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The epidemiology of falling-through-the-ice in Alaska, 1990–2010

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Abstract

Background—Climate change has contributed to increasing temperatures, earlier snowmelts and thinning ice packs in the Arctic, where crossing frozen bodies of water is essential for transportation and subsistence living. In some Arctic communities, anecdotal reports indicate a growing belief that falling-through-the-ice (FTI) are increasing. The objective of this study was to describe the morbidity and mortality associated with unintentional FTIs in Alaska.

Methods—We searched newspaper reports to identify FTI events from 1990 to 2010. We also used data from a trauma registry, occupational health and law enforcement registries and vital statistics to supplement the newspaper reports. Morbidity and mortality rates were calculated for Alaska Native (AN) people and all Alaskans.

Results—During the 21-year period, we identified 307 events, affecting at least 449 people. Events ranged from no morbidity to fatalities of five people. More than half of the events involved transportation by snow machine. Mortality rates were markedly higher for AN people than that for all Alaskans.

Conclusions—We provide a numeric estimate of the importance of FTI events in Alaska. FTIs may represent an adverse health outcome related to climate changes in the Arctic, and may be particularly critical for vulnerable populations such as AN people.

Keywords

morbidity and mortality; public health; social determinants

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Introduction

Over the past 60 years, the time period for which the most reliable meteorological data are available, Alaska has warmed at more than twice the rate of the rest of the USA. The annual average temperature in Alaska has increased 3.08F, with winters warming by 5.8°F.[1] The warming Arctic is changing the quality, spatial covering and thickness of sea ice, resulting in a shorter ice travel season.[2–4] These changes are making subsistence lifestyles more dangerous, a major concern for many Alaska Native (AN) communities.[5,6] One hazard of thinning ice is the potential for an increase in the frequency of falling-through-the-ice (FTI) events.[7]

Subsistence activities such as hunting, fishing and gathering are critical components of the culture and life of many people living in the Arctic, and travel over fresh and saltwater ice is often essential for these activities.[8] FTI events are an enduring hazard in the Arctic, and residents practicing subsistence lifestyles face relatively high exposure to water hazards throughout the year, including during the winter.[9,10] In addition to the potential for injury and death, the risk of FTI events can cause equipment loss, decrease harvest success and adversely affect mental health.[11,12] Recent anecdotal reports suggest that travel conditions in Alaska are becoming increasingly hazardous, with more FTI events.[7,13] Even if the actual risk posed by travel on ice is not increasing, the perception of increased risk may alter timing and routes of travel for Native populations of the Arctic.[14] Increased difficulty in ability to travel to access food sources or for other reasons may be detrimental to the health, economy and subsistence culture of AN communities.

Despite anecdotal reports of increasing FTI events and the importance of this topic to the AN community, no comprehensive assessment of FTI events has been completed. Thus, our objectives were to describe the morbidity and mortality associated with unintentional FTI in Alaska from 1990 to 2010 and to examine the spatial distribution and temporal trends of these FTI events.

Methods

An FTI event was defined as a report of at least one person unintentionally breaking through or falling through ice on a body of water, including in a vehicle, between 1 January 1990 and 31 December 2010. Events included driving into open water if ice was expected. Events excluded falls from a height into a frozen water body; falls on glaciers; falls into non-natural holes (e.g. through a hole chopped in the ice) and events south of the latitude of King Salmon (58°45′N), due to climatic differences in the Aleutian Chain and the Southeast Panhandle areas of AK. No ICD-9 or ICD-10 codes exist for falling through the ice. Therefore, the main data source was newspaper reports of FTI. Databases were searched from Nexis®,[15] Google News,[16] online archives for Alaskan newspapers and the Alaska Outdoor Fatality Listing[17] by use of common search terms (Alaska and 'through the ice' or 'ice' with variations of slip, fall and break). We also searched, via microfiche or hard copy, small, weekly publications and several years of one daily publication (i.e. Fairbanks Daily News Miner) not available online. This search was manual, and it involved scanning headlines, photo captions, police report sections and articles for FTI events. We supplemented the newspaper sources with available data from the Alaska Trauma Registry (which is maintained by the Alaska Department of Health and Social Services, with input from all hospitals),[18] the Alaska Occupational Injury Surveillance System,[19] the Alaska State Troopers and death certificate data.[20] Every effort was made to ensure that events were not counted twice by matching for date of event, circumstances, location and number of people involved. Data sources that appeared to describe the same event were reviewed to identify any additional data elements. We found 88% of events in newspaper reports. The Alaska Trauma Registry and the Alaska Occupational Injury Surveillance System identified 1% of the same events, and the Alaska State Troopers database identified 5% of the same events. Death certificate data were used to fill in information for people who had been identified through another source.

We abstracted the following information, as available, on events: number of people involved, timing and location, activities, transportation type, notification, search and rescue and alcohol use. Activities included subsistence living, which refers to the practice of AN people acquiring natural resources from the land and sea to meet their social, cultural, economic, nutritional and health needs. Additional information on individuals in the events included demographic characteristics, health outcome and use of safety equipment. Data abstraction was performed by one of the authors (N.L.F.) and one research assistant, who was trained on the process, and whose work was evaluated for accuracy. Two or more co-authors reviewed every data abstraction element that was unclear or for which there was disagreement to ensure a consensus decision was reached.

Annual FTI rates were calculated by use of population denominator estimates from the Alaska Department of Labor and Workforce Development,[21] and those rates were smoothed over a 3-year time period to compensate for the small numbers. Rates were calculated for AN people and all Alaskan residents, regardless of race/ethnicity. These two categories are not mutually exclusive. This comparison was made due to the lack of information on race/ethnicity for more than half of the people involved in events. Descriptive analyses and risk ratios were conducted using Stata version 11 (Stata Corp). Events were geocoded for 99% of cases, with .50% within a 1-mile confidence radius and .70% within a 5-mile confidence radius. The map was generated using Google Earth (Google 2012).

Results

We identified 307 FTI events from 1990 to 2010 in Alaska (Table 1). Only one person was involved in 68% of events, although up to 6 people fell through the ice in one case. More than 35% of events involved a fatality. More than 40% of events involved traveling as the primary activity, although hunting and fishing and working were also common activities. An additional 6% of events involved adventure sports, such as dog mushing. More than half of the events involved snow machines (snowmobiles). Most events resulted in a search and rescue operation (68%), and law enforcement was frequently involved (56%). Alcohol use was reported in 7% of events, although in the vast majority of cases (83%) alcohol use was not known or not reported. Falls occurred most frequently on rivers (44%). Overflow, a condition in which water from high tides, rain or snowmelt may collect above surface ice and then freeze, was a factor in 11% of events. The most common months for events were November, December, February and March. Events were most common on the weekends and in the afternoons or at night, although the time of the event was not known or not reported in 41% of the events.

At least 449 people were involved in the FTI events we identified (Table 2), although 25 events did not specify the number of people involved and were thus counted as involving one person; this methodology may underestimate the actual number. The mean age was 33.7 years, with a range of 1–86 years. Most people affected were men (71%). Although race/ethnicity was rarely reported, and could usually be gleaned only in the case of a fatality, 124 AN people were identified in FTIs, while only 40 Caucasians were identified in events. Most people survived their FTI event (66%), although survivors occasionally suffered from frostbite, hypothermia or exposure. Nearly 5% of people were not found and were presumed dead, but additional reports confirming the mortality were lacking. More than one-quarter of people in an FTI event died, most commonly from drowning. Approximately 12% of people were identified as having some type of safety equipment, such as survival gear.

Figure 1 displays the annual rates of individuals falling through the ice and of mortality due to those falls from 1990 to 2010; it compares the rates of AN people with the rates for all Alaska residents, regardless of race/ethnicity. Over time, rates have fluctuated. The FTI rate for all Alaskans was 2.0 per 100 000 people per year from 1990 to 1995, with an increase to 4.7 per 100 000 per year the following 6 years, dropping to around 3.0 per 100 000 per year thereafter. FTI rates for AN people follow a similar pattern over time, although they are consistently higher, with the exception of 2002–04 (risk ratio for entire time period: 1.7, 95% confidence interval: 1.4–2.1). The mortality rate for all Alaskans ranged from 0.6 per 100 000 per year (1993–95) to 1.4 per 100 000 per year (1996–2001). AN people died at more than four times the rate of all Alaskans across the 21-year period (risk ratio: 4.2, 95% confidence interval: 3.3–5.5); the highest mortality rate for AN people was 6.4 per 100 000 per year for the period 1996–98.

When examining the spatial distribution of FTI events across Alaska, we found several clusters (Fig. 2). Many events clustered around the major population centers of Anchorage, Fairbanks (i.e. Chena River), Dillingham and Bethel (i.e. Kuskokwim River). The Yukon River in southwestern Alaska was also a frequent site of events. In addition, communities bordering the Pacific Ocean—including Barrow, Kotzebue and Nome—experienced several events either on the sea ice or in watershed areas.

Discussion

Main findings of this study

This paper provides the first systematic characterization of unintentional FTI in Alaska. We identified > 300 events occurring over a 21-year time period and affecting nearly 450 people. More than 35% of the events included at least one fatality, and half of the events involved a snow machine. Our data demonstrate that AN people were at higher risk than were all Alaskans as a whole, both for being involved in an event and for dying from an event. The higher risk of AN people reflects the increased exposure to risk related to frequent ice travel, including their remoteness from search and rescue professionals and medical care. As increasingly warmer temperatures in Alaska promote the thinning of ice, FTI events may become more frequent, and areas for intervention should be targeted.

What is already known on this topic

Several potential focus areas for preventing morbidity and mortality from FTI events emerged from the analysis. Safer snow machine use is one potential avenue for prevention of FTI events. In this study, snow machines were involved in half of the FTI events; rates of snow machine-related FTI events follow similar patterns to the overall rates shown in Fig. 1 (data not shown). The number of registered snow machines in Alaska increased 5-fold from 1995 to 2004, from just fewer than 10 000 to > 50 000 registered vehicles, with little change after 2004.[22] The peak years or snow machine-related FTI event rates coincided with the rapid increase in registered snow machines between 1995 and 2004, and leveled off thereafter. With the higher prevalence of snow machines, drivers should be aware of the safety of their routes, and they should avoid traveling when ice conditions are poor and when visibility is low

Social and economic conditions also factor into whether people can wait until conditions improve to travel or hunt[14], which in turn influences the risk for FTI events. The necessity or eagerness to travel for food and other reasons, when the ice is newly formed, or when conditions are poor, also results in more risk-taking behavior[14]. In this study, men accounted for ~70% of people involved in FTI events, and 79% of people participating in subsistence hunting and fishing-related FTI events (data not shown). As such, men should be a particular focus of educational interventions. In addition, using safety equipment offers opportunities for intervention. Float coats have been shown to be cost-effective interventions to reduce summertime drowning deaths among AN people.[23] Similar interventions with winter-weight float coats may help reduce drowning deaths during the winter as well. Finally, encouraging traveling with partners may hasten rescue efforts, leading to decreased morbidity and mortality.

The rate of FTI events has fluctuated over time, with the lowest rates occurring in the early 1990's for all Alaskans. Higher rates in later years could be due to a number of factors, including an increase in reporting of FTIs, the increased use of snow machines for winter travel[22] or changes in the climate.[24] AN people suffer from higher rates of FTI events, as well as higher rates of mortality due to events, than do all Alaskans. From 1999 to 2005, the annual rate of unintentional injury deaths of AN people was 101.8 per 100 000 people. Drowning was the leading cause of these deaths, with a rate of 20.9 per 100 000 people per year.[25] During the same time period, our data showed that mortality from FTI of AN people occurred at a rate of 5.0 per 100 000 per year. Since this rate is likely an underestimate (with the race/ethnicity of 13% of fatalities unknown), FTI represent a notable proportion of the unintentional injury deaths of AN people.

More than half of the events (n = 180) occurred during October–November and March–May during freeze-up or thawing. Ice conditions on rivers and other waterways used for transportation should be carefully monitored during these seasons to assure the thickness and stability of the ice before travel is attempted. The Yukon, Kuskokwim and Chena Rivers are some of the most frequent sites of events. Unfortunately, there is no systematic, statewide system monitoring ice thickness and conditions. The National Weather Service does maintain a voluntary River Watch Program with a focus on ice conditions and especially flooding. River Watch Observers are located in communities on many rivers across Alaska. However, ice conditions are not monitored regularly in all locations.[26] Additionally, monitoring is sometimes done on a local level, with people marking places on the river that are known to be weak spots. Conditions are dynamic, though, and those spots often change during the winter.

Limitations of this study

It is likely that our results underestimate the true incidence of FTIs, particularly of FTIs in which no fatalities occurred. Newspapers and police reports are likely to capture only events in which somebody died, or that included a large number of people, or that occurred during a higher profile sporting or school event. Less severe events that did not result in a community response or a death are less likely to be reported. Unfortunately, there is no complete database of FTI events. Although we supplemented news reports with other sources (e.g. trauma registry, trooper reports), the completeness of the data is unknown. However, by triangulating from various data sources, our research represents the best effort to date to document the burden of FTI in Alaska.

The rates of events fluctuated during the time period investigated. It is possible that the differences across time that we observed may be due to changing media coverage, although no source tracks injury reports over time in the media in Alaska, so this cannot be verified. News reports and other sources typically lacked information on race/ethnicity, and only rarely did they include information on drug or alcohol use. When death certificate data could be matched to FTI events, we were able to supplement the news reports with information on race/ethnicity and to verify date of injury as well as the location and cause of death. FTI data have not yet been linked to climatic data, so we cannot directly assess the link with climate change conditions, such as sea ice thickness or time to freeze-up or thaw.

What this study adds

This report represents the first systematic characterization of FTI in Alaska. By triangulating multiple data sources, the data demonstrate the risk of FTI for Alaskans and highlight the particular risk for AN people. FTI may represent an adverse health outcome related to changes in climatic features in the Arctic, and may be especially important for vulnerable, indigenous populations.[27] In Alaska, if FTI are increasing over time, such an increase could discourage ice travel, disproportionately affecting AN people, many of whom live in remote communities and rely on traditional hunting and fishing for food.

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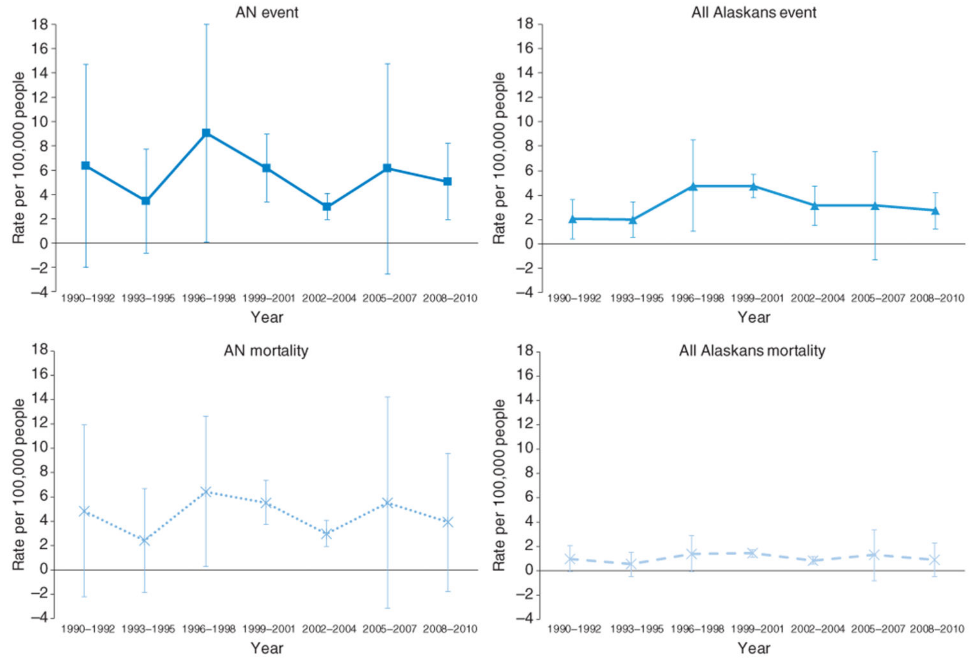

Fig. 1.
Annual rates of unintentional falling-through-the-ice (FTI), Alaska 1990–2010.

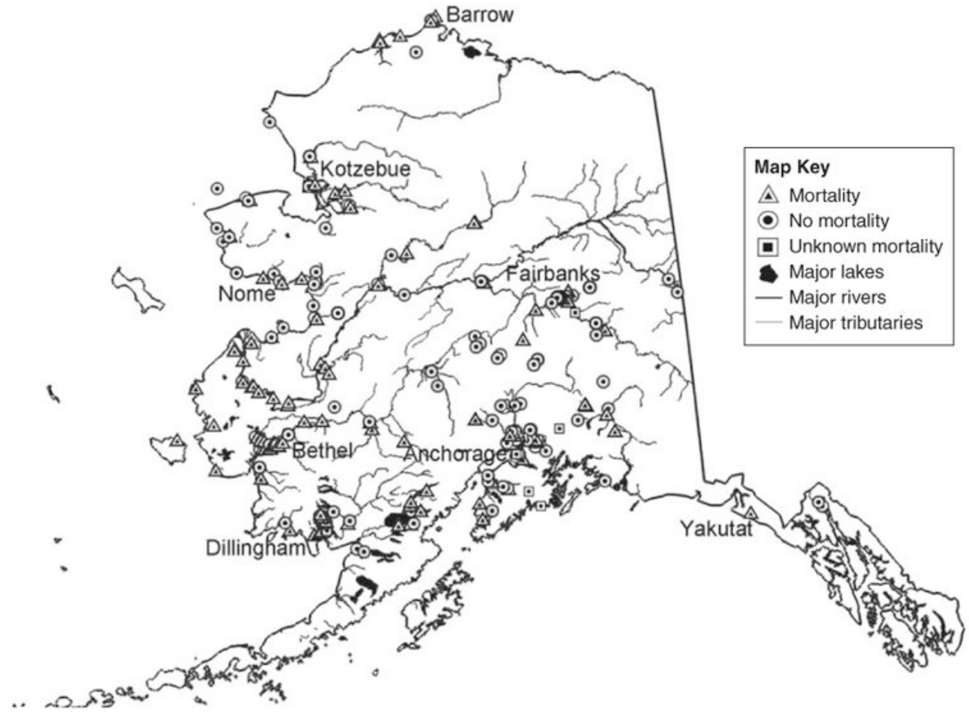

Fig. 2.
Map of morbidity and mortality of unintentional FTI, Alaska 1990–2010.

Table 1

Description of unintentional fall-through-the-ice events, Alaska 1990–2010

	n = *307*
People per event; *n* (%)[a]	
1	191 (67.7)
2	64 (22.7)
3	14 (5.0)
4	8 (2.8)
5	4 (1.4)
6	1 (0.4)
Event involving fatality; *n* (%)	
Yes	112 (36.5)
No	171 (55.7)
No report/unknown	24 (7.8)
Primary activity (mutually exclusive); *n* (%)	
Traveling	132 (43.0)
Subsistence living (e.g. hunting, fishing)	35 (11.4)
Working	22 (7.2)
Adventure sports	19 (6.2)
Playing (skiing, sledding, ice skating, etc.)	15 (4.9)
Search and rescue (people or pets)	4 (1.3)
Other	7 (2.3)
No report/unknown	73 (23.8)
Mode of travel; *n* (%)	
Snowmachine	157 (51.1)
On foot	43 (14.0)
Car/truck/vehicle	27 (8.8)
All terrain vehicle (ATV)	17 (5.5)
Heavy equipment	13 (4.2)
Dog mushing	13 (4.2)
Airplane	10 (3.3)
Ski	7 (2.3)
Bicycle	3 (1.0)
Sled	2 (0.7)
Ice skate	2 (0.7)
Other	3 (1.0)
No report/unknown	10 (3.3)
Notification of event; *n* (%)	
Reported missing	75 (24.4)
Person part of event	73 (23.8)
Bystander	67 (21.8)
No report/unknown	92 (30.0)

	n = *307*
Search and rescue involved; *n* (%)	
Yes	210 (68.4)
No	55 (17.9)
No report/unknown	42 (13.7)
Law enforcement involved; *n* (%)	
Yes	171 (55.7)
No	67 (21.8)
No report/unknown	69 (22.5)
Report of alcohol use; *n* (%)	
Yes	22 (7.1)
No	31 (10.1)
No report/unknown	254 (82.7)
Type of water body; *n* (%)	
River	134 (43.6)
Lake	56 (18.2)
Creek	22 (7.2)
Bay/harbor/port/sound	14 (4.6)
Lagoon	11 (3.6)
Pond	11 (3.6)
Sea ice	9 (2.9)
Slough	9 (2.9)
Other	11 (3.6)
No report/unknown	30 (9.8)
Overflow involved; *n* (%)	
Yes	35 (11.4)
No	15 (4.9)
No report/unknown	257 (83.7)
Month of event; *n* (%)	
September	4 (1.3)
October	29 (9.4)
November	52 (16.9)
December	46 (15.0)
January	28 (9.1)
February	44 (14.3)
March	49 (16.0)
April	30 (9.8)
May	20 (6.5)
June	1 (0.3)
No report/unknown	4 (1.3)
Day of week of event; *n* (%)	
Sunday	57 (18.6)
Monday	37 (12.1)

	n = *307*
Tuesday	32 (10.4)
Wednesday	26 (8.5)
Thursday	35 (11.4)
Friday	43 (14.0)
Saturday	49 (16.0)
No report/unknown	28 (9.1)
Time of day of event; *n* (%)	
Morning (6 a.m.–12 p.m.)	28 (9.2)
Afternoon (12 p.m.–6 p.m.)	70 (23.0)
Evening (6 p.m.–10 p.m.)	26 (8.6)
Night (10 p.m.–6 a.m.)	55 (18.1)
No report/unknown	125 (41.1)

[a] *n* = 282.

Table 2

Characteristics of people involved in unintentional fall-through-the-ice events, Alaska 1990–2010

	n = *449*
Age in years; mean+SD (range)[a]	33.7+16.7 (1–86)
Sex; *n* (%)	
Female	62 (13.8)
Male	317 (70.6)
No report/unknown	70 (15.6)
Race/ethnicity; *n* (%)	
Alaskan Native	124 (27.6)
Caucasian	40 (8.9)
No report/unknown	285 (63.5)
Residence	
Alaska	279 (62.1)
Other US	4 (0.9)
Foreign	16 (3.6)
No report/unknown	150 (33.4)
Taken to hospital or clinic; *n* (%)	
Yes	76 (16.9)
No	92 (20.5)
No report/unknown	155 (34.5)
Not applicable (e.g. person dead at scene, body not recovered)	126 (28.1)
Outcome	
Survived; *n* (%)	295 (65.7)
No adverse outcome	219 (48.8)
Frostbite	17 (3.8)
Hypothermia/exposure	21 (4.7)
Other/not specified	38 (8.5)
Presumed dead; *n* (%)	20 (4.5)
Died; *n* (%)	123 (27.4)
Drowning	64 (14.3)
Hypothermia/exposure	11 (2.4)
Not specified	48 (10.7)
No report/unknown	11 (2.4)
Had safety equipment; *n* (%)	
Yes	56 (12.5)
No	18 (4.0)
No report/unknown	375 (83.5)

[a] $n = 291$.