BRIEF REPORT

Epidemiology of Ice Climbing Injuries Among Recreational Ice Climbers at the 2019 Ouray Ice Climbing Festival

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Introduction—As a close relative to the sports of mountaineering and rock climbing, water ice climbing has been traditionally considered “high risk.” There is little data to support or refute this assertion. Prior estimates of the injury rate range from 4.8 to 248 injuries per 1000 participation hours. In this study, we characterized the types of injuries and determined an injury incidence among water ice climbing participants at the 2019 Ouray Ice Festival climbing manmade ice walls.

Methods—A survey was distributed during the 2019 Ouray Ice Festival in Ouray, Colorado. Respondents were asked to include festival-related injuries and estimate their participation time at the 4-d festival. Individuals who reported an injury were asked to provide additional details with regard to injury type, location, and timing. The injury incidence rate was calculated as the total number of injuries reported divided by the total number of participation hours and is reported as injuries per 1000 participation hours.

Results—A total of 75 surveys were analyzed. A total of 16 injuries, all which were minor, and 912 participation hours were reported, resulting in an injury incidence of 17.6 injuries per 1000 participation hours.

Conclusions—This study reports an injury incidence based on an unselected sample of water ice climbers at an ice climbing festival. Water ice climbing at festivals appears to result in injuries of minor severity with no major accidents or fatalities. This study could be repeated to confirm its validity with a larger sample size.

Keywords: mountaineering, athletic injuries, event medicine, sport festival, ice park

Introduction

Water ice (WI) climbing consists of ascending vertical or overhanging ice formations such as a frozen waterfall or an ice wall using ice tools and crampons (Figure 1).¹ Once limited to elite athletes and mountaineers, the sport is rapidly becoming more accessible to the public. There are now 16 annual ice climbing festivals held in North America that allow enthusiasts to easily obtain the equipment needed to trial the sport. The Ouray Ice

Festival, now in its 26th year, is one of these festivals and is held at the Ouray Ice Park in Ouray, Colorado. The Ouray Ice Park is a manmade ice climbing venue created in the Uncompahgre Gorge (Figure 2). Using an intricate plumbing system, water is sprayed down the walls of the gorge nightly to form the ice necessary for climbing. The Ouray Ice Festival is the largest in North America and hosts approximately 2000 ice climbers of all experience levels.

WI climbing has been traditionally considered “high risk.” However, there is little data to support or refute this assertion. Prior studies of ice climbers have reached no consensus on participant safety, with injury rates ranging from 4.8 to 248 injuries per 1000 participation hours.^{1–3} For comparison, the injury rates of various activities

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Figure 1. Ice formation.

among Finnish adults was found to range from 0.3 per 1000 participation hours for golf to 18.3 per 1000 participation hours for squash.⁴ A prospective study of indoor rock climbers found an injury rate of 0.02 per 1000 participation hours,⁵ and a post hoc analysis of

Figure 2. View of Uncompahgre Gorge from bridge.

data from traditional rock climbers in Yosemite yielded an injury rate of 37.5 per 1000 participation hours.⁶

The lowest ice climbing injury rate (4.8 per 1000 participation hours) is from a retrospective study of predominantly advanced climbers, 20% of whom were competition athletes.¹ Climbers reported injuries and climbing time over the past 3 y in a single survey, introducing significant recall bias and possibility for underreporting of injuries. A single-season, prospective survey of intermediate to advanced climbers found an injury rate of 9.8 injuries per 1000 participation hours.³ Both studies used selected sampling methods in which the authors recruited participants via personal communication with known contacts. The highest injury rate reported is from a study of non-Olympian visitors to the 2014 Sochi Winter Olympics (248 injuries per 1000 participation hours).² This estimate is based on recreational speed ice climbing on the competition climbing wall by visiting spectators. No prior ice climbing experience was required to participate, and no data on the skill level of participants were collected. The authors enrolled all climbers as part of the waiver process. However, this estimate cannot be generalized to WI climbing because participants were limited to 2 min of climbing on a speed climbing wall.

In this study, we characterize the types of injuries and report an injury incidence among WI climbing participants at the 2019 Ouray Ice Festival.

Methods

This study was reviewed and approved by the institutional review board of the University of California San Francisco Fresno medical education program.

SURVEY

A survey was designed using terminology and methods in accordance with Union Internationale des Associations d'Alpinisme (UIAA) Medical Commission recommendations.⁶ Respondents were asked to report ice climbing–related injuries and estimate their participation time (number of climbing days and average hours of climbing per climbing day) at the 4-d festival. The UIAA Medical Commission recommends that injuries and illnesses that occur during belaying, rappelling, approach to climbing, or descent from climbing be reported for epidemiologic analysis of climbing sports and that time spent on these “non-climbing” activities be included in incidence calculations.⁷ As such, we specifically asked participants to report all injuries occurring during these activities. In the event that respondents did not provide an estimated average of hours of climbing per day, 6 h per

climbing day was used based on UIAA Medical Commission recommendations.⁷ Individuals reporting an injury were asked to provide additional details with regard to injury type, location, and timing.

Demographics on the survey included prior ice climbing experience. Participants self-assessed their ice climbing experience by selecting the highest WI grade they could climb consistently. The difficulty of a WI climb is dependent on length, vertical overhang, and ice quality; the difficulty scale ranges from WI 1 to WI 7.⁸ To align with prior literature, climbers were characterized as beginner (WI 1), intermediate (WI 2–WI 4), or advanced ($\geq$ WI 5).³

SURVEY DISTRIBUTION

The 2019 Ouray Ice Festival was held between January 23 and January 26, 2019, in Ouray, Colorado. Paper surveys were distributed by volunteers from the University of Colorado wilderness medicine section and Event Medical Specialists who were staffing the medical tent. Volunteers were present 8 h per day during 3 d of the festival. Multiple volunteers were available, with teams stationed at the medical tent and patrolling the park. Reasons for visiting the medical tent aside from medical care included asking questions about the medical team's role at the festival and available medical courses.

DATA MANAGEMENT AND ANALYSIS

All data were imported into Google Sheets (Google LLC, Mountain View, CA) for analysis. Responses were excluded if the respondent reported an age <18 y or reported not climbing during the festival. Only injuries reported to have occurred during climbing, belaying, rappelling, approach to climbing, or descent from climbing were included in calculations.

The injury incidence rate was calculated as the total number of injuries reported divided by the total number of participation hours and is reported as injuries per 1000 participation hours. When categorical responses or ranges of numerical responses were given instead of a single number, the following methods were used to standardize answers to a numerical format for data analysis: 1) If participants wrote “all” when asked how many days they climbed during the festival, we inputted the median number of days climbed in the remainder of our data, which was 2 d; 2) if participants failed to give an answer or wrote “all day” when asked how many hours climbed per day, we inputted the UIAA recommended estimate of 6 h per day; 3) if participants wrote a number range when asked how many hours climbed per day, we inputted the average of the given range as the value (eg, 3–4 became 3.5); and 4) if participants wrote an answer in the

“X+ hours” format when asked how many hours climbed per day, we inputted the number provided (eg, 8+ became 8). Medical volunteers from Event Medical Specialists and the University of Colorado wilderness medical section were responsible for medical care during any major incidents at the festival (Figure 3). Their reported incidents rates and EMS transports were queried to catch all major injuries.

The incidence rate ratio was calculated to compare injury rates among experience levels. Results are reported as median and interquartile range (IQR) as appropriate.

Results

A total of 81 surveys were completed. Seventy-five surveys were analyzed after 6 were excluded due to age <18 y ($n=1$), not climbing at the festival ($n=4$), and being deemed an outlier for reporting climbing 30 d at a 4-d festival ($n=1$).

Respondent age ranged from 18 to 70 y ($n=72$, median 30.5, IQR 27–36) and 28% ($n=20$) of respondents were female. The median number of seasons of ice climbing experience was 3 ($n=74$, IQR 1–6). The median number of days climbed per season was 5.5 ($n=72$, IQR 3–20). The median highest WI grade climbed consistently was WI 4 ($n=72$, IQR WI 3–WI 4). Safety equipment utilization while belaying and climbing is shown in Table 1.

Fourteen respondents reported a total of 16 injuries. One injury occurring during an unrelated social activity was excluded. An injury occurring during skiing, not climbing, was assumed to be during approach or return and was included in injury calculations. Eleven injuries occurred during climbing or rappelling, and 5 occurred during the approach or descent. Of the 16 injuries, 3 were self-reported as “overuse injuries.” The location and type of injuries are shown in Tables 2 and 3.

Climbing time estimates that were not a numerical response were addressed as per the Methods section. A numerical substitution of the median number of days climbed for a categorical response (“all”) was performed for 2 entries. An estimate of 6 h per climbing day was used for 3 entries. A numerical substitution of the average of an hour range for climbing time was performed for 4 entries. A numerical substitution of the base number of hours being defined as “X+ hours” was performed once. A total of 912 participation hours were reported, resulting in an injury incidence of 17.6 injuries per 1000 participation hours. No medical incidents were reported at the medical tent. No patients required EMS transport. An online search for reported fatalities or major incidents at the 2019 Ouray Ice Festival did not yield any relevant results.

Figure 3. Volunteers providing medical care.

A total of 3 beginner (4%), 52 intermediate (72%), and 17 advanced (24%) climbers responded ($n=72$). Injury rates for the intermediate and advanced climbers were 16.5 and 5.2 per 1000 participation hours, respectively. One injury was reported in the beginner cohort; however, no injury rate was calculated owing to the small sample size of 3 persons. The odds ratio of injuries among intermediate climbers as compared to advanced climbers was 4.3 (95% CI 0.5–36.0).

Discussion

In this survey of ice climbers at the 2019 Ouray Ice Festival, we found an injury incidence of 17.6 per 1000 participation hours. This incidence is comparable to that found in a prospective study (9.8 per 1000 participation hours) and is considerably lower than that found among amateurs with no ice climbing experience at the 2014 Sochi Olympics (248 per 1000 participation hours). The latter study calculated an injury rate using an unselected sample; however, the population studied was one with minimal climbing experience. In contrast, our study

reports an injury incidence based on an unselected population of actual WI climbers.

Although ice climbing may be colloquially viewed as a single sport, using this assumption for epidemiologic purposes is akin to considering “track and field” a single sport. Just as there are differences in the types and number of injuries between those competing in various track and field disciplines,⁹ we must consider differences in risk profiles among the various subdisciplines of ice climbing. This is relevant with regard to discussion of the 2014 Sochi study. The participants of this study climbed on a speed ice climbing wall and were limited to 2 min of climbing for each attempt. Speed ice climbing differs from traditional WI climbing by occurring in standardized, easily accessible venues to ensure fair competition. Because participants are not required to spend time belaying, rappelling, and approaching to or descending from a climb, the time spent speed ice climbing is significantly shorter than the time spent WI climbing. As such, the estimate of 248 per 1000 participation hours is based on a total of 18 injuries that occurred during 73 h of climbing. This injury incidence cannot be generalized to WI climbing as a whole owing to the unique circumstances and risk profile of this study population.

With regard to climbing experience and injury rates, a prior prospective study found a statistically significant difference in the injury rate between intermediate and advanced climbers (16.2 vs 6.3 per 1000 participation hours; OR 2.55, 95% CI 1.17–5.54).³ Our incidence rates are similar for the 2 experience groups, at 16.5 and 5.2 per 1000 participation hours for intermediate and advanced climbers, respectively; however, there was no statistical difference between these 2 groups within our study, which may be related to our small sample size.

We evaluated the safety equipment use, injury locations, and injury description among our participants in a fashion similar to a prior prospective study.³ Our data are consistent in showing that 100% of participants used a helmet while climbing. Of note, 41% of participants reporting using an assisted braking belay device (GriGri), which, if operated correctly, provides an additional safety margin while belaying. We noted that 53% of

Table 1. Reported use of safety equipment

Equipment	Belaying % (n)	Climbing % (n)
Backup belay	27 (20)	–
Crampons	91 (68)	–
Eye protection	49 (37)	53 (40)
Gaiters	–	27 (20)
Assisted braking belay device (GriGri)	41 (31)	–
Helmet	97 (73)	100 (75)
Leashes	–	17 (13)

Table 2. Injury locations

Location	% (n)
Head/Face	31 (5)
Shoulder/Clavicle	13 (2)
Elbow	6 (1)
Lumbar spine	6 (1)
Knee	6 (1)
Lower leg	19 (3)
Ankle	19 (3)

Table 3. Injury descriptions

<i>Description</i>	<i>% (n)</i>
Abrasion	9 (2)
Bone fracture	5 (1)
Contusion	5 (1)
Joint sprain	23 (5)
Laceration	27 (6)
Muscle strain	18 (4)
Tendonitis/Tendon strain	9 (2)
Other	5 (1)

participants used eye protection while climbing, which is higher than the prior value of 31%. This is important given that both our study and this prior study show the most frequent injury location to be the head/face (31%). Unlike this prior study, however, our data revealed the most common injury types were lacerations ($n=6$, 38%), joint sprains ($n=5$, 31%), and muscle strains ($n=4$, 25%). The prior study noted 74% of injuries described as abrasions or contusions, whereas ours only reported 19%. The higher proportion of sprains and strains could be related to the festival setting, where participants might be doing more climbing in a short period of time than they would otherwise. Overall, the severity of reported injuries appears to be minor, with only one reported fracture.

LIMITATIONS

This study has notable limitations. The retrospective nature introduces recall bias. We attempted to limit this by asking participants to only report recent climbing and injuries, rather than those occurring over the course of the past climbing season. Our response rate and sample size are both low (75 of approximately 2000 participants). As with any survey, our study had incomplete and missing data. When ranges, incomplete responses, or categorical responses were given in lieu of a single numerical value, we used median values and/or conservative estimates that would err on the side of inflating the injury rate rather than minimizing it. This was performed in 10 instances. Specifically, 2 participants did not provide an answer to the number of hours climbed in a day and 1 participant responded “all day.” Our calculations used the UIAA recommendations of estimating 6 h per day climbed for these 3 instances. If we imputed the median number of hours climbed per day instead, the calculated injury incidence is 17.7 based on a total of 903 participations hours, which is essentially unchanged.

A single survey did not allow us to collect data on overuse injuries with delayed presentations. This may lead to incorrect estimation of the true injury rate.

Participants were asked to self-report data such as climbing experience and safety equipment use, which can result in recall and social desirability biases. Injury description information is also based on the climber report. It is possible that injuries reported as minor (eg, joint strain, contusion) were later diagnosed as more significant by a medical provider (eg, tendon rupture or fracture). Injury severity was inferred by authors. It is possible that this was underestimated (eg, complex laceration or subsequent infection).

An important caveat to note is the unique climbing setting at ice festivals in general and specifically at the Ouray Ice Park. Festivals tend to be crowded, resulting in decreased spacing among climbers and poor ice quality, both of which have potential for increasing injuries. Questions on alcohol or recreational drug use before climbing were not included in the survey. Some climbers may opt to avoid festivals owing to their crowded nature, leading to selection bias in our study and decreased generalizability to ice climbing outside of this setting. The Ouray Ice Park is unique in its lack of technical approaches, readily available top rope anchors, and predominantly manmade ice. The climbs within the Ouray Ice Park climbs are graded at a maximum of WI 5. A number of mixed (rock and ice) climbs are also available. We did not differentiate between climbers climbing only on WI vs mixed climbs. Any of these factors can conceivably increase or decrease the observed injury rate. Given the differences between ice climbing at a festival and ice climbing outside of this setting, our estimate cannot be readily generalized to WI climbing as a whole.

Conclusions

We calculated an injury incidence rate based on an unselected sample of WI climbers at an ice climbing festival. WI climbing at festivals appears to result in injuries of minor severity with no major accidents or fatalities. This study could be repeated to confirm its validity in a larger sample and would ideally include participant follow-up to further characterize injury severity. Additional studies eliciting injury rates among WI climbers while avoiding the limitations of this and other prior studies are warranted.

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References

1. Schöffl V, Schöffl I, Schwarz U, Hennig F, Küpper T. Injury-risk evaluation in water ice climbing. *Medicina Sportiva*. 2009;13(4):210–8.
2. Mashkovskiy E, Beverly JM, Stöcker U, Bychkovskiy S. Ice climbing festival in Sochi 2014 Winter Olympics: medical management and injury analysis. *Wilderness Environ Med*. 2016;27(1):117–24.
3. Runer A, Lampl K, Neunhäuserer D, Runer F, Frick N, Seitlinger G, et al. A 1-year prospective analysis of ice climbing injuries. *Clin J Sport Med*. 2017;27(2):161–7.
4. Parkkari J, Kannus P, Natri A, Lapinleimu I, Palvanen M, Heiskanen M, et al. Active living and injury risk. *Int J Sports Med*. 2004;25(3):209–16.
5. Schöffl VR, Hoffmann G, Küpper T. Acute injury risk and severity in indoor climbing—a prospective analysis of 515,337 indoor climbing wall visits in 5 years. *Wilderness Environ Med*. 2013;24(3):187–94.
6. Schöffl V, Morrison A, Schwarz U, Schöffl I, Küpper T. Evaluation of injury and fatality risk in rock and ice climbing. *Sports Med*. 2010;40(8):657–79.
7. Schöffl V, Morrison A, Hefti U, Ullrich S, Küpper T. The UIAA Medical Commission injury classification for mountaineering and climbing sports. *Wilderness Environ Med*. 2011;22(1):46–51.
8. International grade comparison chart. American Alpine Journal. Available at: <http://publications.americanalpineclub.org/articles/13201212386/International-Grade-Comparison-Chart#>; 1999. Accessed February 10, 2019.
9. Edouard P, Navarro L, Branco P, Gremeaux V, Timpka T, Junge A. Injury frequency and characteristics (location, type, cause and severity) differed significantly among athletics (‘track and field’) disciplines during 14 international championships (2007–2018): implications for medical service planning. *Br J Sports Med*. 2020;54(3):159–67.