Pediatric Wilderness Recreational Deaths in Western Washington State

Lori M Newman, MD*
Douglas S Diekema, MD, MPH‡
Catherine D Shubkin, MD§
Eileen J Klein, MD, MPH‡
Linda Quan, MD‡

From the Departments of Family Medicine and Pediatrics,‡ University of Washington, Seattle, WA, and the Department of Pediatrics,§ Boston Medical Center, Boston, MA.*

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Address for reprints: Douglas S Diekema MD, MPH, Department of Emergency Services, Mailstop CH-04, Children's Hospital and Regional Medical Center,4800 Sand Point Way NE, PO Box 5371, Seattle, WA 98105; E-mail diek@u.washington.edu.

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Study objective: To determine the causes and characteristics of pediatric recreational wilderness deaths.

Methods: All deaths of children between 12 months and 20 years of age involving a wilderness recreational activity in 5 western Washington counties between 1987 and 1996 were identified by medical examiners' logs. Univariate analysis was used to examine variables such as age, gender, activity, mechanism of injury, adult presence, blood alcohol level, safety equipment, and mode of evacuation.

Results: Of 40 cases meeting inclusion criteria, 90% involved male subjects and 83% of victims were 13 to 19 years old. Hiking (33%), swimming (20%), and river rafting (10%) were the most common activities. Death was most often by drowning (55%) or closed head injury (26%). No victim was alone. All children younger than 10 years of age were accompanied by an adult, in contrast to only 26% of individuals 10 years or older. Only 4 victims had drugs or alcohol in their system. No victim wore a personal flotation device or helmet, and only 5% had foul weather gear. Although nearly one third of victims were transported by airlift, more than half of the victims were dead at the scene.

Conclusion: Males and teenagers were the 2 major risk groups for recreational wilderness deaths. Traditional activities such as hiking and swimming were the most common causes of death. Children younger than 10 years died despite the presence of an adult, whereas teenagers were usually with groups of peers. The majority of victims were not prepared for adverse events with basic safety equipment.

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INTRODUCTION

Exploration of the wilderness has a powerful attraction for people of all ages. People frequently venture far from accessible medical facilities to pursue potentially high-risk activities such as backpacking, rock climbing, or kayaking. A survey by the National Sporting Goods Association revealed that more than 9 million Americans participated in backpacking or wilderness camping in 1988.[1] As access to wilderness areas and sports technology has improved, increasing numbers of these participants are adolescents and children. A similar survey found that approximately 2 million of these individuals were between 7 and 17 years old.[2]

Despite increasing wilderness exposure, there are few studies examining the risks imposed on children by wilderness settings. Whereas injury rates for children in traditional sports such as football, bicycling, swimming, and skateboarding have been published,[3-7] only 1 study has assessed the type of injuries and injury rates among adolescents in wilderness courses.[8] Several studies have deter-

Table 1.
Wilderness recreation deaths among persons younger than 20 years in western Washington.

Age	Sex	Month	Time	Activity	Injury	Circumstances
4	Male	July	Noon–6 PM	Camping	Drowning	Caught in current and drowned
4	Male	June	Noon–6 PM	Camping	Drowning	Entered river with siblings while father gone to shop
5	Male	June	6 AM–Noon	Boating	Drowning	Aluminum boat capsized
7	Male	April	Noon–6 PM	ATV	CHI	ATV flipped over
8	Male	May	Noon–6 PM	Boating	Drowning	Capsized canoe in sound
10	Male	June	Noon–6 PM	Scuba	Drowning	Drowned during scuba class in sound
12	Male	July	Noon–6 PM	Play	Drowning	Fell in river while throwing rocks
13	Male	August	Noon–6 PM	Hiking	CHI	Fell from cliff at mountain lookout
13	Female	April	Noon–6 PM	Rafting	Exposure	River raft (unguided) capsized
14	Male	September	Unknown	Motorcycle	Electrocution	Struck by lightning
14	Male	April	6 AM–Noon	ATV	Neck/back injury	Hit cable stretched across logging road while riding ATV
15	Male	June	Noon–6 PM	Hiking	Drowning	Jumping on rocks and slipped
15	Male	July	Noon–6 PM	Rafting	Drowning	Inner-tubing and fell into river
15	Male	January	Unknown	Hiking	Exposure	Disappeared hiking in snowstorm
15	Male	April	6 PM–midnight	Sightseeing	CHI	Fell 150 ft while trying to aid adult who had fallen
15	Male	June	Noon–6 PM	Hiking	Drowning	Fell into river while climbing down cliff
16	Male	August	6 PM–midnight	Boating	Drowning	Ejected from motorboat
16	Male	June	Noon–6 PM	Rafting	Drowning	Inner-tubing and fell into swift water
16	Female	August	Noon–6 PM	Hiking	CHI	Separated from group and fell 1,000 ft
16	Male	July	Noon–6 PM	Swimming	Drowning	Wading in river, caught in current
16	Male	June	Noon–6 PM	Swimming	Drowning	Bodysurfing in river and caught in current
16	Male	August	Unknown	Swimming	Drowning	Swimming in sound
16	Male	June	Noon–6 PM	Swimming	Drowning	Swimming in river
17	Female	June	Noon–6 PM	Swimming	Drowning	Tried to aid friend in river
17	Male	August	Noon–6 PM	Hiking	CHI	Separated from group and fell 2,000 ft
17	Male	September	Midnight–6 AM	Camping	CHI	Under log that friend was jumping on, log fell on head
17	Male	July	6 AM–Noon	Hiking	CHI	Fell while climbing on cliff near waterfall after consuming alcohol
18	Male	July	6 PM–midnight	Hiking	Drowning	Fell 230 ft off trail into water after consuming alcohol
18	Male	June	Noon–6 PM	Hiking	CHI	Slipped on snowfield and fell 400 ft
18	Male	October	Noon–6 PM	Hiking	CHI	Drinking alcohol and reckless walking along cliff edge
18	Male	August	Noon–6 PM	Rafting	Drowning	Raft (unguided) plunged over waterfall after consuming alcohol
18	Male	July	6 PM–midnight	Hiking	Drowning	Attempted river crossing and fell
18	Male	September	Noon–6 PM	Swimming	Drowning	Jumping rocks in river, slipped, fell 30 ft over waterfall
18	Male	May	Noon–6 PM	Swimming	Drowning	Jumped into river from 40-ft cliff
18	Male	March	Noon–6 PM	Biking	Neck/back injury	Fell while mountain biking without helmet
18	Male	January	Unknown	Hiking	Exposure	Disappeared hiking in snowstorm
18	Male	August	Midnight–6 AM	Play	CHI	Playing paint ball at night and fell off bunker
18	Male	July	Noon–6 PM	Swimming	Drowning	Swimming in river
19	Female	June	Noon–6 PM	Hiking	CHI	Slipped on snowfield and fell 400 ft
19	Male	May	Noon–6 PM	Scuba	Barotrauma	Air embolus while scuba diving

ATV, All-terrain vehicle; **CHI**, closed head injury.

mined mortality rates and causes in adults performing both traditional and wilderness activities.[9-12] A 1995 National Safety Council study described fatalities associated with football, boating, and hunting, but did not detail wilderness activities other than hunting, nor did it categorize age groups of victims.[9] A 1989 study found that the risk of dying while trekking was 15 deaths per 100,000 adult trekkers, but that study did not include children.[12] The paucity of literature on pediatric and adolescent wilderness deaths does not allow adequate understanding of the risks and dangers these age groups encounter in the wilderness setting.

We conducted a multicounty retrospective study of pediatric recreational wilderness deaths to determine the causes and characteristics of these deaths. By identifying the nature and circumstances surrounding these deaths, we hope to build the knowledge base necessary to implement preventative measures for children and adolescents who engage in wilderness activities.

MATERIALS AND METHODS

Cases were defined as individuals older than 12 months but younger than 20 years old who died of injuries sustained while involved in a recreational wilderness activity between 1987 and 1996 in 5 contiguous western Washington state counties (King, Pierce, Snohomish, Skagit, and Whatcom). These 5 counties represent the most popular recreational terrain in the state and include most of the state's population. In this study "recreation" was defined as any activity undertaken for personal enjoyment that did not involve a motorized vehicle capable of interstate traffic. "Wilderness" was defined as any area where natural forces such as weather, terrain, and wildlife could quickly become uncontrollable or life-threatening and where difficult access to vehicular transportation delayed immediate contact with medical facilities.

Western Washington wilderness areas lie in close proximity to major urban centers and include diverse terrain such as the rugged Cascade Mountain range with peaks of up to 14,000 feet, multiple high-volume rivers that drain the snowfields and glaciers of these peaks, and the intricate waterways and islands of Puget Sound and the Pacific Ocean.

Cases were identified from the medical examiners' office logs. All unexpected deaths in Washington State become medical examiner cases and are recorded. The medical examiners' investigative and autopsy reports and death certificates were reviewed for all deaths in this age group identified by the medical examiners as accidental and nontraffic-related. Although the initial injury had to occur in a wilderness area to be included, the location of death (on site, in transport, in hospital) did not affect inclusion.

Cases were excluded if the initial event occurred in areas of substantial population or development or in a home or

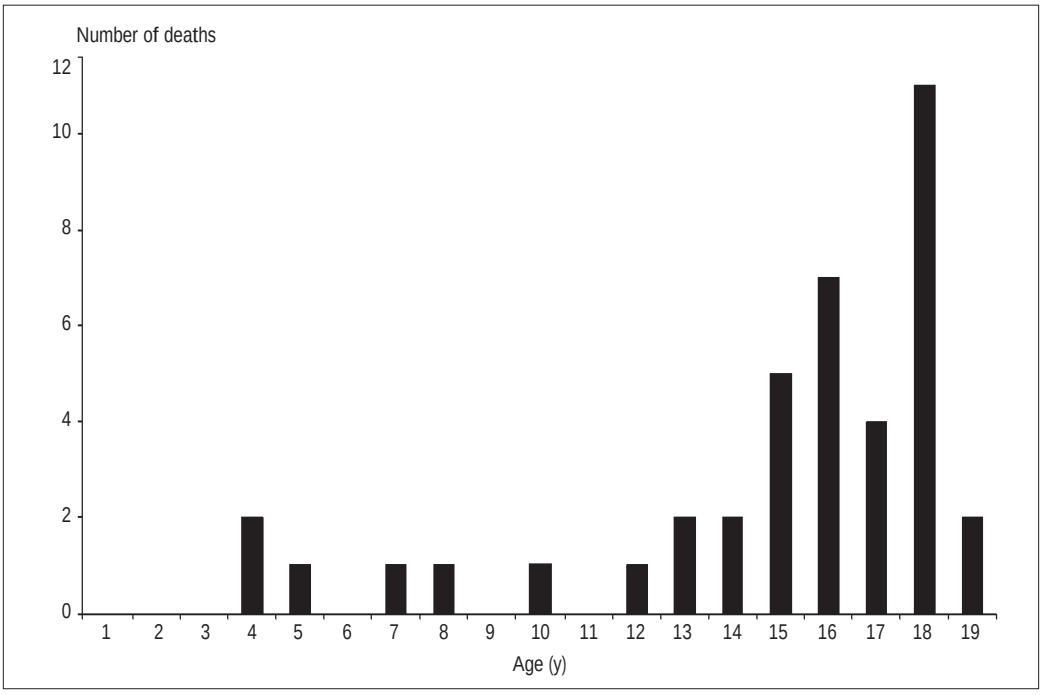

Figure.
Age of victims of wilderness recreational deaths in 5 western Washington counties, 1987–1996.

yard. Cases were also excluded if the event occurred while the individual was in the wilderness for nonrecreational purposes (ie, employment). Any case that occurred in an operating commercial alpine ski area was excluded because these areas have readily accessible transportation, communication, and medical personnel. Authors as a group reviewed unclear or controversial cases, and decisions to include or exclude individual cases were based on consensus of the group.

Data collected included age, gender, race, past medical conditions, date and time of injury, date and time of rescue or body recovery, terrain, weather, season, preinjury activity, number in group, presence of an adult, witnesses of injury, scene of death, mode of evacuation, type and mechanism of injury, blood alcohol level, drug screen results, and presence of safety equipment.

Incidence was calculated using the number of cases with residence in the 5 study counties as the numerator and the number of persons in each age group residing in the 5-county region as the denominator. The 1990 Census data were used to determine the total number of persons in each age group residing in the 5 study counties.[13] Thirty-nine of the 40 cases were residents of the 5 study counties. The remaining person was a Mexican citizen who appeared to be living in 1 of the study counties.

Dichotomous variables were compared with the χ^2 test and Fisher's 2-tailed exact test for expected values less than 5. A 2-sided *P* value less than or equal to .05 was considered statistically significant.[14] StatView (Abacus Concepts, version 4.5) was used in the statistical analysis.

This study was approved by the institutional review board at the authors' institution.

RESULTS

We identified 40 wilderness recreational deaths among individuals 12 months to 20 years of age during the 10-year study period (Table 1). The great majority of deaths (83%) occurred among those between 13 and 19 years old, whereas a smaller peak (8%) occurred in those 4 or 5 years of age (Figure 1). Age-related mortality rates are shown in Table 2. Thirty-six of the 40 victims were males.

Table 2.
Mortality rates in wilderness recreational deaths by age.

Age Group (y)	Rate per 100,000 Persons per Year
0–4	.097
5–9	.149
10–14	.339
15–19	1.634

Hiking was the most common preinjury activity (33%), followed by swimming (20%), and river rafting, or innertubing (10%). Children 10 years of age and older were significantly more likely to have died while swimming or hiking than children younger than 10 years old (62% versus 0%, *P*=.01). The primary injury leading to death was most frequently drowning (55%) followed by closed head injuries (26%). Although 4 (80%) of the 5 deaths among children younger than age 10 were by drowning, none in this age group intended on being in the water (2 children drowned after falls into water from boats, and 2 children drowned while playing or camping near water).

Most deaths occurred during the summer months (June, 11; July, 8; August, 7). Of the 34 deaths in which time of injury was available, 29 (85%) occurred during daylight hours. The peak time period was 2 to 6 PM. All victims were accompanied by at least 1 other person at the time of their injury. Of 32 deaths in which information about the age of accompanying persons was available, only 12 (38%) were accompanied by someone older than 19 years of age. All 5 children younger than 10 years were accompanied by adults, whereas only 7 of 27 (26%) individuals 10 years or older were accompanied by someone older than 19 years of age (*P*=.004).

Table 3 details premorbid activity by mechanism of injury. The mechanism of injury resulting in death included drowning in 21 (52.5%), falls or impacts in 14 (35%), exposure in 3 (7.5%), lightning strike in 1 (2.5%), and air embolus in 1 (2.5%). Drug or alcohol use was suspected in only 4 (10%) cases by the medical examiners' investigations. One body was never recovered, but history obtained from survivors suggested alcohol intake before the activity. Of the 32 cases in which blood alcohol levels were obtained, 25 (78%) had undetectable levels. Three cases had evidence of alcohol use (levels of .19, .17, .04 gm/100 mL). These 3 also had evidence from historical information that they had been drinking before their injuries. An additional 4 cases had detectable blood alcohol levels (.02 to .09 gm/100 mL) in the presence of putrefaction (greater than 1 week between death and discovery of body) suggesting decomposition, not consumption, as the cause of elevated blood alcohol levels.[15] Of 14 cases in which drug screens were performed, only nicotine or caffeine was found.

Most victims were not prepared for an encounter with adverse events in the wilderness. Of the 37 cases in which clothing and gear were mentioned, 27 (73%)

possessed only light clothing, 8 (22%) possessed layered clothing, and 2 (5%) had some kind of foul weather gear. Among the 21 non-scuba drowning cases, none of the victims was wearing a life preserver, and only 1 (5%) had a life preserver nearby at the time of death.

Twenty-nine of 40 (73%) victims were declared dead at the scene, 10 (25%) died in the hospital, and 1 (3%) was never found. Twelve (30%) of the cases (including 7 declared dead at the scene) were transported by airlift, the remainder by ground transportation.

DISCUSSION

This study is the first regional description of pediatric recreational deaths in the wilderness. The 2 major risk groups identified in this study were males and older adolescents. A smaller but also distinct increased number of deaths occurred among 4-or 5-year-old boys. These suggest that teenagers and preschool-age boys are the 2 groups of children who could potentially benefit most from a focused preventive intervention program.

The majority of these deaths were caused by drowning while youth were involved in common water-related activities such as swimming, boating, and rafting. Importantly, they were not associated with high-risk activities such as rock climbing, mountaineering, and scuba diving. The majority of deaths occurred during the daytime hours of summer months, the time and season when most outdoor activity occurs in this region and a finding consistent with the time and season of most pediatric injuries. Therefore it seems important to increase both physician and participant awareness that drowning is the second major cause of nonintentional death in the pediatric population and that the wilderness represents another setting with the potential for a fatal outcome from water-related activities.

Use of personal flotation devices (PFDs) might have prevented the 6 (27%) drowning deaths related to boating, inner-tubing, or rafting. Furthermore, recognition of water conditions such as current and personal swimming ability might have prevented several of the swimming related drownings. Thus basic water safety instruction may be helpful in decreasing fatal outcomes among children involved in wilderness activities.

Importantly, safety was not found in numbers. None of the victims in this study was alone. Teenagers were usually with peers and younger children were with adults. Despite the presence of adults, only 1 of the 5 drowning victims younger than age 10 had a PFD nearby and none was wearing a PFD. These findings suggest that adult supervision alone may not provide adequate protection of young children involved in activities near the water and that PFD use should be emphasized when children are involved in any activity near a body of water. Washington State does not have a law requiring PFD use for children in boats or around water. Such a law might have prevented some of these deaths.

Adolescents with a group of peers may be more likely to act in a foolhardy or risky manner than adolescents by themselves or with adults. Although risk-taking was evident in a few scenarios (diving into river from 40 feet, mountain biking without a helmet, bodysurfing in an engorged river), alcohol or drug use was rare. Thus pre-

Table 3.
Mechanism of injury by recreational activity.

	Mechanism of Injury						
Activity	**Drowning**	**Fall***	**Impact**	**Exposure**	**Lightning**	**Air Embolus**	**Totals**
Hiking	3	8	0	2	0	0	13
Swimming	8	0	0	0	0	0	8
Rafting	3	0	0	1	0	0	4
Camping	2	0	1	0	0	0	3
Boating	3	0	0	0	0	0	3
Riding ATV	0	0	2	0	0	0	2
Scuba diving	1	0	0	0	0	1	2
Playing	1	1	0	0	0	0	2
Mountain biking	0	1	0	0	0	0	1
Motorcycle	0	0	0	0	1	0	1
Other	0	1	0	0	0	0	1
Total	21	11	3	3	1	1	40

ATV, All-terrain vehicle.
*One victim fell from a cliff into a pool of water and drowned.

vention programs should address how peers interact and could prevent or intervene in wilderness emergency situations. Although alcohol use was a factor in a small number of cases, emphasis on the role of alcohol and drug use in deaths related to wilderness activities should not minimize the importance of basic outdoor awareness and skill training.

No victims were identified as having an underlying medical illness that could have contributed to their death. The presence of underlying medical conditions may increase risk of mortality during wilderness activities. However, any intervention using the presence of underlying medical illnesses as a means of identifying high-risk children may not target the majority of fatal situations.

Lack of preparedness appears to play a role in recreational wilderness deaths. Two victims who slipped and fell from a snowfield did not possess an ice ax that might have arrested their slide. The mountain biking victim was not wearing a helmet. In most cases only light clothing was found with the victim's body. The "10 essentials" touted by outdoor safety experts as important to backcountry survival were not found with the body in any of the 37 cases (2 scuba divers were properly equipped for diving, and the medical examiner's report did not mention what was found with 1 body). The 10 essentials for outdoor situations usually include such basic safety items as extra clothing, extra food, sunglasses, knife, firestarter, first-aid kit, matches, flashlight, map, and compass.[16] Although we do not know whether accompanying group members may have carried survival equipment, the children who died did not.

This study was not able to address specific questions about comparative riskiness with regard to factors such as age, gender, or activity because no data are available on age, gender, or activity specific participation rates for wilderness recreation. Furthermore, it was unclear from this study if the risk was inherent to the type of activity, the frequency of the activity being performed, the preparedness of the individual for the activity, or the distance of the activity from medical facilities. We also recognize that the causes and risk factors in this study may be regional in nature because of the unique geography of the Pacific Northwest. Therefore these findings may not apply to other regions.

This study has identified teenage and preschool males as high-risk groups. Common activities such as hiking and swimming in the summer during daylight hours can be fatal in a wilderness area. Being accompanied by adults or peers does not guarantee safety. Lack of preparation for wilderness activity with helmets, PFDs, or the 10 essentials is common in the pediatric age group, and alcohol appears to contribute minimally to wilderness fatalities in this age group. Finally, most deaths occur before rescue.

We hope this information will be used to focus interventions for teenagers, children, and adults. Some benefit may accrue by increasing awareness about the risks involved in common wilderness activities, what survival gear to bring on wilderness activities, what safety equipment to wear, and the importance of knowing basic first-aid and rescue techniques. Similarly, state laws requiring PFD use by children and adolescents in watercraft or licensing and helmet requirements for those using all-terrain vehicles might reduce the number of fatal injuries among children. By identifying the nature and circumstances surrounding wilderness deaths among children, we hope to encourage the development and implementation of preventative measures that will make wilderness activities safer for children.

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