ORIGINAL ARTICLE

Drowning in Alaska: progress and persistent problems

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ABSTRACT

Objectives. The purpose of this study is to evaluate and describe the current problem of drowning in Alaska, measure changes in the rates since earlier studies have been done and compare occupational and non-occupational drowning characteristics.
Study design. This is a descriptive observational study, using existing records obtained from several sources to describe and compare drowning victims and event characteristics.
Methods. Drowning fatality data were collected from death certificates, law-enforcement reports and news articles. Descriptive statistics and risk ratios were calculated to compare levels of risk based on incident and victim characteristics.
Results. During 2000–2006, 402 unintentional drowning deaths, 108 of them occupational, occurred in Alaska, with an average annual fatality rate of 8.9 deaths per 100,000 Alaskans. The victim population was 86% male and 44% Alaska Native; 40% drowned in the south-west region of Alaska. For non-occupational cases with alcohol use documented, 33% were associated with alcohol consumption, as were 78% of those involved with all-terrain vehicle crashes. Only 17% of non-occupational victims who drowned while boating wore a Personal Flotation Device (PFD).
Conclusions. The drowning rate in Alaska during 2000–2006 was 8.9 drowning deaths per 100,000 population. This shows a decrease from the rate reported in a 1996 study, but several problems persist. Males and Alaska Natives had elevated risks for drowning. A substantial portion of fatalities were associated with alcohol consumption. PFD use remains low, and child drowning rates were unchanged from earlier studies. Increased data on water temperature and immersion time may help demonstrate the benefits of PFD use to those at risk. Social marketing efforts should be adapted for at-risk populations.
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INTRODUCTION

Alaska has had a high drowning rate compared to other states. A study of 1988–1992 Alaska drowning deaths found an average annual incidence rate of 20 per 100,000 population, ten times the national rate (1). During 1996–1998, the Centers for Disease Control and Prevention (CDC) reported that Alaska's drowning rate (6.45 deaths per 100,000 population per year) was three times higher than the national average and more than twice that of the next highest state, Hawaii (3.13 per 100,000) (2). Other states with substantial shorelines (rivers, lakes and marine), colder climates and sizeable rural populations (Michigan, Minnesota, Ohio and Maine) had drowning death rates between 1.25 and 1.81 per 100,000. Although several drowning prevention programs have been instituted and significant research has focused on occupational drowning deaths in Alaska, there has been limited examination of non-occupational drowning data (3–8).

An investigation of recreational boating immersions in Alaska examined differences between the survivors and the victims (9). Substantial improvements in survival were seen with use of personal flotation devices (PFD) and avoidance of complete submersion. A Danish study examined 41 drowning cases in Denmark from 1989 to 1993 where PFDs were not used and concluded that, for 24 of these cases, the victims would have survived if they had worn PFDs (10).

Not all drowning deaths in Alaska are vessel-related. More than 30% of those that occurred from 1988 to 1992 were associated with activities other than boating (1). These primarily included falls from a dock or shore, swimming or bathing, aircraft and motor vehicle crashes and falling through ice when driving an all-terrain vehicle (ATV) or snowmobile. During 1993–1994, 27% of all snowmobile-related fatalities in Alaska resulted from drowning (11).

Only one study found in the literature provided a comprehensive analysis on all drowning types in Alaska, including both occupational and non-occupational fatalities (1). It found that between 1988 and 1992, high levels of drowning deaths occurred among males aged 20 to 39 during commercial fishing and non-recreational boating activities. Alaska Natives had a drowning rate almost triple that of non-Natives (43 vs. 15 per 100,000 population per year) and nearly five times that seen in Canada for the Aboriginal population in 1996 (9 per 100,000) (12). Of all recovered victims in the Alaska study, 53% were tested for alcohol and approximately half of those tested had blood alcohol concentrations (BACs) above 100 mg/dl, similar to findings in Finland where 63.9% of boating drowning deaths and 51.6% of other drowning deaths were associated with alcohol between 1987 and 2000 (13). In Alaska's south-west region, drowning rates were elevated: from 90 to 160 per 100,000 per year, up to 80 times the national rate. In comparison, the highest regional rates in Canada were seen in the northern territories, averaging 17 per 100,000, almost ten times the national rate of 1.8 per 100,000 (14).

Since this earlier Alaska study, a number of drowning prevention programs and regulations have been put into place. Several regional public health agencies have maintained or instituted PFD sales programs and sell hundreds of float coats and other types of PFDs annually to residents at reduced prices. One agency, the Yukon-Kuskokwim Health Corporation, sold

430 PFDs from 2005 through 2006 (B. Lefferts, Injury Control and Emergency Medical Services Manager, Yukon-Kuskokwim Health Corporation, personal communication, 2 September 2008). Kids Don't Float, a water safety program, began in 1996 as a grass-roots effort to prevent drowning by providing community-sponsored life jacket loan stations for children and youth at 15 sites in 1 Alaskan community. The program has expanded to more than 500 sites in Alaska, and won nationwide sponsorship by SafeKids Worldwide in 2008 (M. Bailey, Injury Prevention and Emergency Medical Services Project Assistant, State of Alaska Health and Social Services, personal communication, 24 November 2008). The Commercial Fishing Industry Vessel Safety Act, requiring fishing vessels to provide safety and survival equipment and training, was fully implemented by 1995. There was a 67% decrease in commercial fishing deaths between the pre- and post-implementation periods (1990–1992 vs. 1997–1999) (15). The United States Coast Guard (USCG), the Alaska Marine Safety Education Association (AMSEA), commercial fishermen's associations and other agencies offer water safety training programs for occupational and non-occupational settings. From 1993 to 2006, AMSEA held 2,544 training classes for 91,588 students (K. Sherrodd, Marketing and Publications Manager, Alaska Marine Safety Education Association, personal communication, 19 September 2008).

The purpose of the present study is to evaluate the current rates and characteristics of drowning cases in Alaska, document changes in Alaska rates, compare occupational and non-occupational drowning characteristics and rates and provide information to guide further targeting of interventions.

MATERIAL AND METHODS

Case Definition

A case was defined as an unintentional death caused by drowning in the state of Alaska during 2000–2006; all deaths that met this criteria were included in the study. Death by drowning was verified by death certificates. In some cases, the bodies of the deceased were never recovered. Incidents where the victim's body was unrecovered were included if there was strong evidence (such as a presumptive death certificate) that drowning was the cause of death.

A victim was considered to be alone if no one else observed or heard the incident. For this study, children were defined as those less than 18 years old. Cases were identified as having positive alcohol involvement if they had documented test results of .08% BAC or higher or strong evidence (characterized as listed on the death certificate or law enforcement narrative, multiple witness statements or open containers at the incident site). Missing values were excluded from analysis.

Data sources

Death certificates and certificates of presumptive death provided data on demographic characteristics, manner and cause of death and location and time of death. Alaska State Troopers, United States Coast Guard (USCG), local law enforcement and news media reports provided data on circumstances surrounding the death, including alcohol and PFD use.

Occupational drowning deaths were confirmed by the Alaska Occupational Injury Surveillance System, maintained by the National Institute for Occupational Safety and Health (NIOSH), Alaska Pacific Regional Office and the Alaska Fatality Assessment

and Control Evaluation (FACE) data system, which is maintained by the State of Alaska Section of Injury Prevention and Emergency Medical Services.

Population data, stratified by age, race and region, were derived from the Alaska Department of Labor and Workforce Development's (AKDOL) annual population estimates for the state.

Statistical analysis

The crude mortality rate for drowning in Alaska was calculated for each year during 2000–2006. Age-adjusted mortality rates for 10-year age intervals were calculated for each year using the 2000 Alaska population as the standard population. Descriptive statistics and risk ratios were computed to compare levels of risk based on incident characteristics or victim demographics. The six geographic regions of Alaska followed the combined census areas defined by AKDOL (16).

Analyses included the distribution of each variable and cross-tabulations. The chi-square test for independence was used to determine statistical significance, and the chi-square test was used to identify linear trends over time. ANOVA with post-hoc tests were used to analyse the difference in means for variables with more than two categories. Statistical analyses were performed using SPSS ver. 15, and Epi Info Stat Calc.

RESULTS

For the 7-year period, 415 suspected unintentional drowning death cases were gathered. A total of 13 cases were removed prior to analysis because they were determined to be intentional/suicide (5), to have a non-drowning cause of death (7) or to be missing persons who were later found alive (1).

General population determinations

From 2000 to 2006, 402 unintentional drowning deaths occurred in Alaska, a mean of 57 deaths per year and an average annual fatality rate of 8.9 deaths per 100,000 Alaskans (Table I). The highest number of drowning fatalities (80) occurred in 2001, in part due to the sinking of the *Arctic Rose*, a commercial fishing vessel, with 15 lives lost. The trend in the annual drowning death rate over the study period was not statistically significant (Table I).

Alaska residents accounted for 82% of all drowning victims. The proportion of drowning victims that were male was 86% (Table II) with a fatality rate of 14.9 deaths per 100,000 males per year, six times higher than the rate for females (2.5 per 100,000 females per year). For victims aged 0 to 9, the male and female drowning rates were similar: 4.9 and 4.0 fatalities per 100,000 per year, respectively, with a risk ratio of 1.2. Above age 9, the rates changed to 16.8 drowning deaths per 100,000 males and 2.2 per 100,000 females per year, a risk ratio of 7.6.

Alaska Natives made up only 17% of the state population, but represented 44% of all drowning deaths (Table II). Their drowning death rate (22 per 100,000 population per year) was the state's highest, 3.7 times higher than the rate for all other races (6.0 per 100,000 population per year). Regions where Alaska Natives made

Table I. Frequency and rate of drowning deaths in Alaska (n=402).

Year	Frequency	Crude rate*	Age-adjusted rate
2000	54	8.6	8.6
2001	80	12.7	12.7
2002	54	8.4	8.6
2003	45	6.9	6.8
2004	60	9.1	9.0
2005	62	9.3	9.6
2006	47	7.0	7.1

*Chi-square test for linear trends=2.996; p=.083.

Table II. General population demographic characteristics of drowning death victims in Alaska, 2000–2006 (n=402).

Characteristic	Frequency	%
Race		
White	196	49
Alaska Native	179	44
Other	27	7
Gender		
Male	347	86
Female	55	14
Age		
0-9	32	8
10-17	39	10
>17	331	82
Residency		
Alaska	328	82
Other Northwestern U.S.	28	7
Other U.S.	32	8
International	14	3

up the highest proportion of drowning deaths (compared to all races) were the north (89% Alaska Native) and the south-west (59% Alaska Native); those regions with the lowest proportions were the Gulf Coast and the Anchorage/Matanuska-Susitna Borough (both 19% Alaska Native).

The south-west region had the highest all races annual fatality rate (58.2 per 100,000 population per year) and the highest frequency of deaths, with 161 fatalities (40% of all drowning deaths) over the seven years examined (Fig.1). The region with the lowest annual rate of fatal drowning incidents was the Anchorage/Matanuska-Susitna Borough area (1.8 per 100,000 population per year).

For all vessel-related drowning deaths where PFD use was documented (n=179), 18% of the victims wore PFDs. While the proportions of males (18%) and females (21%) wearing PFDs were similar, those of racial groups were substantially different: 8% of Native Alaskan victims and 23% of victims of all other races wore PFDs. The most common circumstances in which victims wearing PFDs drowned were water action (high waves, fast currents), stormy weather, entrapment and remaining immersed in water for over an hour.

Occupational drowning

Of the drowning deaths, 27% were occupational fatalities, only 60% of which were Alaska residents (Table III). The predominant race was white, accounting for 75% of occupational victims. Alaska Natives were the second largest category, with 17 victims. Only one occupa-

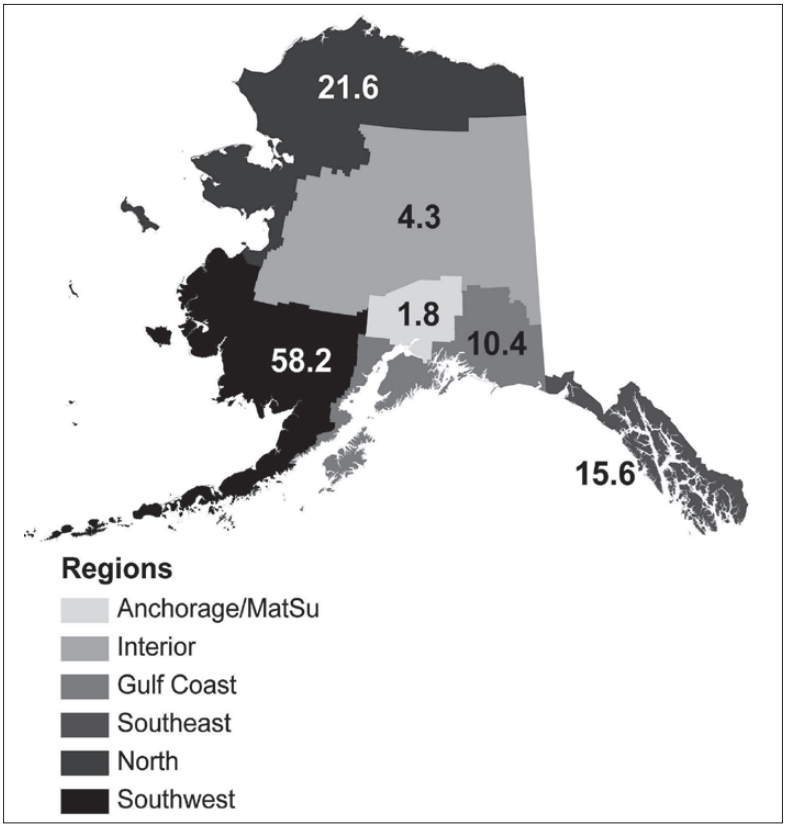

Figure 1. Drowning deaths per 100,000 population by region, Alaska, 2000-2006 (n=402).

Table III. Comparison of occupational and non-occupational drowning deaths in Alaska, 2000–2006.

Characteristics	Non-occupational Frequency	%	Occupational Frequency	%
Residency *				
Alaska	263	90	65	60
Other	31	10	43	40
Race *				
Alaska Native	162	56	17	17
White	120	42	76	75
Other	11	4	8	8
Unknown **	1		7	
Body Status *				
Recovered	244	83	59	55
Not found	50	17	49 45	
Status when incident occurred *				
Alone	124	42	28	25
Witnessed by others	168	58	80	75
Unknown **	2		0	
Alcohol				
Involved with incident	86	33	16	25
No alcohol involved	177	67	47	75
Unknown **	31		45	

* The difference between occupational and non-occupational distributions is statistically significant.
** Missing values are not included in percent calculations.

tional victim was female. The majority of occupational cases were adults (over 18 years old): 88% were between the ages of 20 and 59. Only two occupational victims were children; both of whom drowned during boating activities.

The two most frequent activities associated with occupational drowning were commercial fishing (68%) and commercial aviation (14%) (Table IV). All but one of the boating incidents (99%) involved open or cabin motorboats; one occupational victim drowned while kayaking. The boating fatalities were limited to three primary incident circumstances: vessel sinking (54%), falling overboard (34%) and vessel capsizing (12%). For those vessel-related incidents where PFD use was documented, 19% of occupational victims were wearing PFDs.

The frequency of occupational drowning deaths peaked three times during the year: March to April, July to August, and October. Most victims were not alone: 74% of the occupational drowning deaths were witnessed. The victim's body could not be located in 49 of the occupational cases.

Table IV. Occupational drowning deaths in Alaska by activity, 2000–2006 (n=108).

Activity	Frequency	%
Commercial fishing	73	68
Onboard aircraft	15	14
Onboard other vessel	8	7
Scuba diving	4	4
Other	8	7

Table V. Non-occupational drowning deaths in Alaska by activity, 2000–2006 (n=294).

Activity	Frequency	%
Boating	127	43
Walking near water	42	14
Swim/Play in water	32	11
Riding snowmobile	29	10
Play around water	19	7
Fish from shore/dock	11	4
Riding ATV	10	3
Other	24	8

For occupational incidents with documentation on alcohol use, 16 (25%) showed alcohol involvement, 12 were associated with boating and the remaining four with walking. Only three cases had any evidence indicating drug use.

Non-occupational drowning

The most frequent activities for non-occupational drowning deaths were boating, walking near water, swimming or playing in water and riding a snowmobile (Table V). Nearly 70% (88) of boating fatalities occurred in open or cabin motorboats; 25% occurred in non-powered recreational boats such as canoes, kayaks and rafts. Drowning deaths that occurred while swimming or playing in water were primarily associated with overexertion, being overcome by a strong current and cold shock from cold water immersion. Falling through ice was the primary circumstance for all 29 snowmobile incidents and 50% (5) of ATV incidents. Non-occupational fatalities showed a sustained peak during summer months, May through September.

Alaska Native children had a drowning fatality rate of 15.7 deaths per 100,000 per year; non-Alaska Native children had a rate of 2.1 deaths per 100,000 per year. The crude rate among male children overall was 6.9 deaths per 100,000 per year; female children had a rate of 3.5 deaths per 100,000 per year.

For non-occupational drowning deaths, 33% were associated with alcohol use. For Alaska Native victims, 43% of all drowning deaths were documented as alcohol-related, compared to 20% of non-Native drowning fatalities (χ=16.62, p<.001). Alcohol involvement showed statistically significant differences between activities (F=2.674, p<.01). The

activity having the highest association with alcohol for non-occupational events was ATV riding (7 out of 9), followed by snowmobiling (51%) and walking (42%). For boating-related drowning deaths, 29% of fatalities involved alcohol. Alcohol use did not vary significantly by region (p=.169).

PFD use was documented for 115 of the 127 non-occupational drowning deaths that occurred while boating. PFDs were worn by 17% victims aged 13 and above and 22% of victims under age 13 (p=.690) at the time of the incident. For non-occupational boating incidents, 25% of non-Native victims and 8% of Alaska Native victims were wearing PFDs.

Of the non-occupational drowning deaths, 43% (124) occurred when the victim was alone, ranging from zero while driving an automobile or scuba diving to more than 80% while walking and bathing. Alcohol involvement was documented for 53% of victims who were alone, compared to 26% of victims of witnessed events. All 12 victims who drowned in residential water (bathroom, sink, bucket or pool) were alone when they died (p<.001).

DISCUSSION

Determinations

The drowning rate calculated by CDC for Alaska during 2000–2005 with a restricted case definition (3.84 per 100,000) remains higher than other states (up to 2.57 per 100,000) and higher than the national average (1.18 per 100,000) (17). Our study found 8.9 drowning deaths per 100,000 population during 2000–2006. A 1988–1992 study, which used similar case definitions, found a rate of 20 per 100,000 (1). Drowning fatality rates were found to be much higher for males than for females, likely explained by earlier findings that males have a higher exposure to water environments and engage in riskier behaviours on the water (18).

The south-west region of Alaska had the highest regional drowning rate. This is an area of major commercial fishing activity, with large numbers of transient workers engaging in activities with high-drowning risks. Other regions with high-drowning fatality rates were those in remote, sparsely populated areas of Alaska that rely heavily on natural bodies of water for subsistence and transportation. The most populated area, Anchorage-MatSu, had the lowest rate.

Occupational drowning

This study found that 27% of the drowning deaths were occupational fatalities, compared to 38% in the earlier study (1). While the work-related fatality rate for commercial fishermen in Alaska is still very high, it has decreased by 47% since the early 1990s (19).

The success in reducing commercial fishing drowning deaths is due in part to the USCG implementation of new safety requirements in the early 1990s. In 2004, 96% of commercial fishermen involved in vessels sinking or capsizing survived, compared to only 73% in 1991. Other interventions include continued safety training focused on the commercial fishing industry. NIOSH reviewed the impact of this training and found that survivors of vessel losses were 1.5 times more likely to have had safety training (95% CI 0.9–2.4; p=.14) (20). Furthermore, the USCG has developed tailored solutions to high-risk fisheries such as the Bering Sea red king and opilio crab fleet which resulted in an 81% decrease in fatalities in this fleet (21). Fisheries management

policies have also changed, with a subsequent 81% decline in fatalities among the halibut and sablefish fleets (22).

Differences between occupational and non-occupational cases

Dissimilar seasonal trends were observed for occupational and non-occupational drowning deaths. The peak for non-occupational deaths parallels the high level of recreational water activities during the summer months. Occupational drowning fatalities peaked in months when the most fishing occurs (July–August) and at the beginning of the winter fishing season (October). The peak of drowning deaths seen in March–April was likely attributable to a random event, in this case the 2001 sinking of the *Arctic Rose* which claimed the lives of 15 fishermen.

Alaska residents were more commonly non-occupational drowning victims than occupational victims. Non-occupational victims, including those participating in subsistence activities, were also more likely than occupational victims to be Alaska Native and to be alone at the time of the incident. Alcohol involvement was not statistically different between occupational and non-occupational fatalities.

Over one-third of the incidents in this study were unobserved, with a significantly higher proportion for non-occupational victims than for occupational. Many of these fatalities may have been prevented if witnessed, for example, through a buddy system, allowing an immediate rescue effort. For vessels, devices such as person overboard alarms and EPIRBs (Emergency Position Indicating Radio Beacons) have been developed to alert others that someone has fallen overboard into the water (5).

Alaska Natives

During 2000–2006, the Alaska Native population had a drowning fatality rate almost four times higher than other racial groups. Many Alaska Native communities depend on rivers and oceans for basic needs like food and transportation, which increases their exposure time on the water. Alcohol involvement was higher for Alaska Native drowning victims than other racial groups. This suggests that multiple risk factors for drowning, such as differences in exposure and behaviours, affect risk differences among gender or racial groups.

Alcohol use

Although it is illegal in Alaska to operate a boat with a BAC of .08% or higher, almost one-third of the boating drowning events included in the study were associated with alcohol consumption (23). Alcohol involvement was not statistically different between occupational and non-occupational fatalities. Activities with high levels of alcohol-related deaths also have a high proportion of fatalities while alone, possibly indicating a decreased capacity for self-rescue. Risks may increase whenever alcohol impairs judgement, for example, when trying to determine whether ice is thick enough to support a snowmobile. Alcohol consumption can also impair balance and coordination and lengthen reaction time, increasing the chance of falling into the water.

Use of personal flotation devices (PFD)

USCG reported that in 2004 in the United States, 484 recreational boaters died by drowning, and of these almost 90% were not wearing PFDs. Similarly in our study, 83% of non-occupational boaters who drowned were not wearing PFDs. Although this could

suggest a greater chance of drowning for those not wearing PFDs, it may also reflect PFD use rates for all boaters. One observational survey in Alaska found that only 27% of boaters wore PFDs (24). Studies on survivors and drowning victims have reported survival odds ratios up to 11.4 for those using PFDs (3,7).

The risk of drowning in Alaska is exacerbated by the severity of the water temperatures (less than 15°C) (7). A person accidentally entering cold water can experience cold shock within two minutes, swimming failure within 30 minutes and hypothermia after 30 minutes (20,25). Each of these can lead to submersion and death by drowning. However, if the victim is wearing a flotation device and does not become completely submerged, he/she may survive up to six hours before hypothermia is severe enough to become life-threatening (18). Data on water temperature and duration of immersion that would allow discrimination between cold shock, swimming failure and hypothermia are not routinely recorded (20), but such data might be pivotal in convincing marine travellers to wear flotation devices or survival gear.

In this study and others from several states, more than half of the drowning events were witnessed (8,26,27). Witnesses may not understand the immediacy of the danger, being unfamiliar with drowning risks associated with cold shock and swimming failure. Additional circumstances such as strong currents, extreme weather or other injuries to the victim or rescuers can prevent witnesses from reaching the victim.

Child drowning fatalities

The crude drowning fatality rate among male children was twice that of females. Alaska Native children had a crude rate that was eight times greater than the non-Alaska Native rate. Below age 10, rates for males were only slightly higher; the difference increases substantially for those aged 10 and above. It is possible that male children, especially between the ages of 10 and 17, have a higher exposure to water environments and engage in riskier behaviours than female children in this age group (18).

The majority of child drowning deaths in this study (55 of 71) occurred in open bodies of water (lakes, rivers, oceans), comparable to other states (28). Alaska children share many risk factors with children in other states, including not using PFDs, being subject to the risky behaviour of supervising adults and to caregivers' overconfidence about children's safety awareness and abilities (29).

Many families in Alaska participate in commercial fishing activities during summer months. Targeted water safety programs for children and families have been implemented in coastal communities, including statewide public safety announcements on both radio and television, which are intended to enhance awareness of water safety for groups of mixed ages. Other statewide interventions include marine safety education in schools, recreational boating classes and CPR training for children and young adults.

Limitations

One limitation of this study was the denominator or reference population. Using the Alaska census population does not account for differences in exposure, that is, time spent in the vicinity of water. Seasonal migration of residents between Alaska regions for recreational, subsistence fishing or commercial fishing activities affects the accuracy of

regional rates. The census population may not be appropriate for determining rates for workers, since many of the commercial fishermen are not Alaska residents. In addition, the lack of demographic data, such as age, race, gender and other characteristics, for occupational populations prevents rate calculations for those groups.

The accuracy of risk assessment is limited by the lack of data on the prevalence of risk factors in the reference population. While the substantial percentage of alcohol-related incidents or victims not wearing PFDs might suggest an increased risk of drowning associated with consuming alcohol or not wearing PFDs, it may simply reflect the rates of the denominator population. Comprehensive data on risk factors such as PFD use and alcohol consumption of victims and survivors would improve interpretation and better inform the public on the merits of PFDs.

Conclusion

The overall drowning rate during 2000–2006 was lower than reported for 1988–1992. It is possible that stricter requirements in occupational safety practices and implementation of water safety programs may have played a role, but confirming that determination is beyond the scope of this study.

The results of this study show that several problems persist. Males and Alaska Natives have elevated risks of drowning. A substantial portion of fatalities continue to be associated with alcohol consumption. PFD use continues to be low, and child drowning rates remain similar to those of earlier studies. Lack of documentation of the water temperature and length of time the victim was immersed makes it more difficult to distinguish between drowning and hypothermia; increased efforts to collect these data may allow more direct conclusions for those at risk about the benefits of PFD use. Successful prevention methods and social marketing efforts should be adapted to ensure that drowning prevention programs are effectively implemented among the identified at-risk populations.

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