. MMWR Suppl 1986; 35:1S-11S.
5. Centers for Disease Control: Progress toward achieving the national 1990 objectives for injury prevention and control. MMWR 1988; 37:138-149.
6. Centers for Disease Control: Drownings—Georgia, 1981-1983. MMWR 1985; 34:281-283.
7. Davis S, Ledman J, Kilgore J: Drownings of children and youth in a desert state. West J Med 1985; 142:196-201.
8. Centers for Disease Control: North Carolina drownings, 1980-1984. MMWR 1986; 35:635-638.
9. O'Carroll PW, Aldon E, Weiss B: Drowning mortality in Los Angeles County, 1976 to 1984. JAMA 1988; 260:380-383.
10. Dietz PE, Baker SP: Drowning: Epidemiology and prevention. Am J Public Health 1974; 64:303-312.
11. Pearn JH, Wong RYK, Brown J, Ching YC, Bart R, Hammar S: Drowning and near-drowning involving children: A five-year total population study from the city and county of Honolulu. Am J Public Health 1979; 69:450-454.
12. Wintemute GJ, Kraus JF, Teret SP, Wright M: Drowning in childhood and adolescence: A population-based study. Am J Public Health 1987; 77:830-832.
13. Milliner N, Pearn J, Guard R: Will fenced pools save lives? Med J Aust 1980; 2:510-511.
14. National Safety Council: Accident facts. Chicago: National Safety Council, 1985.
15. Centers for Disease Control: Aquatic deaths and injuries. MMWR 1982; 31:417-419.
16. Orłowski JP: Adolescent drownings: Swimming, boating, diving, and scuba accidents. Pediatr Annals 1987; 17:126-32.
17. Centers for Disease Control: Alcohol as a risk factor for injuries. MMWR 1983; 32:61-62.
18. Centers for Disease Control: Premature mortality due to unintentional injuries—United States, 1984. MMWR; 1987:814-815.
19. Parker DL, Schultz JM, Gertz L, Berkelman R, Remington PL: The social and economic costs of alcohol abuse in Minnesota, 1983. Am J Public Health 1987; 77:982-986.
20. Glasser JH: The quality and utility of death certificate data. Am J Public Health 1981; 71:231-232.

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