ORIGINAL RESEARCH

Recreational Injuries in Washington State National Parks

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Objectives.—The objectives of this study were to identify the number and types of recreational injuries sustained by visitors to Mount Rainier National Park and Olympic National Park in Washington State and to compare the nature of injuries sustained by children compared with adults.

Methods.—We retrospectively reviewed case incident reports obtained by rangers in Mount Rainer National Park and Olympic National Park between 1997 and 2001. Data collected included victim age, gender, date of injury, activity preinjury, type of injury, and mechanism of injury.

Results.—There were 535 cases of recreational wilderness injuries (including 19 total deaths), yielding a rate of 22.4 injuries per million visits. The mean age of injury victims was 34 years. Males were more likely to sustain injury than were females (59% vs 41%). Most injuries occurred during summer months between noon and 6:00 PM, and 90% occurred during daylight hours. The most common preinjury activities included hiking (55%), winter sports (15%), and mountaineering (12%), and the most common types of injuries included sprains, strains and soft tissue injuries (28%), fractures or dislocations (26%), and lacerations (15%). A total of 121 (23%) of the injuries occurred in children (<18 years of age). There were 19 deaths in the 2 national parks (18 men, 1 woman); all victims were adults. Hiking (58%) and mountaineering (26%) were the most common activities at the time of death. Mechanism of death included falls (37%), medical (eg, myocardial infarction) (21%), drowning (5%), and suicide (5%).

Conclusions.—The most common type of injury was soft tissue injury, and injuries occurred most commonly while hiking, during daylight hours, and in the summer. Preinjury activities and types of injuries were different in children compared with adults. Knowledge of how and when injuries occur in national parks can assist in determining what resources are needed to help provide a safer environment for park visitors. This study may also aid prevention strategies in the national parks, guide training of rangers, aid in the preparation of first aid kits, and further the education of people who participate in wilderness activities.

Key words: Washington, recreation, state parks, injuries

Introduction

Wilderness recreation has a powerful allure for many people. In a national survey published in 1999 on recreation and the environment, 94.5% of the population reported participating in outdoor recreation in the previous year.¹ In recent years, it seems that more and more people are venturing farther away from paved roads and easy access to health care for recreational purposes. Injuries to people in the wilderness offer a unique challenge to health care providers.

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Some of the most popular and heavily used wilderness areas in the United States are the national parks. Mount Rainier National Park (MRNP) and Olympic National Park (ONP) are popular national parks in Washington State that lie close to major urban centers and include diverse wilderness terrain. Mount Rainer National Park contains 228 480 acres of wilderness with more than 300 miles of trails, multiple rivers, lakes, glaciers, and a peak of 14 411 feet. Olympic National Park contains 876 669 acres of wilderness with 60 miles of Pacific Ocean coastline, more than 600 miles of trails, a rain forest, mountains, rivers, lakes, and glaciers. Together, these parks recorded more than 24 million visitors between 1997 and 2001.²

Despite continued growth in recreational use of these

parks, there are few data on the types of recreation injuries and rate of injuries in these types of wilderness areas and no data on parks in the Pacific Northwest. There are also no data that compare injuries sustained by children with those sustained by adults.

The aim of this study was to identify risks of national park recreation. We conducted a retrospective study with case incident reports obtained by rangers at both national parks to identify the types and rate of injuries to visitors to MRNP and ONP. By determining what risks visitors face, we hope to provide information to improve safety in these areas.

Materials and Methods

Cases included individuals who sustained injuries while involved in a recreational activity in MRNP and ONP between 1997 and 2001. For this study, we defined *recreational activity* as any activity performed for personal enjoyment that did not involve a motor vehicle or activity on paved areas of the park. Cases were identified from the case incident report files of MRNP and ONP. Case incident report files include all incidents that come to the attention of park officials, including injuries, motor vehicle accidents, and criminal activity. All incident reports regarding sick and injured individuals and search-and-rescue operations were reviewed for the 5-year period. The injuries recorded in the case incident reports were based on assessments by paramedics, emergency medical technicians, and park rangers.

Cases were excluded if the injury occurred while an individual was performing a nonrecreational activity (ie, employment), an activity that involved a motor vehicle, or an activity on paved areas of the park. We also excluded winter injuries that occurred within the boundaries of the lift-served downhill ski area within ONP, 44 individuals (24 from MRNP and 20 from ONP) who were recorded as incidents in a logbook but for whom no file existed, and 65 noninjured visitors who had become lost. Injuries in this study refer to all incidents, including deaths. Deaths were also analyzed separately. We defined adults as 18 years of age and older and children as less than 18 years of age.

Data collected included age, gender, past medical conditions, date and time of injury, area of park, activity preinjury, type and mechanism of injury or illness, outcome of victim, and type of transport. Daylight hours were defined as 8:00 AM to 8:00 PM. Winter sports included skiing, sledding, snowboarding, snow play, and snowshoeing. Injury was categorized as multiple trauma when an individual sustained potentially life-threatening injuries to more than 1 body area. Mechanism was attributed to exacerbation of underlying medical condi-

Figure 1. Gender differences.

tions when the medical event was clearly related to a previously existing medical condition (eg, a cardiac arrest in an individual with a history of heart disease). Dichotomous variables were compared by using the chi-square test and Fisher 2-tailed exact test for expected values less than 5. A 2-sided *P* value of less than or equal to .05 was considered statistically significant. Statview 5.0 (SAS Institute Inc) and Epi Info 3.2.2 (Centers for Disease Control and Prevention) were used in the statistical analysis.

Injury and death incidences were calculated with visitation statistics for the 2 parks during 1997 to 2001 as a denominator. The data and the method used to calculate them are available on the Internet at <http://www2.nature.nps.gov/stats>.²

The Children's Hospital and Regional Medical Center Institutional Review Board in Seattle, WA, approved this study.

Results

We identified 535 individuals who sustained recreational injuries or medical events in the 2 national parks during the 5-year study period. Injury rates were 47.2 per million visits in MRNP and 12.7 per million visits in ONP. The mean age of injured victims was 34 years. One quarter of victims were younger than age 18 ($n = 121$, 23%). Males were more frequently injured than females (59% vs 41%) (Figure 1). Most injuries occurred during the summer months (Figure 2). Of the 526 incidents in which time of accident was available, 352 (67%) occurred between noon and 6:00 PM and 472 (90%) occurred during the daylight hours (Figure 3).

Hiking was the most common preinjury activity (55%), followed by winter sports (15%), mountaineering

Figure 2. Number of injuries by month.

Figure 3. Number of injuries by time of day.

(12%), camping (6%), swimming and beach play (3%), and rock or ice climbing (1.5%). The most common injuries included sprains, strains and soft tissue injuries (28%), fractures or dislocations (26%), lacerations (15%), closed head injuries (5%), multiple traumas without closed head injury (5%), hypothermia or frostbite (4%), and insect stings (3%). The mechanism of injury included falls ($n = 293$, 54.8%), overuse or exertion ($n = 76$, 14.2%), exacerbations of underlying medical conditions ($n = 41$, 7.7%), collisions or impacts with falling objects ($n = 31$, 5.8%), and insect stings ($n = 20$, 3.7%).

Of the 535 incidents, 121 (23%) occurred in children. Of all adult incidents, 3.4% were fatal. There were no fatal pediatric incidents. Gender distribution (60% male) and time of day of injury (90% during daylight hours) among children were nearly identical to adults. A greater percentage of children sustained their injuries during the winter months compared with adults. In children, 22 of 120 (18%) sustained their injuries between December and March compared with 42 of 413 (10%) adults.

Injuries sustained while participating in winter sports (23% vs 12%), camping (15% vs 3%), and during swimming or beach play (7% vs 1%) were more common in children than adults. Injuries sustained while hiking (60% vs 38%) or mountaineering (15% vs 1%) were more common in adults than children. The Table summarizes the types of injuries sustained by adults and children. Children sustained lacerations (26% vs 12%), insect stings (7% vs 1%), burns (6% vs 1%), and allergic reactions (5% vs 0%) more frequently than did adults. Children were less likely to sustain fracture dislocations (14% vs 29%), multiple traumas (1% vs 6%), and medical conditions (2% vs 8%) than were adults. The cause of injury in children compared with adults was more frequently a result of insect stings (11% vs 2%), burns (6% vs 1%), and collisions or impacts with falling objects (12% vs 5%). Children less frequently sustained injuries as a result of overuse (7% vs 16%), medical

illnesses (5% vs 8%), altitude (0% vs 2%), or avalanches (0% vs 1%) than did adults.

In terms of surrounding terrain at time of injury, compared with adults, children were more frequently injured in campgrounds (12% vs 3%), on flat ground (7% vs 2%), and in the forest (9% vs 4%) and were less frequently injured on trails (34% vs 43%), mountains (1% vs 14%), or lakes and rivers (0 vs 5%).

Of 535 individuals with injuries, 165 (31%) required transport to a medical facility by airlift or ambulance.

Type of injury

Type of injury	Adults ($n = 414$)†		Children (<18 y old, $n = 121$)	
	No.	%	No.	%
Sprain/strain/soft tissue	114	28	35	29
Fracture dislocation*	112	29	17	14
Laceration*	49	12	31	26
Medical illnesses	32	8	2	2
Multiple traumas (no closed head injury)*	26	6	1	1
Closed head injury	16	4	9	7
Hypothermia/frostbite	18	4	5	4
Insect stings*	6	1	9	7
Dehydration	11	3	1	1
Burns*	3	1	7	6
Allergic reactions*	2	0	6	5
Altitude illness	5	1	0	0
Snow blindness	5	1	0	0
Submersion injury	4	1	0	0
Other/poorly defined	20	5	3	2

† n refers to individuals with injury. Numbers in the table exceed n because some individuals sustained more than 1 distinct injury that did not meet the definition of multiple trauma (eg, a fracture and laceration).

* $P < .05$ for difference between adults and children.

Of individuals transported to a medical facility, 62 (38%) required airlift. Of the 414 adults with injuries, 135 (33%) required transport as compared with 30 of 121 (25%) children. Only 9 (7%) children required airlift compared with 53 (13%) adults.

Of 19 deaths in the 2 national parks during the 5-year period, 18 were accidental (9 in each national park) and 1 was a suicide. Accidental death rates were 1.4 per million visits in MRNP and 0.5 per million visits in ONP. The mean age of victims who died was 42 years, and all victims were older than 18 years. Of the 19 deaths, 18 occurred among men. Activities at the time of death included hiking ($n = 11$, 58%); mountaineering ($n = 5$, 26%); and canoeing, skiing, and snowboarding ($n = 1$ in each, 5%). Mechanism of death included falls ($n = 7$, 37%), medical (eg, myocardial infarction) ($n = 4$, 21%), drowning ($n = 1$, 5%), and suicide ($n = 1$, 5%). Six victims disappeared and their bodies were never found. All 4 medical deaths were cardiac related. The average age of those with medical deaths was 69 years, significantly older than those with deaths attributed to other causes (mean age 35 years). The most common terrain at the location of death was mountains (37%), followed by trails (21%) and cliffs (11%). Nine (47%) of the victims were part of a group, and 7 (37%) were by themselves (the status of 3 victims was unknown).

Discussion

Several studies have evaluated the morbidity and mortality of wilderness recreation. A study similar to ours by Montalvo et al³ in 1998 evaluated morbidity and mortality of all visitors to 8 California national parks. Several studies have attempted to identify the morbidity and mortality of participants in wilderness recreation through search-and-rescue logs, medical examiner reports, or wilderness school incident reports. These studies have included wilderness areas in New Hampshire, Oregon, Alaska, Arizona, Washington State, and Colorado, among others.⁴⁻¹³ Other studies have attempted to define injuries related to participation in specific recreational activities or by type of problem, such as mountain climbing, long-distance hiking, endurance events, high-altitude sickness, and drowning.¹⁴⁻²¹ This study attempted to assess details about not only numbers of wilderness recreational injuries in the Pacific Northwest but also types of injuries, conditions under which injuries occurred, activities performed at the time of injuries, and the age and gender of those injured. We also compared the differences in injuries between children and adults.

In this study, the incidence of injury in MRNP and ONP was 4.7 and 1.3 per 100 000 visitors. These findings were significantly lower than the incidence of 9.2

per 100 000 visitors reported by Montalvo et al³ for visitors to California national parks. However, a direct comparison among different national parks may not be possible, given the different methods of counting "visitors" used by the individual parks.² Likewise, direct comparisons among published studies may be limited because of different inclusion criteria (eg, Montalvo et al³ included all injuries, whereas we included only those injuries that visitors sustained while participating in wilderness recreation) and the use of different data sources.

The incidence of injuries in our study was also significantly lower than that found in a study by Twombly and Schussman¹³ that included participants of the Colorado Outward Bound School, where 85% of males and 94% of females self-reported some type of injury. The higher injury rates may reflect differences in the way the data were collected. Both our study and the Montalvo et al³ study included only those injuries that came to the attention of park rangers and resulted in an incident report. The Twombly and Schussman¹³ study was based on self-reported injuries in response to questioning and was therefore more likely to include less severe injuries. These differences highlight the fact that although our study may underestimate the incidence of minor injuries, it is unlikely to underestimate the number of serious injuries and those requiring immediate medical care.

Studies have also revealed different patterns of wilderness injuries. We found that hiking, snow activities, and mountaineering were the most common activities during which injuries occurred. Several studies have reported that hiking, which is a low-risk, popular activity, has consistently been the most common activity during which injuries occurred.^{3,4,11}

Previous studies have demonstrated that musculoskeletal injuries comprise the majority of wilderness recreation injuries. These findings were supported by our study in which soft tissue injuries, fractures or dislocations, and lacerations comprised 60% of all injuries. First aid kits and wilderness participants should be stocked to care for these types of injuries.

As expected, males represented a greater percentage (58%) of injury victims than did females. This is similar to the findings of other studies. For example, males represented 64.5% of search-and-rescue victims in New Hampshire⁴ and 57% of search-and-rescue victims on Mount Hood.¹² The only study to demonstrate an increased rate of injury among women is that of Twombly and Schussman¹³ in which 94% of females reported injury vs 85% of males. The latter study was based on self-reports that tended to overemphasize minor injuries not requiring medical care. The existing data seem to suggest that males are more likely to experience serious injuries than are females. Whether this is due to an in-

crease in risk-taking behavior or a greater amount of time involved in wilderness activities has not been established, though Ela⁴ concluded that “the proportion of males and females requiring search and rescue in NH appears to reflect overall population visiting NH wilderness areas.”

Males are clearly overrepresented when one considers recreational deaths in wilderness areas. In our study, only 1 of 19 deaths was a woman, a 19-year-old who drowned after falling while crossing a river in the spring. The high percentage of deaths among males has been demonstrated in other studies as well. Goodman et al⁷ analyzed search-and-rescue reports from Pima County, AZ, and reported that males accounted for 87% of deaths. In the study by Montalvo et al³ regarding visitors to California national parks, 78% of 78 reported deaths were males. Notably, this trend seems to be sustained across all age groups. Newman et al¹¹ analyzed medical examiner reports in King County, WA, to assess pediatric wilderness recreation deaths and reported that males accounted for 90% of 40 deaths.

The majority (67%) of injuries in our study occurred between noon and 6:00 PM and in the summer months. This correlates with the peak time of outdoor recreation in the northwest, and it corresponds with the summer vacation period. The parks may benefit by continuing to increase ranger patrols and safety education efforts during these times.

The types of activities as well as types of injuries sustained during those activities differed when comparing children with adults. Children more frequently sustained injuries while participating in winter sports or camping, whereas adults more frequently sustained injuries while hiking and mountaineering. Children were significantly more likely than adults to sustain lacerations, and adults were more likely than children to sustain fractures. These differences most likely reflect differences in the activities pursued by adults, who are more likely to participate in high-risk activities than are children. Also, children sustained significantly more burns than did adults (6% vs 1%), which probably reflects the lack of experience most children have around open fires. These data should encourage visitor education about appropriate campfire and camp stove safety.

Our study was limited by the nature of case incident report files in several important ways. Our data recorded only those injuries that came to the attention of park rangers and resulted in a case incident report being filed. This limitation of the case incident report files likely leads to a significant underestimation of minor injuries and illnesses while capturing the great majority of serious injuries.

It is notable to point out the low number of medical

illnesses that occurred during our study. This may reflect the acute nature of injuries vs the chronic nature of many illnesses. A person who became ill from giardia, for example, would not have been detected in this study because of the delayed onset of symptoms.

Injuries recorded in the case incident reports were based on assessments by paramedics, emergency medical technicians, and park rangers and were rarely confirmed by more definitive assessment, testing, or follow-up. It was difficult to assess the difference between a fracture and a sprain in many cases. We relied upon the case incident report files because we did not collect identifying data and thus were unable to follow up with hospital records.

It is also notable that our incidence calculations are based on the total number of visitors to the parks. This number includes people who may not have participated in wilderness recreation. As a result, our incidence figures underestimate the true incidence of injuries among those actually actively participating in wilderness recreation.

Unfortunately, because of the lack of data on specific participation rates and therefore lack of denominators, we were unable to determine proportions of individuals participating in specific activities. Thus, we were not able to address specific questions about comparative risk regarding factors such as age, gender, activity, and so on. Although hiking was the leading cause of injury in our study, it does not necessarily follow that hiking is a dangerous activity. It is more likely a reflection of the high number of participants rather than the inherent risk of the activity.

The causes and risk factors in this study are regional because of the unique geography of the Pacific Northwest; therefore, these findings may not apply to other regions. National parks limit the type of activities that are allowed in the wilderness. Thus, there are few injuries with mountain bikes and off-road vehicles.

This study provides a description of wilderness recreational injuries in 2 northwest national parks and demonstrates some of the differences that exist between children and adults. This information may aid in the development of prevention projects targeted at decreasing wilderness injuries. In addition, this information can be used to guide training protocols for rangers and other personnel caring for those injured in wilderness areas. Future research should include studies that assess the total number of participants by activity. Ascertaining denominators would enable the comparison of risk by activity.

Conclusions

The most common type of injury occurring in these 2 northwest national parks was soft tissue injury, and in-

juries occurred most commonly while hiking, during daylight hours, and in the summer. Preinjury activities and types of injuries were different in children compared with adults. There were 19 total deaths over the 5-year study period, most involving men who suffered falls. Knowledge of how and when injuries occur in national parks may assist in resource allocation and prevention strategies.

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