

Injuries in Commercial Whitewater Rafting

Steven A. Whisman, PhD, and Steven J. Hollenhorst, PhD

Division of Forestry, West Virginia University, Morgantown, West Virginia

Objective: To describe injuries sustained by participants in commercial whitewater rafting.

Design: Analysis of injury reports submitted by commercial outfitters to the West Virginia Division of Natural Resources.

Participants: Customers of commercial rafting outfitters who sustained injuries in the 1995-1997 whitewater seasons on the New, Gauley, Cheat, and Shenandoah Rivers and for whom injury reports were submitted as required by the West Virginia Legislative Rules.

Results: A total of 200 rafting injuries were reported from 1995 through 1997, with a resulting overall injury incidence rate of 0.263 per 1,000 rafters. Incidence rates ranged from 0.145 per 1,000 on the Shenandoah to 0.381 per 1,000 on the Gauley River. The average age of injured persons was 33.14 years, 53.3% were male, and 59.8% had previous rafting experience. The body part most frequently injured was the face (33.3%), including the eye (12.1%), mouth (6.6%), other facial parts (5.1%), nose (4.5%), and teeth (4.0%), followed by the knee (15.3%), arm/wrist/hand (11.6%), other parts of the leg, hip, or foot (10.5%), ankle (7.4%), torso (6.8%), shoulder (6.3%), and head/neck (5.3%). Predominant injury types included lacerations (32.5%), sprains/strains (23.2%), fractures (14.9%), contusions/bruises (9.8%), dislocations (8.2%), and two deaths. On-site administration of first aid included bandages (29%), ice (26.9%), splinting/immobilization (17.7%), antiseptic (11.3%), direct pressure (4.2%), elevation (2.1%), cardiopulmonary resuscitation (1%), and treatment for shock (0.4%). No first aid was administered for 4.6% of injuries.

Most injuries occurred in the raft (51.3%) as a result of collisions among passengers, being struck by a paddle or other equipment, or entanglement of extremities in parts of the raft; 40.3% of injuries occurred in the water after falling from the raft. Types of injuries were independent of where they occurred, but differences were found in injured body parts by location of occurrence. Injuries occurring in the raft more commonly were to the face, and injuries occurring in the water involved the extremities and face. Injuries requiring evacuation to an outfitter's base camp or to a medical facility occurred at a higher rate among persons without previous rafting experience. Gender differences were not found for types of reported injuries, but body part injured did vary by gender. Female boaters more frequently sustained facial injuries, whereas male boaters more frequently sustained injuries to the limbs and torso.

Conclusion: Overall injury rates were low, but verification limitations render a determination of unreported injuries difficult. Because most injuries occur in the raft while running rapids, involve injuries to the face, and result from contact among passengers or paddling equipment, preventive measures such as attaching face protection to paddling helmets, carrying fewer passengers per raft, or portaging dangerous rapids are suggested. More research is needed to verify injury rates and severity, and to document related medical costs.

Key Words: Adventure recreation—Injuries—Whitewater rafting.

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According to the Travel Industry Association of America, half of the adults in the United States, or 98 million people, have taken an adventure trip in the past 5 years.¹ This statistic includes 31 million who engaged in hard adventure activities such as scuba diving, mountain biking, and whitewater rafting. Following this national trend, whitewater rafting, kayaking, and canoeing in West Virginia are among the most rapidly growing adventure travel activities, especially in the commercial sector, as Americans seek out and participate in adventure sports. West Virginia's premier whitewater rivers attract approximately 250,000 people annually who participate in commercially guided raft trips.² More than half of these commercial boaters rafted the New River, a

river with Class II to V rapids according to the International Scale of River Difficulty (American Whitewater Affiliation; available at <http://www.awa.org/awa/safety/safety.html> [1995] or at http://www.awa.org/awa/river_project/West_Virginia/index.html [1998]). Nearly one third rafted the Gauley River, a Class III to V river that is among the most technically challenging whitewater rivers in North America. On each of these two rivers, commercial rafters may number as many as 5,000 per day.

Despite increasing participation in commercial whitewater rafting in West Virginia and other states, little is known about the rates and types of injuries that occur in the growing population of commercial boaters. The American Canoe Association (ACA) periodically publishes river safety reports that chronicle fatalities, near misses, and safety issues related to whitewater sports.³⁻⁶ However, these reports are largely anecdotal, compiled from paddling club newsletters, newspaper clippings,

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Address correspondence and reprint requests to Steven A. Whisman, PhD, Route 3, Box 458, Milton, WV 255541.

TABLE 1. Generalized whitewater classification of study rivers*

River	Classification	Range
Cheat	class II-IV	novice to advanced whitewater
Shenandoah	class II-III	novice to intermediate whitewater
New	class II-V	novice to expert whitewater
Gauley	class III-V	intermediate to expert whitewater

* American Whitewater Affiliation; available at http://www.awa.org/awa/river_project/West_Virginia/index.html(1998).

phone conversations, email communications, state accident summaries, and individual narratives of persons involved in the accidents. According to the most recent ACA river safety report,⁶ obtaining complete information on whitewater accidents is made difficult by privacy concerns associated with government records, the reluctance of commercial outfitters to disclose information because of the risk of litigation, and the emotional toll of recounting accident details on those who have lost a friend or family member on the river. Further, the accidents are presented in a more or less descriptive narrative format to illustrate what went wrong, with case-by-case analysis and interpretation for prevention purposes.

In 1994, commercial outfitters in West Virginia were required to report injuries sustained by their guests that occur during the performance of a licensee's [outfitter's] services while underway [on the river] that require medical treatment by a licensed healthcare provider, excluding diagnostic analysis (West Virginia Legislative Rule §47-27-11 [Accident Reports]). This generally has been

interpreted to mean injuries requiring a treatment procedure (e.g., setting a fracture, sutures, etc.) performed by a medical doctor, osteopath, registered nurse, or physician's assistant. Before adopting this definition of injuries, injury reporting was required of the commercial rafting industry in West Virginia, but what qualified as a reportable injury was poorly defined. Consequently, reports of rafting injuries before 1994 were considered unreliable.

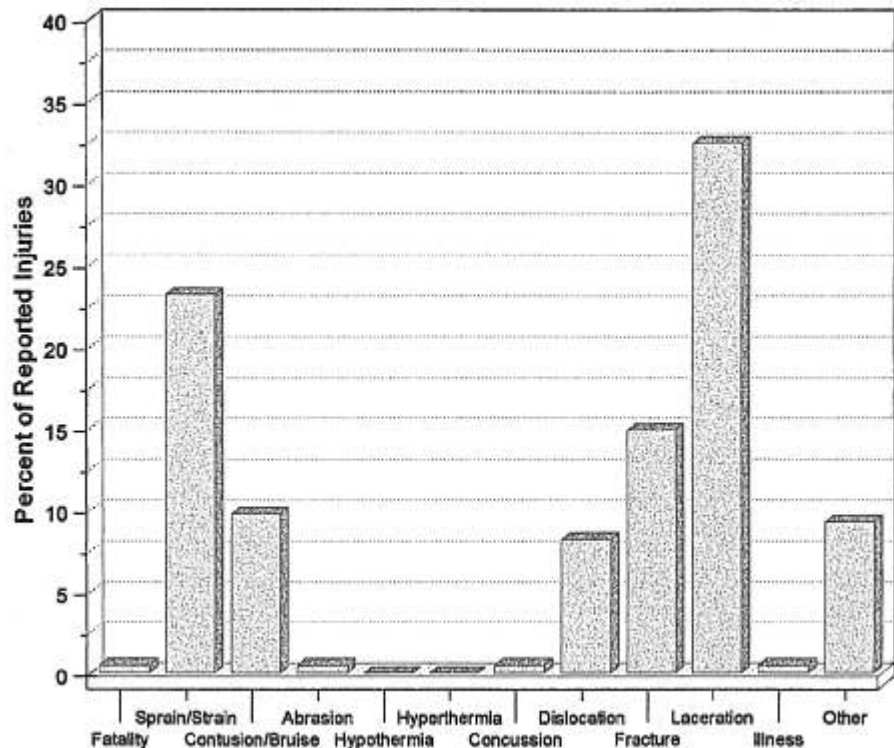
The information currently required to be reported is limited to the general nature of the injury and an account of the circumstances leading to the injury. Details of the medical diagnosis and specific treatments administered are not required and thus are unavailable.

PATIENTS AND METHODS

Injury reports submitted by commercial outfitters to the West Virginia Division of Natural Resources for the 1995 through 1997 whitewater seasons on the New, Gauley, Cheat, and Shenandoah Rivers were compiled into a computer database for summary and analysis. It was assumed that all injuries reported by outfitters were consistent with the State's definition of reportable injuries described above. Identifying information of injured persons was omitted from the data set to protect privacy concerns.

Data analysis in the form of descriptive statistics, frequency distributions, and cross-tabulations was performed using SAS statistical software (SAS Institute, Cary, NC). Significance of observed differences in inju-

FIG. 1. Percent of reported injuries in commercial whitewater rafting by type of injury.



ries by gender, previous experience, injured body part, location of occurrence, and river classification was tested by means of analysis of variance and the Pearson chi-square test.

RESULTS

Demographic Data

For the three rafting seasons for which data were analyzed, 200 commercial rafting injuries were reported. The average age of injured individuals was 33.14 years, with a majority (51.3%) between 20 and 39 years of age. The proportion of injured individuals younger than 20 years of age or 40 years of age and older were approximately even, at 22.1% and 26.6%, respectively. Most individuals (59.8%) sustaining injuries during the three seasons had previous rafting experience, meaning they had taken at least one commercial rafting trip before the trip on which they were injured. These individuals had taken an average of 2.6 previous rafting trips. A significantly greater proportion of injured male boaters ($p < 0.02$) had rafting experience than of injured female boaters. No significant differences were found among age groups for gender.

Only slight differences were observed in the demographic characteristics of injured individuals compared with the general population of commercial rafters. From a general survey of more than 1,800 commercial boaters on all study rivers in 1995 and a health profile survey on the Gauley River in 1993, average ages were 30.78 and 31.39 years, respectively.² The respective proportions of male boaters in the two surveys was slightly higher at

62.1% and 62.2%. Finally, in the 1995 survey, 56.1% of boaters had previous rafting experience.

Incidence Rates

Based on actual numbers of rafters on each river, injury incidence rates ranged from 0.145 per 1,000 commercial users on the Shenandoah River to 0.381 on the Gauley River, yielding an overall injury rate of 0.263 per 1,000 commercial rafters across the four rivers. The rivers range from novice to expert class whitewater (Table 1), and commercial use levels range from approximately 10,000 on the Cheat River to 160,000 on the New River per year. Analysis of variance showed significantly higher injury rates among rivers with higher class whitewater ($p < 0.0001$). No statistically significant differences in injury rate were found among rivers according to level of use.

On an annual basis, incidence rates showed no general increasing or decreasing trend during the 3-year period. In fact, a higher rate was observed in 1996, 0.35 per 1,000, than either 1995 or 1997 when 0.20 and 0.24 injuries per 1,000 rafters were observed, respectively. Higher precipitation and consequent river flows in 1996 may have contributed to this observation.

Injuries

Insufficient information was available with which to assess the severity of injuries sustained while participating in commercial whitewater rafting. However, it is suspected that most injuries were minor. Predominant injury types included lacerations (32.5%), sprains/strains (23.2%), fractures (14.9%), contusions/bruises (9.8%),

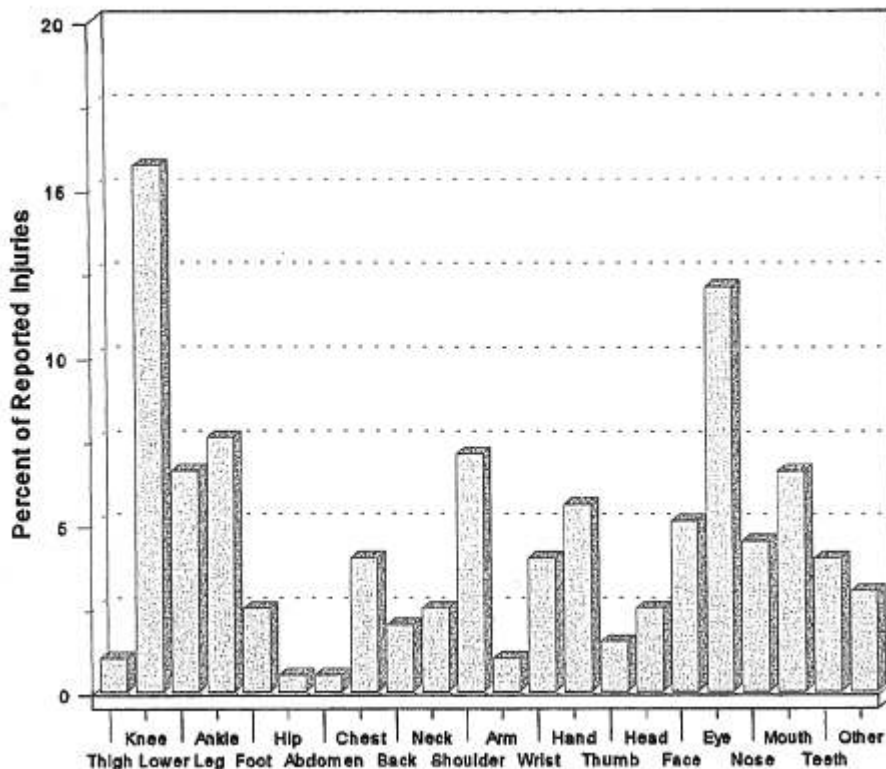
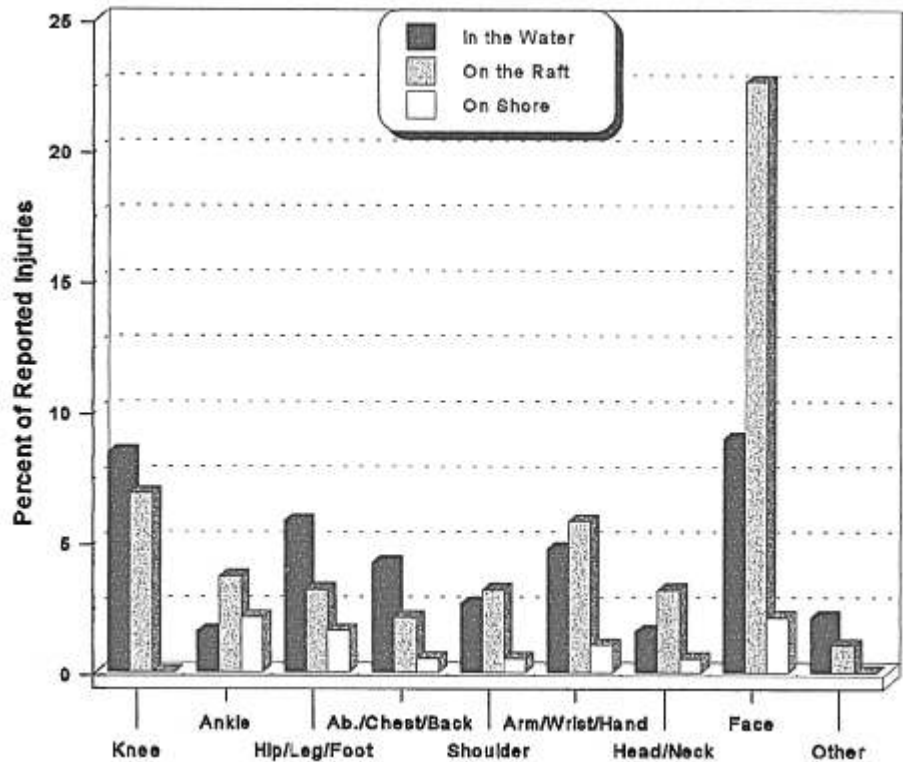


FIG. 2. Percent of reported injuries in commercial whitewater rafting by injured body part.

FIG. 3. Percent of injuries to various body parts during commercial whitewater rafting, by location of occurrence (i.e., in the water, on the raft, or on shore).



and dislocations (8.2%). The remaining 11.4% of injuries consisted of one abrasion, one concussion, one related to an unspecified illness, 18 other unspecified injuries, and two fatalities, which were attributed to drowning and a severe asthma episode, respectively (Fig. 1).

The most frequently injured part of the body was the face (33.3%), including the eye (12.1%), mouth (6.6%), other facial parts (5.1%), nose (4.5%), and teeth (4.0%). Other frequently injured body parts were the knee (15.3%), arm/wrist/hand (11.6%), other parts of the leg, hip, or foot (10.5%), ankle (7.4%), abdomen/chest/back (6.8%), shoulder (6.3%), and head/neck (5%) (Fig. 2). A relatively high proportion of injuries (40.2%) required evacuation either to an outfitter base camp or medical facility, or otherwise prevented the injured person from completing the raft trip.

On-site administration of first aid for injuries included application of bandages (29%), ice (26.9%), splinting/immobilization (17.7%), antiseptic (11.3%), direct pressure (4.2%), elevation (2.1%), cardiopulmonary resuscitation (CPR; 1%), and treatment for shock (0.4%). No first aid was administered for 4.6% of injuries.

Most injuries (51.3%) sustained by commercial boaters occurred in the raft. These injuries resulted from collisions between passengers in the raft, being struck by a paddle or other rafting equipment, or entanglement of extremities in parts of the raft. This was followed by injuries occurring in the water after falling from the raft while running rapids (40.3%). Passengers thrown from a raft are subject to the forces of high volume, turbulent water in which they may encounter boulder entrapments,

floating debris, or other hazards. The remaining 8.4% of injuries occurred on shore during lunch or rest stops.

Injury Associations

The large number of body part categories were collapsed to facilitate cross tabulation and tests for independence. Types of injuries were independent of the river on which they occurred, or whether they occurred in the raft, water, or on shore. However, significant differences ($p < 0.05$) were found in body parts injured by location of occurrence (Fig. 3). Injuries occurring in the raft more commonly were to the face, whereas injuries occurring in the water involved the extremities and face. Gender differences were not found for types of reported injuries; however, injured body parts did vary by gender ($p < 0.05$). Female boaters more frequently sustained facial injuries, whereas male boaters more frequently sustained injuries to the limbs (knee, arm/wrist/hand, shoulder) and torso (Fig. 4). A statistically significant association ($p < 0.001$) was found between types of injuries and injured body part. Generally, lacerations more commonly involved injuries to the face; sprains/strains occurred more often to the knee, ankle, and arm/wrist/hand; fractures more often involved the extremities, including the ankle, hip/leg/foot, and arm/wrist/hand; and dislocations more often involved the shoulder. Finally, injuries requiring evacuation to an outfitter's base camp or to a medical facility were more common among persons lacking previous rafting experience ($p < 0.001$). While accounting for approximately 44% of the rafting population and 40% of reported injuries, novices accounted for 60% of

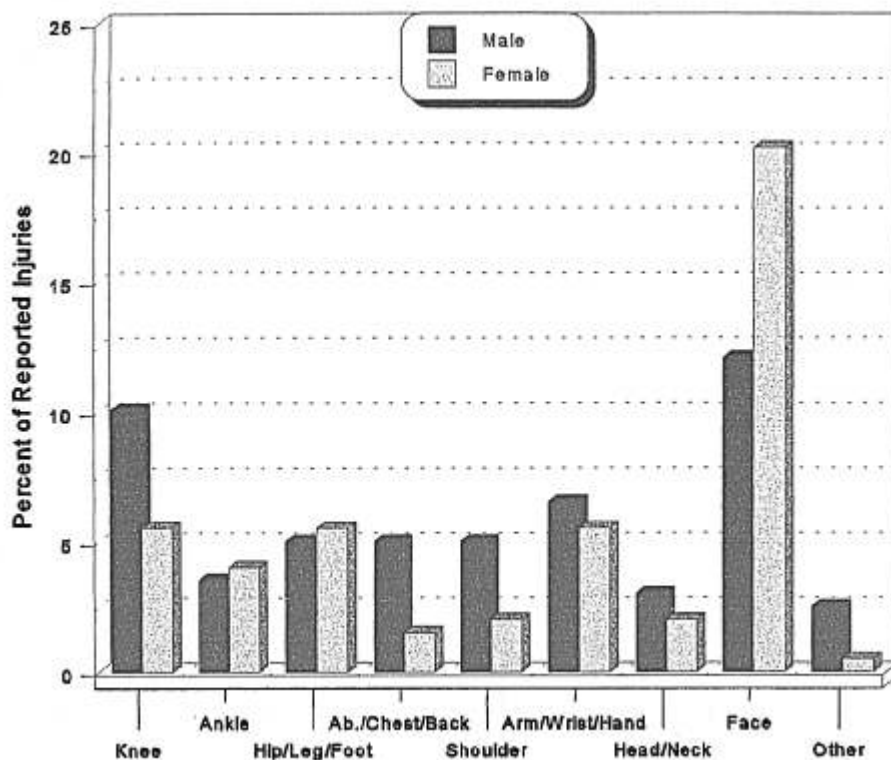


FIG. 4. Percent of injuries to various body parts during commercial whitewater rafting, by gender.

evacuations. Comparisons of injury type and injured body part relative to past rafting experience were not significant.

DISCUSSION

A review of medical and recreation literature discovered no published studies of commercial rafting injuries, consequently few sources were available with which to compare the findings of this study. The injury incidence rate of 0.263 per 1,000 appears consistent with that of unpublished data on the Arkansas River, a Colorado river similar in character of commercial rafting use to those in this study, where an injury rate of 0.234 per 1,000 was reported in 1997.⁷

However, these incidence rates are suspected to underestimate the true incidence of commercial rafting injuries. Studies of the incidence of commercial rafting injuries are complicated by factors similar to those seen in studies of cross-country skiing, in which incidence rates of 0.1 to 0.49 per 1,000 skiers have been reported.⁸⁻¹⁰ Direct observation of rafting injuries as they occur is made impractical by the low probability of being at the right place at the right time over the entire course of a river. The commercially rafted sections of the rivers evaluated for this study range from 4 to more than 50 miles in length. Further, most regulatory agencies that require injury reporting rely on self-reporting methodologies, whereby outfitters provide notification of injuries that meet certain reporting criteria. Consequently, accurate injury rates largely depend on the assiduity of

outfitters in meeting these reporting requirements, and regulatory agencies have few reliable ways of determining how many injuries go unreported. In addition, a variety of definitions may be used by different agencies to identify reportable river injuries, and these definitions may be differently interpreted among target populations.

Outfitters in West Virginia are required by law to provide personal flotation devices for their guests. Additionally, outfitters strongly recommend or require guests to wear paddling helmets, and recommend wet suits in cold water conditions. These preventive measures likely account for the low incidence of drowning fatalities, head injuries, and instances of hypothermia. Since 1984, at least 2 million people have participated in commercial rafting in West Virginia, but according to the West Virginia Division of Natural Resources only 11 deaths have occurred on commercial rafting trips during that time. Of these deaths, four were medically related and seven were caused by drowning, including those reported in this study (Mason M: West Virginia whitewater stays the course for 30 years, *Charleston Gazette*, August 2, 1998, p. 1C). Ten (5%) of the injuries reported herein were head/neck injuries. These were predominantly sprains or strains of the neck region, lacerations to the head, or were unspecified injuries.

Conversely, injuries to the face accounted for one third of the injuries reported in this study, of which a majority involved the region around the eye (12.1% of all injuries) and were lacerations. Further, a significant proportion of these injuries occurred in the raft as a result of contact among passengers or being struck by paddles or other

rafting equipment. It is not uncommon for as many as nine guests plus a guide to paddle advanced- to expert-level whitewater in 16-foot rafts. Preventive measures such as providing some form of eye and/or face protection as required or recommended safety equipment, reducing the number of passengers per raft, or requesting passengers to portage high-intensity dangerous rapids may significantly reduce the incidence of reportable rafting injuries.

However, although face guards or other protective equipment may reduce facial injuries, they may contribute to a higher rate of neck injuries or drowning as a result of entanglement with unseen obstacles such as rocks, trees, or other debris in the water. Further, fewer people per raft may reduce the incidence of facial injuries but might lead to an increased rate of raft pins and flips. These incidents contribute to passengers falling from the raft in dangerous whitewater. Finally, the consequence of requesting passengers to portage dangerous rapids is that it may detract from the nature of rafting as an adventure sport, and may subject them to greater exposure to slippery rocks, poison ivy, snakes, bees, or other hazards. Further study is needed to understand the benefits and costs of these preventive measures.

Sprains/strains, fractures, and dislocations accounted for 46.3% of reported injuries. As would be expected, these injury types most commonly involved the extremities, including the knee, ankle, arm/wrist/hand, and shoulder. This is similar to findings of previous research in other types of adventure activities. In alpine and back-country skiing, for example, sprains, fractures, and dislocations are among the most common injuries, and frequently involve the extremities (available at weber.u.washington.edu/~mtuggy/sfm/teleg1.html).¹¹

The observed gender differences in injury patterns may be attributed to several factors. First, women tend to request positions in the middle or rear of the raft, assuming these positions to be less hazardous (Proctor J: personal communication). Depending on water levels and intensity of rapids, passengers in the middle or rear positions of rafts tend to fall out as frequently as guests riding in the front. However, passengers seated in the front tend to be thrown backwards into those in the middle or rear of the raft. As a result, middle and rear raft passengers may be more susceptible to facial injuries. Second, male boaters also show a propensity for more adventurous river trips than their female counterparts (Proctor J: Personal communication). Male boaters tend to choose more difficult whitewater, select times of higher river flows, be less cautious and more active in their participation, and fall into the water more frequently (Proctor J: Personal communication). Combined, these factors may account for the higher rates of injuries to the extremities and torso observed among male boaters.

Finally, the significantly higher rate of evacuations among novices is difficult to account for, but may reflect a lack of knowledge, skill, or understanding of what to expect by continuing the river trip. Uncertainty about the severity one's own injury and one's ability to continue the trip with the injury may contribute to a greater propensity among novices to request evacuation. The fact that injury type and injured body part were independent of past experience supports this explanation.

Injury incidence rates were low among the population of commercial rafting participants, but verification limitations make it difficult to determine how many rafting injuries go unreported. Future research should focus on methodologies for verifying or improving the accuracy of injury rate estimates. Because most injuries occur in the raft while running rapids, involve injuries to the face, and result from contact among passengers or with paddling equipment, preventive measures such as providing face and eye protection as additional safety equipment are recommended. As well, carrying fewer people per raft or portaging dangerous rapids may reduce the incidence of injurious contact among passengers. However, these preventive measures may have consequences of equal or greater severity, and therefore warrant further examination. Finally, little is known about the severity, medical diagnoses, administered treatments, and associated costs of injuries sustained during commercial rafting trips. Future studies of these issues will facilitate a more complete understanding of rafting injuries and the risks of whitewater sports.

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