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ORIGINAL RESEARCH

# National Estimates of Outdoor Recreational Injuries Treated in Emergency Departments, United States, 2004–2005

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**Objective.**—To provide national estimates of nonfatal outdoor recreational injuries treated in US emergency departments (EDs).

**Methods.**—Outdoor recreational injuries from January 2004 through December 2005 were identified using the National Electronic Injury Surveillance System–All Injury Program, a nationally representative sample of ED visits. National estimates of outdoor recreational injuries were calculated, and activities leading to injury, demographic characteristics, principal diagnoses, and primary body parts affected were described.

**Results.**—From January 2004 through December 2005, an estimated 212 708 (95% CI = 113 808–311 608) persons were treated each year in US EDs for outdoor recreational injuries. The annual rate of injuries was 72.1 per 100 000 population (95% CI = 38.6–105.6). Males accounted for 68.2% of the injuries. The lower limb (27%), upper limb (25%), and head and neck region (23.3%) were the most commonly injured body regions. Fractures (27.4%) and sprains or strains (23.9%) were the most common diagnoses. Traumatic brain injuries were diagnosed in 6.5% of injuries, and 5% of injuries resulted in hospitalization or transfer to another hospital.

**Conclusions.**—The results of this study provide a starting point for further research into the epidemiology of outdoor and wilderness injury. The results reinforce many common perceptions about the nature of these injuries while highlighting the potential severity and long-term consequences of the injuries. The general recommendations of proper planning, preparation, and problem anticipation for outdoor and wilderness injury prevention should be followed to reduce both the number and severity of injuries.

*Key words:* outdoor, recreation, injury, prevention, wilderness

## Introduction

Outdoor pursuits form a large and continually growing segment of recreation in the United States. According to the Outdoor Industry Foundation, 86.5% of Americans between the ages of 16 and 24 years of age participated in outdoor activities in 2005.[1] The National Survey on Recreation and Environment estimates that 69.7 million people hiked and 22.2 million people backpacked between 1999 and 2003 in the United States.[2] The National Sporting Goods Association estimates that the number of people backpacking or wilderness camping increased from 10.2 million in 1994 to 13.3 million in 2004, a 30.4% increase. (The National Sporting Goods Association estimates the number of people greater than 7 years of age who participate in a sports activity more than once during the year surveyed.) During the same time, the number of people hiking increased from 25 million to 29.8 million, a 19.2% increase.[3] Participants in other outdoor recreation activities, such as kayaking, rafting, mountain biking, and snowboarding, also increased from 1994 to 2004.[3]

Current studies of activities associated with outdoor

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recreational injuries focus on individual pursuits (such as hiking,[4] mountain biking,[5] kayaking and rafting,[6] skiing, snowboarding and sledding,[7] and rock climbing[8]), select populations (such as the National Outdoor Leadership School[9] and Outward Bound[10] populations), or particular locations (such as New Hampshire wilderness areas,[11] 8 California National Parks,[12] and Mount Rainier and Olympic National Parks[13]). Additional studies focus on emergency response in wilderness settings.[14] To date, a surveillance system that tracks the nationwide incidence of wilderness-related morbidity and mortality does not exist.[15] The purpose of this study was to develop national estimates of outdoor recreational injuries and to describe their occurrence based on selected demographic characteristics. More specifically, we included injuries that occurred as a result of participation in activities that involve interaction with the natural environment. This study is the first one known to present national estimates of outdoor recreational injuries.

## Methods

The National Electronic Injury Surveillance System (NEISS) is an emergency department (ED) surveillance system used to monitor product-related injuries in the United States. The system, maintained and operated by the US Consumer Product Safety Commission (CPSC), consists of 100 hospital EDs that represent a stratified probability sample of all US and US-territory hospitals that have at least 6 beds and provide 24-hour emergency services.

The NEISS–All Injury Program (NEISS-AIP) is a subsample of NEISS consisting of 63 hospital EDs (Figure 1). NEISS-AIP tracks all injuries treated in each of the 63 represented EDs regardless of cause or whether or not injuries were associated with consumer products; as such, NEISS-AIP is a source of nationally representative data on injuries. NEISS abstractors review ED records to identify cases that are injury related. Abstractors will only include cases in which the principal diagnosis is an injury. NEISS-AIP provides data on approximately 500 000 ED-reported injuries annually; the data collected include age, gender, day and month of treatment, consumer products or activity involved, primary body part injured, principal diagnosis, location of injury, disposition at ED discharge, and a 2-line narrative describing the injuries and associated circumstances. NEISS-AIP is a collaborative effort of the Centers for Disease Control and Prevention's National Center for Injury Prevention and Control and the CPSC.[16] For this project, NEISS-AIP data from January 1, 2004, to December 31, 2005, were analyzed to estimate the number and rate of outdoor recreational injuries in the United States.

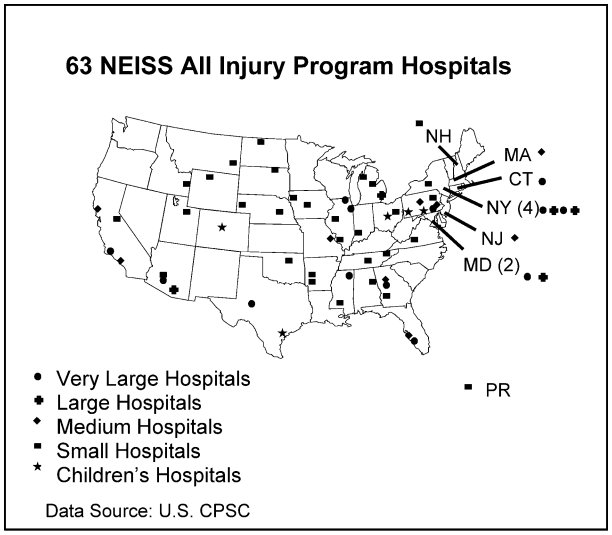


**Figure 1.** Distribution of National Electronic Injury Surveillance System–All Injury Program (NEISS-AIP) hospitals. Note: Hospital size based on number of emergency department (ED) visits per year: small, 1 to 16 830 visits; medium, 16 831 to 28 150 visits; large, 28 151 to 41 130 visits; very large, 41 131+ visits; children's hospitals, various. Abbreviations: NH indicates New Hampshire; MA, Massachusetts; CT, Connecticut; NY, New York; NJ, New Jersey; MD, Maryland; PR, Puerto Rico; and CPSC, Consumer Product Safety Commission.

Each case in this study was assigned a sample weight based on the inverse probability of the hospital being selected. Ninety-five percent CIs were calculated using a direct variance estimation procedure that accounted for the sample weights and the complex sample design.[16] Rates were calculated using US Census Bureau bridged-race population estimates for 2004 to 2005.[17]

NEISS-AIP defines a sports or recreational injury as one that occurs during organized or unorganized activity, whether or not the injury is work or product related. Injury is defined as bodily harm resulting from exposure to an external substance. The diagnosis of traumatic brain injury (TBI) is derived by including all cases with the body part of head and a diagnosis of concussion or internal injury. NEISS has a classification system for sport/recreation injuries that groups each case into 1 of 39 mutually exclusive sport/recreation categories based on an algorithm that includes the consumer product or activity involved and information from a 2-line narrative description of the event (the narrative provides an opportunity to document more specific information about each injury and is part of the surveillance system).[18] Since estimates of all-terrain vehicle injuries have already been reported using NEISS-AIP data, we did not include those injuries in the current study.[19] NEISS-AIP

**Table 1.** Categories of outdoor recreational injury

| |
|---|
| Boats |
| Bobsleds |
| Camping equipment |
| Climbing, mountain |
| Exercise (hiking) |
| Fishing |
| Horseback riding |
| Ice/snow boating |
| Jet skis |
| Mountain bikes |
| Scuba diving |
| Sleds |
| Skydiving/hang gliding |
| Snow disks |
| Snow skiing |
| Snowmobiles |
| Snowboarding |
| Surfing |
| Swimming |
| Toboggans |
| Water skis |

**Table 2.** Narrative key words

| | | |
|---|---|---|
| Altitude | Hiking | Poison plants |
| Back country | Hot air balloon | Raft |
| Backcountry | Hunt | Rafting |
| Back pack | Hunting | River |
| Backpack | Hyper therm | Rock |
| Bird watching | Hypertherm | Snake bite |
| Camp | Hypo therm | State park |
| Dehydrate | Hypotherm | Stream |
| Dehydration | Kayak | Tent |
| Excess cold | Kayaking | Too cold |
| Excess heat | Lake | Too hot |
| Exposure | Lightning | Toxic plants |
| Field | Mountain | Trail |
| Forest | National park | Wilderness |
| Hang glide | Parachute | Wilderness area |
| Hike | Path | Woods |

excludes cases if the primary diagnosis was illness. Cases in which the patient reports having pain only, psychological harm only, contact dermatitis, or adverse effect from surgery or therapeutic drugs or cases in which the patient was dead on arrival or died in the ED were also excluded.

This study defined an outdoor recreational injury case by adapting the NEISS-AIP definition of a sports or recreational injury. Cases were selected for injuries that occurred in natural or environmental settings and that were associated with 1 of 21 outdoor consumer products used or for activities participated in (if no consumer product was involved) during outdoor recreation in natural or environmental settings (Table 1). Two authors independently reviewed the 2-line narrative description for all cases initially selected to determine the exact activity and locale at the time of the incident. Any differences were discussed and resolved.

In addition to representing products, NEISS-AIP product codes were also used to code for activities. NEISS-AIP product codes do not specifically cover every product or activity possible, so some products and activities were grouped under a single code that accounts for many products or activities. For example, incidents associated with hiking, running, or jogging were all coded as ''exercise.'' Because of this lack of specificity, cases coded as exercise, boats, camping equipment, fishing, horseback riding, and swimming were included in this study only if their 2-line narratives contained at least 1 of the 48 keywords in Table 2. Similarly, the 2-line narratives for incident locales were reviewed because the NEISS-AIP definition of ''place of recreation or sports'' included bowling alleys, amusement parks, sports fields, lakes, mountains, beach resorts, parks, and recreation areas. Cases that were not associated with an outdoor recreational activity or in which the injury did not take place in an outdoor setting were excluded. Based on these criteria, 133 cases (2.3%) were excluded.

## Results

During the period ranging from 2004 to 2005, an estimated 212 708 (95% CI = 113 808–311 608) persons were treated annually in US EDs for injuries sustained while participating in outdoor recreational activities. The annual rate of outdoor recreational injuries was 72.1 per 100 000 population (95% CI = 38.6–105.6) (Table 3). The injury rate was 2.2 times higher in males (99.9 per 100 000 population, 95% CI = 53.4–146.3) than in females (45.1 per 100 000 population, 95% CI = 23.2–67.0). The injury rate was highest in the 15- to 19-year age group (214.0 per 100 000 population, 95% CI = 98.2–329.7) and lowest in the 45 years and older age group (25.3 per 100 000 population, 95% CI = 12.6–38.0).

Table 4 shows that the most common anatomical locations for outdoor recreational injuries were the extremities—lower limb (27%) and upper limb (25%)—followed by the head and neck region (23.3%). Fracture (27.4%) and strain or sprain (23.9%) were the most common primary diagnoses, and TBI, defined as a concussion or internal head injury, was diagnosed in 6.5% of injuries (Table 5). In 5% of all outdoor recreational in-

**Table 3.** National estimates of outdoor recreational injuries and rate per 100 000 population, by gender and age, United States, 2004–05

| | *No. of sample cases 2004–05* | *Estimated annual No.* | *%* | *Annual rate** | *95% CI* |
|---|---|---|---|---|---|
| Gender† | | | | | |
| Male | 3803 | 145 073 | 68.2 | 99.9 | 53.4–146.3 |
| Female | 1823 | 67 576 | 31.8 | 45.1 | 23.2–67.0 |
| Age, y | | | | | |
| 0–9 | 482 | 12 693 | 6.0 | 31.9 | 17.1–46.7 |
| 10–14 | 1220 | 39 284 | 18.5 | 187.1 | 84.3–289.9 |
| 15–19 | 1178 | 44 677 | 21.0 | 214.0 | 98.2–329.7 |
| 20–24 | 604 | 25 442 | 12.0 | 121.1 | 72.9–169.3 |
| 25–34 | 838 | 35 935 | 16.9 | 89.7 | 42.2–137.1 |
| 35–44 | 634 | 27 270 | 12.8 | 62.0 | 31.5–92.5 |
| 45+ | 671 | 27 406 | 12.9 | 25.3 | 12.6–38.0 |
| Total | 5627 | 212 708 | 100.0 | 72.1 | 38.6–105.6 |

*Annual rate is cases per 100 000 population.
†Data on gender missing for 1 case.

jury cases, hospitalization or transfer to another facility for treatment was indicated.

Figure 2 depicts the distribution of the primary causes of nonfatal outdoor recreational injuries. The leading causes were falls (48%), being struck by or against an object (18%), and overexertion (10%). Snowboarding (25.5%), sledding (10.8%), and hiking (6.3%) were the leading activities associated with outdoor recreational injuries (Table 6).

## Discussion

In this study, males accounted for a higher percentage (68.2%) and a higher rate of injury than females, per population. These injury rates do not take higher rates of participation in outdoor recreation among males into consideration.[1,20] Many studies of outdoor recreational activities confirm these results,[11–13] but, similarly, they do not report data based on the number of actual participants. Thus, these rates do not represent risk of injury based on actual exposure to certain products or activities.

Gentile and colleagues[9] accounted for exposure (in person-days) at the National Outdoor Leadership School. They found that male and female injury rates did not differ significantly among instructors whom they assumed to be equally skilled and conditioned. Among students, however, they found that females were at greater risk of injury than males based on exposure in person-days. Researchers postulated that male students were better conditioned and more motivated to continue de-

**Table 4.** National estimates of outdoor recreational injuries and rate per 100 000 population by primary body part injured, United States, 2004–05

| | *No. of sample cases 2004–05* | *Estimated annual No.* | *%* | *Annual rate** | *95% CI* |
|---|---|---|---|---|---|
| Head/neck | 1310 | 49 501 | 23.3 | 16.8 | 7.4–26.1 |
| Upper trunk | 900 | 35 340 | 16.6 | 12 | 5.7–18.3 |
| Lower trunk | 420 | 16 203 | 7.6 | 5.5 | 3.1–7.9 |
| Upper limb | 1449 | 53 080 | 25 | 18 | 9.4–26.6 |
| Lower limb | 1520 | 57 367 | 27 | 19.4 | 10.8–28.1 |
| Other† | 28 | 1216* | 0.4* | . . . | . . . |

*Rate not presented when the estimates might be unstable because the coefficient of variation is >30% or the number of nonfatal injuries is <1200.
†Includes unknown and all body parts.

**Table 5.** National estimates of outdoor recreational injuries and rate per 100 000 population by primary diagnosis, United States, 2004–05

| | *No. of sample cases 2004–05* | *Estimated annual No.* | *%* | *Annual rate** | *95% CI* |
|---|---|---|---|---|---|
| Contusion/abrasion | 891 | 33 847 | 15.9 | 11.5 | 6.8–16.2 |
| Dislocation | 201 | 8157* | 3.81 | . . . | . . . |
| Fracture | 1623 | 58 332 | 27.4 | 19.8 | 8.3–31.3 |
| Laceration | 707 | 31 422* | 14.81 | . . . | . . . |
| Strain/sprain | 1332 | 50 934 | 23.9 | 17.3 | 9.4–25.1 |
| TBI† | 467 | 13 785* | 6.5* | . . . | . . . |
| Other‡ | 406 | 16 231 | 7.6 | 5.5 | 3.7–7.3 |

*Rate not presented when the estimates might be unstable because the coefficient of variation is >30% or the number of nonfatal injuries is <1200. Coefficient of variations: dislocation (36%), laceration (35%), and traumatic brain injury (TBI) (33%).

†TBI (Traumatic Brain Injury) includes concussion or internal injury to the head.

‡Includes amputation, avulsion, burn—not specified, burn—thermal, conjunctivitis, crushing, dental injury, dermatitis, foreign body, hematoma, hemorrhage, internal injury—excluding head, nerve damage, poisoning, puncture, dilation, submersion, and other.

spite injury than were female students. They also proposed that instructors may have stopped injured female students more often than injured male students from participating in activities, resulting in more reports of injury to females. Based on these limited findings, we cannot conclude that one gender is at greater risk for injury than the other when participating in outdoor recreational activities.

The 10- to 19-year and 20- to 29-year age groups accounted for the greatest percentage of injuries in this study. The mean age for injuries has differed among various studies of outdoor recreational injuries, depending on the activity or locale reported. Gentile and colleagues[9] found results similar to those of this study in the National Outdoor Leadership School population, and Montalvo and colleagues[12] found that most injuries in California National Parks occurred in 20- to 30-year olds. Studies of New Hampshire wilderness areas and Washington State National Parks showed mean ages of injury of 35.6 and 34 years, respectively.[11,13] The mean age for mountain biking,[5] sledding, and snowboarding[7] injuries was under 30 years of age, while hiking,[4] snow skiing,[7] whitewater canoeing, and kayaking[6] injuries had a mean age of greater than 30 years. These results indicate that young males aged 10 to 35 years account for the greatest number of outdoor recreational injuries. These results likely reflect this group's high rate of participation in these activities.

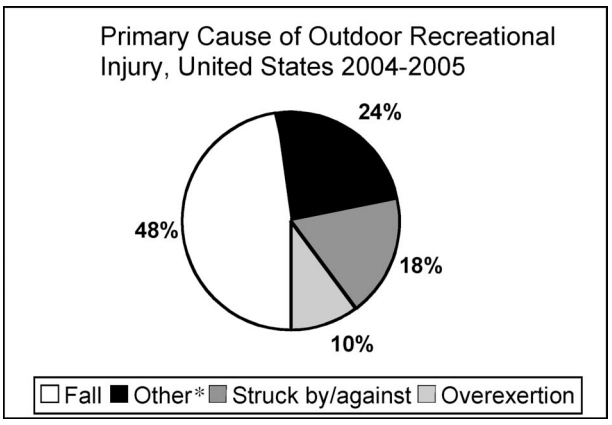


**Figure 2.** *Other includes pedal cyclist (3.5%), cut/pierce (2.6%), nature/environment (0.4%), drowning/near-drowning (0.1%), motor vehicle occupant (0.03%), pedestrian (0.1%), other transport (7.7%), fire/burn (0.1%), poisoning (0.02%), foreign body (0.1%), dog bite (0.1%), other bite/sting (0.5%), other specified (0.8%), and unspecified and unknown (7.8%).

The lower limb, upper limb, and head and neck region were the most commonly affected body regions. Though these findings may not be surprising, they do highlight the importance of prevention when considering the potential consequences of these injuries. Severe injuries to the lower limbs, such as fractures, have been shown to lead to extended recovery periods and extended loss of time at work.[21]

Head injuries, even when considered to be mild, have been shown to cause TBIs with potential short- and/or long-term sequelae.[22] Head injuries accounted for 10.7% of all outdoor recreational injuries (national annual estimate = 22 740), and 13 785 of those head injuries were TBIs, identified by a diagnosis of concussion or internal head injury. Thus, 60.6% of all outdoor recreational head injuries and 6.5% of all outdoor recreational injuries reported in this study were diagnosed as TBI. Current studies have reported a greater than 5% incidence of head injuries (ranging as high as 50%) depending on the activity or locale.[5,7,9,12,13] These results indicate that

**Table 6.** National estimates of outdoor recreational injuries and rate per 100 000 population by activity at the time of injury, United States, 2004–05

| *Activity* | *No. of sample cases 2004–05* | *Estimated annual No.* | *%* | *Rate** | *95% CI* |
|---|---|---|---|---|---|
| Boats | 46 | 1597 | 0.8 | 0.5 | 0.3–0.7 |
| Camping equipment | 42 | 1529 | 0.7 | 0.5 | 0.3–0.7 |
| Fishing | 156 | 7061 | 3.3 | 2.4 | 1.4–3.4 |
| Hiking† | 383 | 13 448 | 6.3 | 4.6 | 2.0–7.2 |
| Mountain biking | 216 | 7656 | 3.6 | 2.6 | 1.2–4.0 |
| Personal watercraft | 234 | 7734 | 3.7 | 2.6 | 1.5–3.8 |
| Sledding‡ | 746 | 22 780 | 10.8 | 7.7 | 4.2–11.3 |
| Snowboarding | 1457 | 53 996 | 25.5 | 18.3 | 7.8–28.8 |
| Swimming | 99 | 4438 | 2.1 | 1.5 | 0.8–2.2 |
| Water ski/tubing | 206 | 7560 | 3.6 | 2.6 | 1.6–3.5 |
| Other§ | 2024 | 84 074* | 39.7* | . . . | . . . |

*Rate not presented when the estimates might be unstable because the coefficient of variation is >30% or the number of nonfatal injuries is <1200.

†Product code for exercise; defined as hiking based on the 2-line narrative.

‡Includes sleds, toboggans, snow disks, and snow tubing.

§Includes horseback riding (1.2%), ice/snow boating (0.1%), mountain climbing (4.9%), scuba diving (0.9%), snowmobiles (9.6%), snow skiing (61.0%), surfing (21.1%), and other (1.1%).

participants in outdoor recreational activities should make an extra effort to reduce the risk of sustaining a head injury. A study by the US CPSC showed that wearing a helmet while skiing and snowboarding could decrease head injuries by 44%.[23] The CPSC recommends specific helmet types for a number of activities, including downhill mountain biking, rock climbing, snowmobiling, and sledding.[24]

Fractures and sprains or strains were the most common injuries, while falls and being struck by or against an object were the most common causes of injury. These less-dramatic yet high-frequency occurrences do not stimulate media interest and therefore lead to a diminished public awareness. The resulting misperception can lead to an underestimation of risk.[25] However, with an increase in awareness of the most common injuries and an appreciation for how frequently they occur, we can reduce optimism bias—the belief that ''nothing is going to happen''—and the misperceptions that lead to overconfidence or misjudging an activity's level of risk.[25]

National estimates and injury rates in this study varied largely by activity. National estimates could not be reported for some activities that depended on geographic location, despite a large number of injuries, because NEISS-AIP is based on a national sampling strategy. For example, unweighted frequencies for persons with snow skiing– and with surfing-related injuries represented approximately 22% and 8% of all study cases, respectively. However, because these injuries were concentrated in a few hospitals, the coefficient of variance was too high (greater than 30%) to provide reliable national estimates. On the other hand, treatment for snowboarding injuries was limited to many of the same hospitals as snow skiing injuries, but snowboarding injuries were more evenly distributed among those hospitals, allowing the study to report national estimates and injury rates. Furthermore, some states with large areas for outdoor activities, such as Washington and Maine, have no representation in the NEISS-AIP database or have hospitals represented that are far from outdoor recreations areas (eg, Texas, Arizona).

This study's results are subject to further limitations based on the database from which they were drawn. For example, injury rates were based on the US population and not on the number of outdoor recreation participants because population-based data on exposure time were not available. In addition, case identification depended on reviewing narrative comments, which may have been incomplete and could have resulted in underreporting outdoor recreational activities. Another important limitation is that the report included only nonfatal injuries treated in hospital EDs and did not include injuries treated elsewhere or not at all. Also, illnesses, such as diarrhea, acute mountain sickness, and cardiac arrest, have been shown to cause considerable morbidity and mortality in outdoor settings but were not included in the study.[9,11,12] Finally, NEISS-AIP provides only national estimates and cannot be used to obtain state-level estimates.

Despite these limitations, this study's results have im-

portant implications for the growing field of wilderness medicine, for which wilderness injury prevention is central to the mission of minimizing the risks of wilderness environments.[15] The definition of a wilderness injury has 3 aspects: locale, activity, and the injury itself.[26] Although in this study we could not determine if an injury had occurred in a true wilderness setting—1 to 2 hours from hospital-based care—the study did select cases that occurred in an outdoor, natural, or environmental setting. It also selected activities commonly considered to be outdoor recreation and identified specific injuries.[1,2,15] Although the study calls these injuries ''outdoor recreational injuries'' instead of ''wilderness injuries,'' many cases described here are subject to the same risks and complications as ''true'' wilderness injuries.

The results of this study provide a starting place for further research into the epidemiology of outdoor and wilderness injury. The results reinforce many common perceptions about the nature of these injuries while highlighting the potential severity and long-term consequences of these injuries. The 3 principles of wilderness injury prevention—planning, preparation, and problem anticipation—should be followed to reduce both the number and severity of injuries.[15] Primary injury prevention strategies include maintaining fitness levels in anticipation of the added stress of outdoor activities, knowing one's skill and experience and not exceeding these limits, and maintaining and using proper equipment. Carrying a wilderness first-aid kit and a 2-way communication device and alerting others about one's activity plans are secondary prevention strategies to prevent a non–life threatening injury from evolving into a more serious condition.[15]

Outdoor recreational surveillance can provide the up-to-date information on outdoor recreational injuries that core groups involved in these activities need in order to continue to establish recommendations for good practice. Most outdoor recreational activities are not regulated; instead, education and social pressure from core groups motivate participants to adhere to accepted good practices.[25] Following these recommendations can result in fewer and less-severe injuries and can decrease dependence on the already-strained resources for wilderness emergency services.[13]

This study is the first one known to provide national estimates of outdoor recreational injuries. Despite the limitations, NEISS-AIP is an important injury surveillance system for this purpose. Further study of NEISS-AIP is needed to better assess its adaptability and to more specifically capture outdoor recreational injuries. NEISS-AIP could be improved by adding a specific wilderness locale variable, which would allow researchers to more easily separate outdoor recreational injuries from recreational injuries that happen to take place outside, such as injuries occurring in baseball or football. Moreover, adding specific product codes to differentiate among certain activities, such as boating vs kayaking vs rafting or running vs hiking vs backpacking, would increase the surveillance system's specificity for activities associated with outdoor recreational injuries. These measures would ensure good surveillance of injury incidence in the population who participate in outdoor recreational activities. This information is necessary to guide future outdoor recreational access, education, and health care planning.[15,27]

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