ORIGINAL RESEARCH

Year 2000 Whitewater Injury Survey

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Objective.—To gather retrospective data on paddling style, equipment, and acute and chronic/overuse injuries in hard shell whitewater canoe and kayak paddlers, to compare injury rates and patterns in different groups of paddlers, and to evaluate the incidence in paddlers of self-reported giardia infection.

Methods.—In the summer and fall of 2000, a survey was distributed at riverside, through paddle club bulletins, and was posted on the Internet.

Results.—Three hundred nineteen useable surveys were returned reporting 388 acute and 285 chronic injuries. The shoulder, wrist/hand, and elbow/forearm were the most common sites of injury. Sprain/strain was the most common (26%) known acute injury, followed by laceration and contusion (each 17%). Tendinitis was the most common (44%) known chronic injury diagnosis, followed by sprain/strain (27%). Forty-seven percent of acute and 36% of chronically injured paddlers sought medical attention. Giardia infection was reported in 14%.

Conclusions.—The shoulder and wrist/hand areas were the most common injured sites in this survey. Sprains, tendinitis, lacerations, and contusions were the most common known injury diagnoses. Injuries due to portage were common. Giardia infection may be common in whitewater paddlers.

Key words: whitewater, injury, paddle, canoe, kayak, survey

Introduction

Whitewater paddling has evolved from the early days of John Wesley Powell exploring the Grand Canyon in wooden dory boats to the recreational sport it is today.¹ The modern era began after World War II, with paddlers exploring rivers with surplus army rubberized rafts and wood-framed, canvas-covered kayaks. In the 1960s and 1970s, fiberglass kayaks were manufactured in garages. New plastics and manufacturing techniques have led to the development and design of kayaks that are stronger, allowing for the exploration of creeks, the running of waterfalls, and the evolution of the modern play boat.

The popularity of whitewater paddling is on the increase, as judged from indirect data on participants and boat sales.² Canoe and kayak participants (including flatwater paddlers) participants rose from 16.7 million in 1994–95 to 22.6 million in 1999.

Whitewater canoes and kayaks vary in design and materials from inflatable to fiberglass and plastic. Canoes vary from open to decked and are paddled by 1

person or 2. C-1 and C-2 refer to decked 1- and 2-person canoes, respectively. Kayaks also may be open (“sit-on-top”) to decked single and doubles. Canoeists use a single-blade paddle and are seated in a kneeling position, while kayakers use a double-blade paddle and are seated with their knees and hips slightly flexed. Kayak paddle blades may be feathered, which refers to the degree of offset of the planes of the 2 blade surfaces; nonfeathered paddles have both blades in the same plane. Bent-shaft kayak paddles have an offset shaft that is ergonomically designed to reduce wrist strain.

Whitewater paddling styles include general river running, creek boating (the running of steep and narrow creeks), rodeo/play boating (trick paddling involving playing with river hydraulics and features), and slalom racing (competitive running of gates in a set course for time). Each style requires a specifically designed craft. Creek boats often are short, maneuverable, and high volume; rodeo/play boats are shorter and low volume, with sharp ends and edges; slalom race boats are long, lightweight, and narrow.

The American Whitewater Affiliation’s International Scale of Difficulty rates whitewater difficulty and risk

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Age distribution of respondents to the Whitewater Injury Survey.

on a scale of I to VI. Class I is easy with slight risk to swimmers, and class VI is nearly impossible and very dangerous.

There is relatively little literature on acute and chronic overuse paddling injuries. The American Whitewater Affiliation keeps data on severe injuries and deaths.³ The survey by Fiore⁴ was the first look at acute vs chronic injury and the duration of effect on paddling. No data were found comparing injuries in canoe vs kayaker or between different types of paddling.

Over the last 10 to 15 years, paddling has changed. The average recreational kayak length has decreased from 11 to less than 8 feet, and boat volumes have decreased. There seems to be an increase of creek and play/rodeo boating by recreational boaters. The running of waterfalls seems to have become more common. Because of these significant changes, the rates and types of injuries may be changing.

The purpose of this survey was to review paddling injury history and to compare injuries by craft, type of boating, gender, experience, and difficulty of paddling. The frequency of reported giardia diagnosis was also reviewed.

Materials and methods

A detailed multiple-choice and open-ended question survey was developed in the winter and spring of 2000. The survey included sections on demographics, paddling equipment and style, acute injury, and chronic

Table 1. Years paddled and total days paddled per year; Total, % column represents the percentage of respondents in that group

	No. respondents	Total, %
Years:		
<2	57	17.9
2-4	83	26.0
5-7	61	19.1
8-10	36	11.3
11-13	26	8.1
14-16	18	5.6
>16	38	11.9
Total, d/y:		
0-50	156	49.7
51-100	102	32.5
101-150	33	10.5
151-200	12	3.8
>200	11	3.5

injury. The demographic section gathered data on age, gender, craft, type of paddling, experience, frequency, and difficulty of paddling. The injury sections collected data on injury location, medical visits, surgery, and duration of effect on paddling. The survey was distributed at river takeouts in Washington State between June and December 2000, placed in paddle club bulletins across North America, and placed on a website advertised in club bulletins and news groups.

Hard-copy responses ($n = 80$) were coded into Excel and Statmost software for analysis; on-line responses ($n = 239$) were electronically coded into that same software. Univariate categorical analysis was used to describe the findings. Statistical testing was done using chi-square for categorical data, t testing for comparing means, and linear regression testing for trend data, with the α level set at .05 to define statistical significance.

Results

Between June 5 and December 1, 2000, useable questionnaires were obtained from 319 respondents. A small number of survey responses were excluded because they contained incomplete or inconsistent information.

DEMOGRAPHICS

Eighty percent of respondents were between ages 20 and 50 (Figure), and 72% of respondents were men (28% female). The estimated average paddling experience was 7.3 years, with an estimated median of 50

Table 2. Type and class of whitewater run*

	<i>No. paddling, n</i>	<i>No. paddling, %</i>	<i>Median d/respondent/y</i>	<i>Median time on class, %</i>
Type of paddling				
River	304	96	30	...
Slalom	52	16	9	...
Creek	115	36	15	...
Other	50	16	20	...
Rodeo	155	49	20	...
Class river				
2-2+	211	66	...	30
3	230	72	...	25
3+	234	73	...	25
4	206	65	...	20
4+	120	38	...	10
5+	80	25	...	10
Ocean surf	70	22	...	5

*The percentage sum is over 100% because respondents could select more than 1 type of paddling or river class. Type of paddling is reported in median days each year; class is reported in percentage of time spent on each class. The No. paddling column represents those paddling any time on the listed type or class of river.

days paddled per year (5–300 days) (Table 1). Table 2 shows the style of paddling and the difficulty of whitewater paddled by the respondents. Most respondents paddled whitewater difficulty classes 2 to 4. Class 5 and higher rivers were paddled by 25% of respondents, with a median of 10% of their boating time (Table 2). One third of the respondents reported paddling a canoe at least some of the time, while only 7% reported a canoe as their only craft (Table 3). Seventy-four percent of canoe paddling reported was in open canoes.

EQUIPMENT

A helmet with a face guard was reportedly used by 11% of paddlers, of whom 69% reported it had protected their face. Bent-shaft paddles were reportedly used by 12% of kayak paddlers. Feather angle was reported at 45 degrees in 46%, 60 degrees in 26%, 80 degrees in 9%, and 0 degrees in 6% (feathering does not apply to canoe paddles). Thirteen percent reported they had decreased feather angle due to wrist problems, and 73% of those felt that change had helped their wrist.

INJURIES

Acute injuries numbered 388 (1.2 per respondent), and chronic injuries numbered 286 (0.9 per respondent), for a total of 677 injuries (2.1 per respondent). Seventeen percent reported no acute or chronic injuries. As expected, injuries generally rose with increased exposure,

as represented by days paddled each year and years paddled (Table 4).

The location of injuries is shown in Table 5. The shoulder/arm was the site most commonly injured for both acute and chronic injuries.

INJURY TYPE

Blisters represent the most common minor injury. Foot blisters affected 22% of the respondents; hand blisters

Table 3. Craft used*

<i>Craft</i>	<i>Exclusive craft used,† %</i>	<i>Some use,‡ %</i>
Kayak	63	90
Open canoe	6	25
C-1	1	7
C-2	0	2
Other	0	12

*The “some use” column reports those who use more than 1 type of craft (eg, kayak and open canoe). The “other” group represents rafting and inflatable kayaking (not included in this study). C-1 refers to single-decked canoe, and C-2 refers to double-decked canoe.

†Sum is less than 100% because some respondents did not report the exclusive use of a single type of craft.

‡Sum is more than 100% because some respondents reported use of multiple types of craft.

Table 4. No. previous injuries per respondent, according to years paddled and days paddled each year

	<i>Injuries per respondent</i>
Paddled, y	
<2	1.3
2–4	1.8
5–7	2.4
8–10	1.6
11–16	1.9
>16	2.7
Paddled yearly, d	
<50	1.7
51–100	2.2
101–150	2.5
>150	2.8
(<i>P</i> for trend)	<.05

affected 94%. Three and one-half percent reported altering their paddling because of blisters. Blister injuries are excluded from the nonblister injury data presented below.

Nonblister injury type was taken from responses to an open-ended question asking for details of the injury.

Acute injuries

Direct trauma (combining laceration [17%], contusion [17%], and abrasion [6%]) was the most common mechanism of acute injury (40%), and sprain/strain represented 26%. Fractures were 9% of acute injuries. Fractures represented 19% of both acute back/chest/hip and ankle/foot injuries and 14% of acute wrist/forearm injuries. Dislocations were 6% of all acute injuries;

these all occurred at the shoulder/arm, representing 22% of all acute shoulder/arm injuries.

Chronic injuries

Chronic injuries were dominated by tendinitis (44%) and sprain/strain (27%) in all areas. The type of chronic injury could not be determined in 25%.

INJURY SEVERITY

Medical attention was required for 47% of the acute injuries and for 36% of the chronic injuries (Table 5). Seventy-seven percent of those receiving chronic head/face/neck injuries received medical care.

Sixty-nine percent of both acute shoulder/arm and acute head/face/neck received medical care. Surgery was most commonly required for acute shoulder/arm at 13% of injured (Table 5). Back/chest/hip injuries had the longest duration of effect on paddling. A duration longer than 24 months was reported in 9.5% of acute and in 40.5% of chronic back/chest/hip injuries (Table 6).

CANOERS VS KAYAKERS

Comparisons were made in those paddling 50% or more of the time canoe (average, 94% of time) ($n = 40$) vs kayak (average, 96%) ($n = 267$). Kayakers reported slightly more acute injuries (1.23 injuries/person kayak vs 1.0 injury/person canoe). Chronic injuries were equal at 0.9 injury/person for both groups. The most common kayaker injury site was shoulder for both acute and chronic injuries. For canoers, knee/leg was the most common acute injury site and elbow/forearm for chronic injuries. Kayakers had more head/face/neck

Table 5. Injury severity detail; this table summarizes acute and chronic injuries reported by area and percentage of the injured having medical treatment or surgery

Area	<i>Acute injuries</i>				<i>Chronic injuries</i>			
	<i>Injured</i>		<i>Medical Visit</i>	<i>Surgery</i>	<i>Injured</i>		<i>Medical Visit</i>	<i>Surgery</i>
	n	Respond %	Injured %	Injured %	n	Respond %	Injured %	Injured %
Shoulder/arm	95	30	69	13	83	26	41	1
Elbow/forearm	40	13	28	0	60	19	32	3
Wrist/hand	67	21	30	3	62	19	16	1.6
Head/face/neck	58	18	69	5	13	4	77	8
Back/chest/hip	41	13	54	2	46	14	50	0
Knee	50	16	22	2	11	3	55	9
Ankle/foot	40	13	35	2.5	11	3	9	0

Table 6. Duration of effect of injury on paddling; this is presented as a percentage of injuries in the area with no effect on paddling and those with an effect lasting longer than 24 months

Area	Acute injury		Chronic injury	
	No effect, %	>24 mo, %	No effect, %	>24 mo, %
Shoulder	1.8	8.8	14.5	27.6
Elbow	15.6	2.2	13.2	20.8
Wrist	20.6	4.4	21.2	28.8
Head	34.6	2.5	15.4	30.8
Back	2.4	9.5	16.2	40.5
Knee	41.3	0	30.0	40.0
Ankle	29.7	2.7	50.0	12.5

injuries (17.6% vs 5.0%; $P < .05$). Canoeists reported more chronic elbow/forearm injury (30% vs 17%; $P < .05$). Kayakers had a tendency to more acute shoulder/arm injuries (31% vs 17.5%), though this was not statistically significant.

GENDER

The overall number of injuries was similar for men and women. However, men did report relatively more acute back injuries than did women (80.5% vs 19.5%; $P < .05$), whereas women reported relatively more chronic back/chest/hip injuries than did men (37% vs 64%; $P < .05$). Women were more likely to report having been injured during portage than were men (36% vs 24%; $P = .05$).

BOATING STYLE

Rodeo and slalom paddlers may have higher injury rates than general river runners, as evidenced by reported injury rates (Table 7).

GIARDIA

Giardia diagnosis or treatment was reported in 14.5%. Sixty-four percent (9.5% of respondents) of this group felt the infection was from their paddling activities.

Discussion

This study of whitewater paddling injuries is limited to hard shell canoers and kayakers. Other studies often include rafters who may have different injury patterns and rates.⁴ This survey provides new data on severity

Table 7. Paddling type vs injury rate; this table gives the injury rate reported for each type of paddling in those who spend 50% or more of their time in the listed style of boating

Type of boating	n	Mean injuries reported	P value (from t test vs river)
River	215	1.83	...
Rodeo	44	2.45	.04
Creek	21	2.29	.27
Slalom	11	2.82	.07

(medical visits, surgery, and the duration of effect on paddling) and divides injuries into acute and chronic/overuse types. On the basis of whitewater class and days paddled per year, this survey represents a moderate to serious recreational paddling group.

SIGNIFICANT FINDINGS

Using the estimated average reported years paddling (7.3) and the number of days paddled yearly (64.25), the incidence of any injury was estimated at 4.5 injuries per 1000 days paddled. By comparison, alpine skiing has 3.2 injuries per 1000 days; cross-country skiing and wind surfing have approximately 1 injury per 1000 days.^{5,6} In our study, the incidence of significant injuries (defined as an injury in which medical care was sought) was estimated at 1.9 injuries per 1000 days paddled. If the average paddle day is estimated to be 4 hours on river, the incidence of significant injury with whitewater canoe/kayak is 0.48 significant injuries per 1000 hours paddled.

Injury type and incidence in our study are generally similar to prior reports, with most injuries above the waist. Nonblister injuries were most common in the shoulder/arm, followed by the wrist/hand. Shoulder/arm injuries were common with a relatively high incidence of medical visitation, surgery, and chronic problems affecting paddling.

Back/chest/hip injuries also had significant findings, with 19% of acute injuries listed as fractures and long durations for both acute and chronic injuries. One can ask if the chronic back/chest/hip problems may be rising because of increased play boat use in kayakers. The high incidence of reported foot blisters may imply more use of tight-fitting play boats. And can the increased running of waterfalls explain the high incidence of back/chest/hip fractures?

In general, paddling injuries frequently led to medi-

cal visitation (42% overall) and were relatively significant based on the duration of effect on paddling. Chronic overuse injuries had longer lasting effects on paddling. Injury hiking to and around rivers was frequently reported and occurred significantly more commonly among women.

Giardia infection is reported quite commonly by whitewater paddlers (14.5%). By comparison, the background prevalence rate for giardia in the United States is 4%.⁷

STUDY LIMITATIONS

It is important to note that this study does not address drowning or near-drowning events that account for most fatalities or life-threatening injuries in paddlers.^{2,3}

Surveys have significant limitations. No conclusions can be drawn, but areas of interest may be identified. This survey cannot be assumed to be a representative sample of the paddling community. Recall or memory bias is possible, especially because 18% of respondents have paddled more than 14 years. Injuries tend to be overrepresented, because injured individuals are more likely to respond (participation by the noninjured was encouraged). This survey was long and had some complexity to it; this fact may introduce the potential for error or incorrect reporting. Data on injury type were estimated from the description of injury reported by respondents, leaving room for error. Incidence and prevalence of injury data are the most suspect and can only be applied to this exact group. Our calculated injury rates were based on estimates and must be considered as such.

The survey is limited by small numbers for comparing groups by difficulty of water paddled, type of paddling, and craft.

FUTURE DIRECTIONS

Future studies should try to obtain larger numbers in canoe, slalom, rodeo, and creek paddlers. It would also be best to prospectively follow a large number of pad-

dlers over time to more accurately ascertain injury rates and types with medical record review.

SUMMARY

We found the reported location and type of injuries to be relatively similar to previous studies.^{4,8} Medical care is received frequently, and the duration of effect on paddling is significant. Back/chest/hip injuries may be on the rise. There may be craft, gender, and style differences in injury patterns. Large-scale prospective studies are needed to clarify true injury patterns.

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