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Upper Extremity Pain and Overuse Injuries in Fly-Fishing

A North American Cross-Sectional Survey and Implications for Injury Prevention

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Investigation performed at Vanderbilt University Medical Center, Nashville, Tennessee, USA

Background: Fly-fishing requires rhythmic, coordinated movements to successfully cast a fly line. Previous studies have shown that the biomechanical demands of fly-casting may cause some individuals to develop upper extremity pain or injuries.

Purpose: To report the rates, trends, and contributing factors of upper extremity pain and overuse injuries in a sample of North American recreational fly-fishers.

Study Design: Descriptive epidemiology study.

Methods: Participants were reached via 3 popular online fly-fishing forums in April 2019. Each consenting North American participant over 18 years of age was given a link to a unique survey that recorded his or her demographic and orthopaedic histories, fly-fishing experience, equipment, casting techniques, upper extremity pain after fly-fishing, and chronic outcomes.

Results: The 162 fly-fishers included were 63.3 (\pm 11.5) years of age, and 95.1% were men. In total, 59 (36.4%) reported experiencing upper extremity pain immediately after fly-fishing. Pain was rated a 4.0 (interquartile range, 3.0-6.0) on a 10-point Likert scale, commonly lasting less than 1 day (45.0%) or between 1 day and 1 week (45.0%). The majority (62.7%) reported not needing to see a medical provider for their pain/soreness. Those who did most commonly received diagnoses of elbow or rotator cuff tendinitis. Pain/soreness was associated with casting in an elliptical/sidearm fashion, compared with overhead or 2-handed casting ($P = .006$) using a weighted line or added weight (split-shot, weighted heads, etc) ($P = .034$) and with grip styles where the hand was pronated compared with being in a more neutral position ($P = .046$). The mean shortened version of the Disabilities of the Arm, Shoulder and Hand score was 10.8 (\pm 11.5). Higher scores were associated with a history of self-reported upper extremity orthopaedic injuries ($B = 6.059$ [95% CI, 2.476-9.642]; SE, 1.814; $P = .001$) and having had surgery for these injuries ($B = 8.484$ [95% CI, 4.454-12.513]; SE, 0.314; $P < .001$).

Conclusion: In this sample of recreational fly-fishers, no aspects of fly-fishing were associated with long-term upper extremity disability, and only a little more than a third reported having transient pain immediately after fishing. Casting style, using weighted lines or added weight, and grip style were all associated with pain. These are modifiable risk factors that can be adjusted to reduce the risk of upper extremity pain immediately after fly-fishing.

Keywords: fly-fishing; fishing; casting; upper extremity; shoulder; elbow; wrist; pain

Fly-fishing is the oldest documented form of recreational angling and involves swinging a 7- to 11-foot rod back and forth to propel forward a fishing line with an artificial fly tied to the end of it.¹¹ Fly-fishing continues to be a popular sport in the United States, where an estimated 6.5 million participants older than 6 years of age spent a cumulative 77.1 billion days on the water in 2016.¹⁰ In addition to the physical benefits of being an outdoor recreational sport, many anglers describe fly-fishing as a religious, spiritual,

or sacred practice.¹² For unique populations such as veterans with combat-related disabilities or patients with breast cancer, fly-fishing has been shown to increase subjective and objective measures of healing and quality of life.^{1,6,7}

Fly-fishing is technical and requires rhythmic, coordinated movements to successfully cast a fly line, and studies have shown that the biomechanical demands of fly-casting may cause some individuals to develop shoulder, elbow, and wrist injuries or pain.^{2,8,13} Interestingly, the nuances among different fly-casting techniques, styles, and equipment may predispose individuals to certain injuries. In 2001, Berend² surveyed 89 fly-fishers online as well as 42 anglers from a local fly-fishing club in person and found

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that saltwater fly-fishers had the highest rates of shoulder and elbow pain, whereas trout fly-fishers had the highest rates of wrist pain. Moreover, in 2004, McCue et al⁸ randomly selected 577 fly-casting instructors and found that of 292 usable surveys, overhand casting was associated with less frequent wrist and elbow pain compared with sidearm and elliptical casting. In addition, upper extremity pain was more associated with casting with a “haul,” using “shooting heads,” and having added weight to “sinking flies.” Moderate to severe pain was again more frequent among fishers of heavy saltwater fish species.

Both the Berend² and McCue et al⁸ studies have helped to identify patterns of upper extremity injuries in fly-fishers; however, more data are needed in the general recreational fly-fishing population. The purpose of this study was not only to better understand and delineate the rates of upper extremity pain and overuse injuries potentially associated with fly-fishing but also to further uncover predisposing factors in a large national sample of recreational fly-fishers. These data may help manage expectations as well as identify patterns and trends that could help keep fly-fishers on the water longer and prevent upper extremity pain or overuse injury.

METHODS

Study Design

This was an online, survey-based cross-sectional study of North American fly-fishers older than 18 years of age. The survey is available as supplemental material. Institutional review board exemption was granted for this study.

Study Population

Participants were reached through different modes of online communication, as this method of reaching participants has been shown to be reliable in a previous study of fly-fishers.² Three popular online community fly-fishing forums (theflyfishingforum [theflyfishingforum.com], Reddit [reddit.com/r/flyfishing], and Trout Unlimited's Open Forum [community.tu.org]) were utilized. An online post delineated the nature and purpose of the study and included an invitation to be involved in this study. Participants were asked to pass the survey along to other individuals who may have been interested in taking the survey as well. Each consenting North American participant over the age of 18 years was given a link to the REDCap survey, and a unique ID was generated. REDCap is a secure, web-based application designed to support data capture for research

studies, providing (1) an intuitive interface for validated data entry, (2) audit trails for tracking data manipulation and export procedures, (3) automated export procedures for seamless data downloads to common statistical packages, and (4) procedures for importing data from external sources.^{4,5} All data compiled in the REDCap survey were anonymous and deidentified. Participants had 1 month to complete the survey and were neither rewarded nor adversely affected by their decision to participate.

Survey Elements

Survey fields included information about the participants' characteristics, including age, sex, height, weight, calculated body mass index (BMI), state of residence, profession or occupation, and hours of strenuous activity per week (not including fly-fishing, with strenuous activity defined as work, labor, exercise, etc). We also asked about handedness for casting and for reeling/line management. Each participant's fly-fishing exposure/experience was gauged by asking the total number of years they have been fly-fishing, the average number of days of fly-fishing per year, the average number of consecutive days of fly-fishing per outing, and the mean number of casts made per fly-fishing day. Questions were then directed toward the primary type of fly-fishing each participant engaged in.

Items about equipment were included, such as rod length, weight, and action as well as line weight. Style of casting (2-handed/spey, overhead, elliptical, or sidearm) and hauling technique (no haul, single haul, or double haul), grip style, most common fly types thrown (wet flies/nymphs/midges, dry flies/terrestrials, or streamers), and whether they use weighted line or added weight was also inquired. A glossary of these and other fly-fishing terms can be found online at websites such as Fly Fisher Pro³ or Orvis.⁹ Participants were able to select, list, and describe whether they have had previous orthopaedic upper extremity injuries and/or surgeries.

We asked all participants if they typically have upper extremity pain/soreness after fly-fishing and then to select the anatomic location(s) of their pain/soreness. For each location, we asked them to indicate (1) the laterality of the pain, (2) the rating of the pain (1-10), (3) the duration of the pain, (4) whether they have seen a physician or advanced care practitioner for the pain; and (5) whether a diagnosis was made for the pain and to specify the diagnosis as applicable. Chronic outcomes included the Disabilities of the Arm, Shoulder, and Hand (DASH) Sports/Performing Arts Module scores as well as the shortened version of the DASH (QuickDASH). The survey instrument can be found as supplemental material.

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Ethical approval for this study was waived by Vanderbilt University (ref No. 190117).

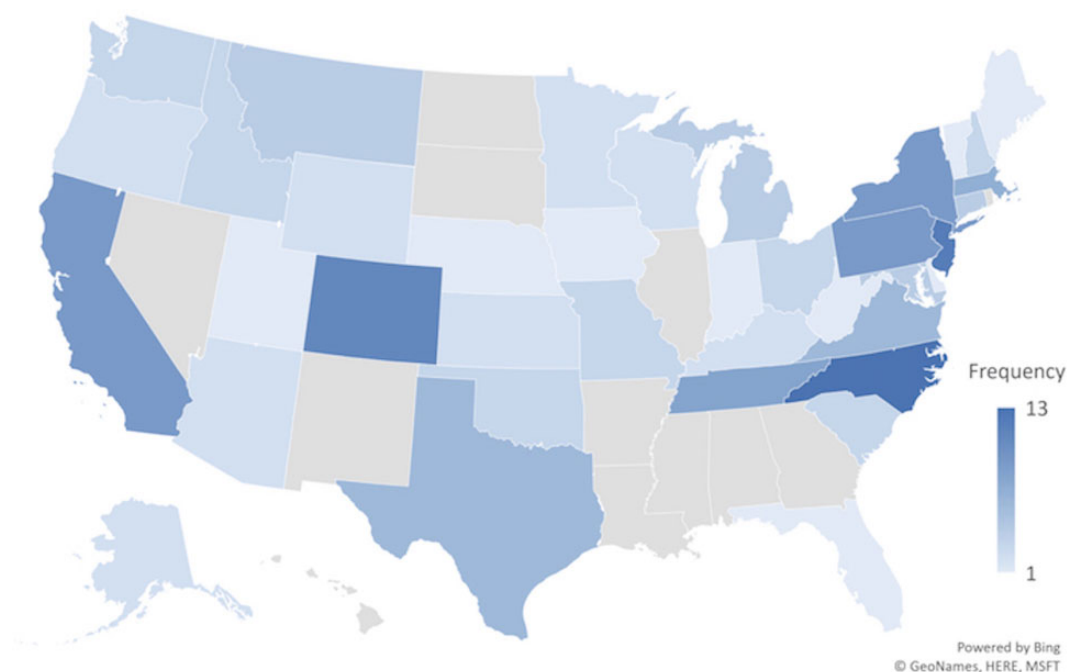


Figure 1. Residences of the 162 fly-fishers included in this study.

Statistical Analyses

Descriptive statistics were utilized to describe the sample across all survey items. Descriptive data were described and reported utilizing raw counts, measures of central tendency (mean, median, or mode), and measures of data dispersion (95% CIs, standard deviations, standard errors, and interquartile ranges [IQRs]) where appropriate. Acute pain after fly-fishing was then delineated by anatomic location and reported descriptively. Correlates of acute pain immediately after fly-fishing were assessed utilizing contingency tables and chi-square (χ^2) analyses for categorical predictor variables and binary logistic regression for continuous ones. Chronic outcomes (QuickDASH and DASH Sports/Performing Arts Module) were similarly correlated with pertinent exposure variables utilizing linear regression. All data were analyzed utilizing SPSS 26.0 (IBM) at the 95% CI.

RESULTS

Participant Characteristics

One-hundred sixty two fly-fishers responded and were included in this study. Utilizing the REDCap “data quality tool” for the sample, there were 121 missing survey values of more than 8000 (>95.5% completion). The fly-fishers had a mean age of 63.3 (± 11.5) years, with the majority self-identifying as male (95.1%). The mean height and weight were 70.5 (± 3.0) inches and 200.5 (± 39.4) pounds, respectively, equating to a mean BMI of 28.3 (± 5.2). The most common states of residence were North Carolina (8.0%), New Jersey (7.4%), and Colorado (6.8%); these data are presented in Figure 1 and delineated in Appendix Table A1.

Most respondents reported having either sedentary (51.9%) or active (41.4%) professions/occupations. There was 1 (0.6%) fly-fishing guide who responded to the survey. The majority cast with their right arm (89.5%) and reel/manage line with their left (77.2%). A large percentage (60.5%) had previous upper extremity orthopaedic injuries, and a lesser number had surgeries addressing these conditions (23.5%). The most commonly reported conditions were rotator cuff tendinitis ($n = 30$), elbow tendinitis ($n = 18$), and previous shoulder subluxation or dislocation ($n = 13$). Characteristics of the 162 fly-fishers included in this study can be found in Table 1, and a list of previous self-reported upper extremity orthopaedic injuries can be found in Appendix Table A2.

Fly-Fishing Experience, Equipment, and Techniques

The study participants had a median of 30.0 (IQR, 15.0-47.0) years of fly-fishing experience. They reported spending 30.0 (IQR, 20.0-60.0) days per year fly-fishing and casting 200.0 (IQR, 100.0-500.0) times each fly-fishing day. The median number of consecutive days fly-fishing was 3.0 (IQR, 2.0-5.0). The primary type of fly-fishing reported was in freshwater (89.6%). Those who primarily fish in saltwater or on flats were less represented (9.3%). The most common rod outfit used was a 4- to 6-weight rod (72.2%) that was 9.0 or more feet (40.1%) in length, with medium (46.9%) or fast (43.2%) action holding a 4- to 6-weight line (70.4%). They reported primarily casting overhead (72.8%) with a single haul (41.4%) while holding their rod with their thumb on top (63.6%). The most common types of flies thrown were wet flies/nymphs/midges (45.1%) followed by

TABLE 1
Fly-Fisher Characteristics^a

Characteristic	Value
Age, y	63.3 ± 11.5
Sex	
Male	154 (95.1)
Female	3 (1.9)
Unknown	5 (3.1)
Height, in	70.5 ± 3.0
Weight, lb	200.5 ± 39.4
BMI	28.3 ± 5.2
Profession/occupation	
Sedentary	84 (51.9)
Active (requiring movement and walking, etc)	67 (41.4)
Strenuous labor (construction, warehouse, etc)	3 (1.9)
Fly-fishing guide	1 (0.6)
Unknown	7 (4.3)
Hours of strenuous activity	10.5 ± 9.1
Handedness (casting hand)	
Right	145 (89.5)
Left	17 (10.5)
Reeling/stripping hand	
Right	36 (22.2)
Left	125 (77.2)
Unknown	1 (0.6)
Previous upper extremity orthopaedic injuries	
Yes	98 (60.5)
No	63 (38.9)
Unknown	1 (0.6)
Previous upper extremity orthopaedic surgery	
Yes	38 (23.5)
No	123 (75.9)
Unknown	1 (0.6)

^aData are presented as mean ± SD or n (%). BMI, body mass index.

dry flies/terrestrials (34.6%). Almost half (44.4%) use weighted line or added weight. Fly-fishing experience, techniques, and equipment utilized by the 162 fly-fishers in this study can be found in Table 2.

Upper Extremity Pain After Fly-Fishing

In total, 59 of the 162 fly-fishers (36.4%) reported experiencing upper extremity pain/soreness immediately after fly-fishing. The shoulder joint (44.7%) was the most commonly affected anatomic location of pain/soreness, followed by the elbow (16.0%) and hand (16.0%). The right side was more commonly affected (79.8%). The anatomic location of pain/soreness can be visualized in Figure 2.

The 59 rated their pain a 4.0 (IQR, 3.0-6.0) on a 10-point Likert scale, commonly lasting less than 1 day (45.0%) or between 1 day and 1 week (45.0%). The majority (62.7%) reported not needing to see a physician or advanced care practitioner for their pain/soreness. All (100.0%) who did see someone received a diagnosis. The most common diagnoses were elbow tendinitis (n = 6), rotator cuff tendinitis (n = 6), and carpal tunnel syndrome (n = 5). All diagnoses can also be found in Appendix Table A2. Upper extremity pain delineated by anatomic location can be found in Table 3.

TABLE 2
Primary Fly-Fishing Experience^a

Characteristic	Value
Total No. of years fly-fishing	30.0 (15.0-47.0)
Mean No. of days fly-fishing per year	30.0 (20.0-60.0)
Mean No. of consecutive days fly-fishing	3.0 (2.0-5.0)
Mean No. of casts per fly-fishing day	200.0 (100.0-500.0)
Primary type of fly-fishing	
Freshwater small creek	55 (34.0)
Freshwater medium/large river	90 (55.6)
Flats/saltwater	15 (9.3)
Unknown	2 (1.2)
Primary type of rod used, wt	
1-3	16 (9.9)
4-6	117 (72.2)
7-9	25 (15.4)
10+	3 (1.9)
Unknown	1 (0.6)
Primary length of rod used, ft	
6.0-7.5	12 (7.4)
7.6-8.5	21 (13.0)
8.6-9.0	58 (35.8)
9.1+	65 (40.1)
Unknown	6 (3.7)
Primary rod action	
Slow	11 (6.8)
Medium	76 (46.9)
Fast	70 (43.2)
Unknown	5 (3.1)
Primary line weight	
1-3	13 (8.0)
4-6	114 (70.4)
7-9	29 (18.0)
10+	2 (1.2)
Unknown	4 (2.5)
Primary type of casting	
2-handed/spey casting	3 (1.9)
Overhead	118 (72.8)
Elliptical	18 (11.1)
Sidearm	19 (11.7)
Unknown	4 (2.5)
Primary grip style	
V-style	53 (32.7)
Thumb on top	103 (63.6)
Finger on top	3 (1.9)
Other/unknown	6 (3.7)
Most common fly type thrown	
Wet flies/nymphs/midges	73 (45.1)
Dry flies/terrestrials	56 (34.6)
Streamers	33 (20.4)
Primarily use weighted line or added weight	
Yes	72 (44.4)
No	89 (54.9)
Unknown	1 (0.6)
Primary hauling technique	
No haul	44 (27.2)
Single haul	67 (41.4)
Double haul	50 (30.9)
Unknown	1 (0.6)

^aData are presented as median (IQR) or n (%). IQR, interquartile range.

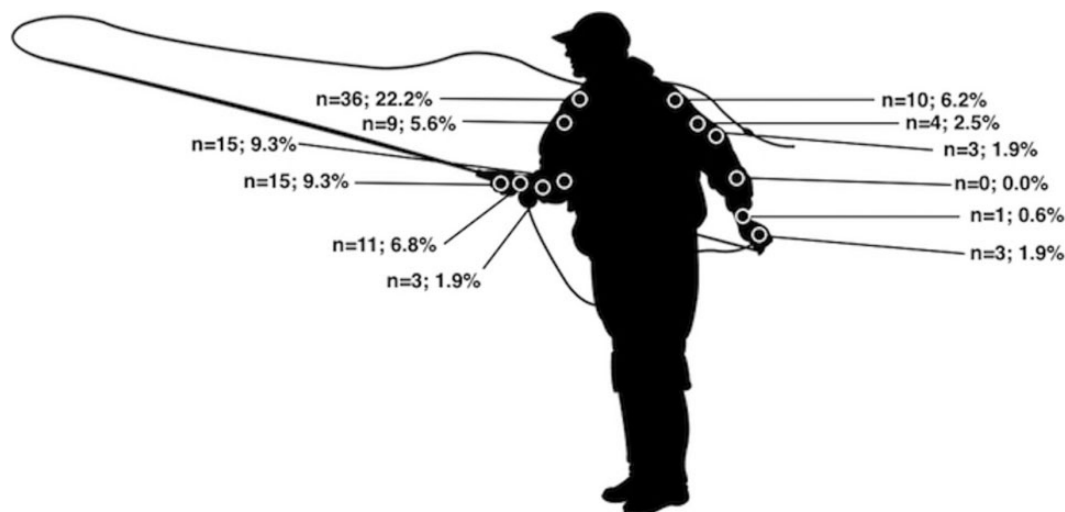


Figure 2. Anatomic location of pain/soreness in 162 surveyed fly-fishers immediately after fly-fishing.

TABLE 3
Upper Extremity Pain After Fly-Fishing^a

Characterization of Pain	Shoulder (n = 42)	Arm (n = 10)	Elbow (n = 15)	Forearm (n = 3)	Wrist (n = 11)	Hand (n = 15)	Total (n = 94)
Laterality of pain/soreness							
Right	32 (76.2)	6 (60.0)	12 (80.0)	3 (100.0)	10 (90.9)	12 (80.0)	75 (79.8)
Left	6 (14.3)	3 (30.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	7 (7.4)
Bilateral	4 (9.5)		3 (20.0)	0 (0.0)	1 (9.1)	3 (20.0)	14 (14.9)
Rating of pain/soreness (1-10 Likert)							
	4.0 (3.0-6.0)	3.0 (2.0-6.0)	3.0 (2.5-5.0)	2.0 (2.0-2.0)	4.0 (3.0-6.0)	4.5 (3.0-6.0)	4.0 (3.0-6.0)
Duration of pain/soreness ^b							
<1 d	22 (47.8)	9 (69.2)	6 (33.3)	1 (33.3)	4 (33.3)	7 (41.2)	49 (45.0)
1 d to 1 wk	22 (47.8)	4 (30.8)	10 (55.6)	2 (66.6)	3 (25.0)	8 (47.1)	49 (45.0)
1 wk to 1 mo	1 (2.2)	0 (0.0)	1 (5.6)	0 (0.0)	1 (8.3)	1 (5.9)	4 (3.7)
1 mo to 1 y	0 (0.0)	0 (0.0)	1 (5.6)	0 (0.0)	1 (8.3)	1 (5.9)	3 (2.8)
1 y or longer	1 (2.2)	0 (0.0)	0 (0.0)	0 (0.0)	3 (25.0)	0 (0.0)	4 (3.7)
Has seen a physician or advanced care practitioner for pain/soreness							
Yes	18 (39.1)	4 (30.8)	7 (38.9)	0 (0.0)	5 (41.7)	7 (58.3)	41 (37.3)
No	28 (60.9)	9 (69.2)	11 (61.1)	3 (100.0)	7 (38.9)	11 (61.1)	69 (62.7)
Diagnosis made by the physician or advanced care practitioner							
	18 (100.0)	4 (100.0)	7 (100.0)	0 (0.0)	5 (100.0)	7 (100.0)	41 (100.0)

^aData are reported as median (IQR) or n (%). IQR, interquartile range.

^bOne participant did not indicate the duration of hand pain after fly-fishing, which accounts for the discrepancy in frequencies.

Upper extremity pain/soreness after fly-fishing was associated with casting in an elliptical/sidearm fashion, as opposed to casting overhead or 2-handed ($\chi^2 = 7.44$; $P = .006$). Pain/soreness was also associated with using weighted line or added weight (split-shot, weighted heads, etc) ($\chi^2 = 4.51$; $P = .034$). All respondents who held their rod with their finger on top (3/3; 100%) reported upper extremity pain/soreness after fly-fishing, compared with 34% and 30% of those who held their rod with their thumb on top or with a "V-style" grip ($\chi^2 = 6.17$; $P = .046$). There were no nonmodifiable risk factors (eg, age) associated with developing pain after fly-fishing, and those with a history of previous upper extremity orthopaedic injuries were not more likely to develop pain.

There was no significant difference in reported isolated shoulder/arm pain between overhand/2-handed casting versus elliptical/sidearm casting ($\chi^2 = 3.05$; $P = .081$). Type of fly-fishing (salt vs freshwater) did not result in different anatomic patterns of upper extremity pain/soreness (isolated shoulder/arm vs other) in this cohort either ($\chi^2 = 0.554$; $P = .457$).

Chronic Outcomes

The mean QuickDASH and DASH Sports/Performing Arts Module scores for the entire sample were 10.8 (± 11.5) and 9.6 (± 15.0), respectively. DASH data are tabularized in Table 4 and visualized in Figure 3.

Higher QuickDASH and DASH Sports/Performing Arts Module scores were associated with having a history of

TABLE 4
QuickDASH and DASH Sports/Performing Arts Module Scores^a

DASH Measure	Score
QuickDASH	
Opening jar	1.0 (1.0-2.0)
Performing heavy household chores	1.0 (1.0-2.0)
Carrying shopping bag	1.0 (1.0-1.0)
Washing back	1.0 (1.0-2.0)
Cutting food with a knife	1.0 (1.0-1.0)
Performing recreational activities	1.0 (1.0-2.0)
Engaging in social activities	1.0 (1.0-1.0)
Working/regular daily activities	1.0 (1.0-1.0)
Pain	2.0 (1.0-2.0)
Tingling	1.0 (1.0-1.0)
Sleeping difficulty	1.0 (1.0-2.0)
Total standardized score, mean \pm SD	10.8 \pm 11.5
DASH Sports/Performing Arts Module	
Fly-fishing in your usual way	1.0 (1.0-1.0)
Fly-fishing because of arm, shoulder, or hand pain	1.0 (1.0-2.0)
Fly-fishing as well as you would like	1.0 (1.0-2.0)
Spending your usual amount of time fly-fishing	1.0 (1.0-2.0)
Total standardized score, mean \pm SD	9.6 \pm 15.0

^aData are reported as median (IQR) unless otherwise indicated. DASH, Disabilities of the Arm, Shoulder and Hand; IQR, interquartile range; QuickDASH, shortened version of the DASH.

upper extremity orthopaedic injuries ($B = 6.059$ [95% CI, 2.476-9.642], $SE = 1.814$, $P = .001$; $B = 6.721$ [95% CI, 2.024-11.419], $SE = 2.378$, $P = .005$) as well as requiring surgery for these injuries ($B = 8.484$ [95% CI, 4.454-12.513], $SE = 0.314$, $P < .001$; $B = 9.795$ [95% CI, 4.432-15.157], $SE = 2.715$, $P < .001$). There were no fly-fishing-related variables associated with chronic disability as measured by these outcomes.

DISCUSSION

In a sample of 162 recreational North American fly-fishers, we found that a little more than one-third reported having upper extremity pain/soreness immediately after fly-fishing. Pain was rated a 4 out of 10, generally lasting less than 1 day or only between 1 day and 1 week before subsiding. Of those who visited a medical provider for their pain, the most common diagnoses made were elbow tendinitis and rotator cuff tendinitis. Pain was shown to be significantly associated with casting in an elliptical/sidearm fashion (as opposed to casting overhead or 2-handed), varying grip style, and using weighted line or added weight (split-shot, weighted heads, etc). A major strength of the current study was that the general North American recreational fly-fishing population was surveyed, which may make our results more generalizable to the "average" fly-fisher.

In our study, the prevalence of upper extremity pain was 36.4%, predominantly affecting the shoulder, wrist/hand, and elbow, most often lasting less than 1 day or between 1 day and 1 week. Berend² found that 26%, 18%, and 23% of their sample reported having wrist/hand, elbow, and

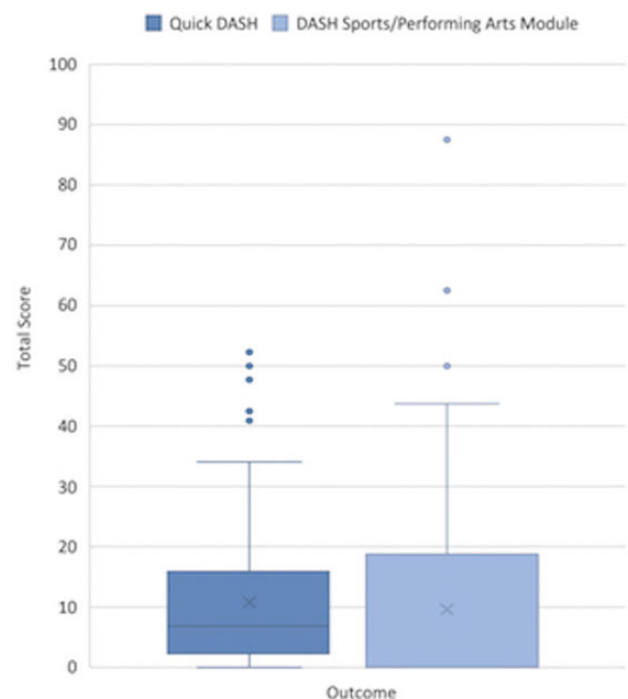


Figure 3. Box plot of QuickDASH and DASH Sports/Performing Arts Module scores.

shoulder pain, respectively. That sample was similarly predominantly men (93%), but almost 15 years younger. McCue et al⁸ found that among their sample of professional fly-casting instructors, nearly half (49.8%) reported shoulder pain, 39% elbow pain, and 36% wrist pain. Similarly, the majority of their cohort reported that their pain lasted only for hours (58%) or days (28%); however, their sample consisted of professional fly-casting instructors who spent a median of 100 days casting a year compared with the 30 days in our sample. Additionally, the median number of casts made per fly-fishing day was not reported in the McCue et al study, whereas in ours, a median of 200 casts were made per day.

As alluded to, the rates of upper extremity pain after fly-fishing may be the result of a host of factors. The type of fly-fishing (freshwater vs saltwater) was surveyed in all 3 studies and may hold answers to some of the reasons why. McCue et al⁸ found that 31% of those who fished for heavy saltwater fish reported moderate to severe shoulder, elbow, or wrist pain after casting compared with 19% of those who had not fished for heavy saltwater species. The majority of the participants (91%) in the Berend² study fished for trout in freshwater; however, 50% of their respondents also reported fishing in saltwater. Although no statistically significant differences were seen between type of fly-fishing and upper extremity pain in their study, there was a trend for saltwater fly-fishers to have a higher prevalence of shoulder and elbow pain, whereas freshwater fly-fishers had a higher prevalence of wrist and hand pain.

Saltwater fly-fishers target larger species of fish, requiring heavier gear. They typically need to cast

overhand, utilizing a double haul, with longer rods, heavier line, and larger flies. In the McCue et al⁸ study, the weight of the fly rod correlated with the degree of wrist pain, and each additional foot of length of rod increased the odds of reporting some pain in the shoulder, elbow, or wrist by 46%. They also found that those who use a haul have more pain and symptoms than those who do not, likely related to increasing torque on the arm. Utilizing shooting heads and added weight led to a higher prevalence of pain. While we did not find an association between hauling technique or rod weight or length, we found that in our sample of recreational fly-fishers, using shooting heads or additional weight also led to an increased prevalence of upper extremity pain/soreness. It should be noted that only 9.3% of our sample reported primarily fishing for saltwater species.

McCue et al⁸ found that overhead style casting was associated with less elbow and wrist pain than the side-arm/elliptical styles, and in our study, upper extremity pain/soreness after fly-fishing was significantly associated with casting in an elliptical/sidearm fashion. We did find a trend between overhand/2-handed casting and isolated shoulder/arm pain compared with elliptical/sidearm casting (76.3% vs 54.5%); however, that relationship did not reach a conventional level of statistical significance. These data suggest that different casting styles may cause different anatomic locations of pain, and that elliptical/sidearm casting may cause more pain in the recreational fly-fisher, which would be isolated to the elbow and wrist. Measuring the biomechanical demands of different casting styles in a controlled laboratory setting could help with understanding how each style could potentially lead to different pain or injury patterns.

In the current study, all respondents who held their rod with their finger on top (3/3; 100%) reported upper extremity pain/soreness after fly-fishing, compared with 34% and 30% of those who held their rod with their thumb on top or with a V-style grip. Grip style also rendered significant correlations in the McCue et al⁸ study, where moderate to severe shoulder pain was seen more often in the 3-point and finger-on-top gripping styles. These data suggest that grip styles that place the hand in pronation throughout the fly-cast may predispose fly-fishers to upper extremity pain more often than grips where the hand is in a more neutral position⁸; however, further biomechanical study is needed.

The mean QuickDASH and DASH Sports/Performing Arts Module scores for the entire sample were 10.8 (\pm 11.5) and 9.6 (\pm 15.0), respectively, with 12% meeting criteria for having at least "mild disability." The mean DASH score in the McCue et al⁸ study was 6.5 (\pm 8.9), with 4% having at least "mild disability." In the current study, no fly-fishing variables were associated with DASH outcomes, and the only variables that predicted higher QuickDASH and DASH Sports/Performing Arts Module scores were having a history of previous upper extremity orthopaedic injuries and requiring surgery for those injuries.

There are many limitations of this study worth mentioning. First and foremost, sampling was completed online, and although it has been shown to be a valid sampling technique,² it may have introduced selection bias.

Second, this was only a small representative sample of the entire fly-fishing population. Our sample seemed to be biased toward those who are older (mean age, 63.3 years). We were also unable to obtain a large representative sample from the Gulf states and those who fly-fish in the ocean/flats. Third, even though there was a deliberate effort to sample all fly-fishers and not just those with pain, participants who have a history of upper extremity pain may have been more likely to complete the survey, inadvertently inflating our reported prevalence rate of acute pain. On the contrary, we may have missed those who stopped fly-fishing because of arm pain/problems. Fourth, the survey items were based on the primary type of fishing each participant engages in, and many likely participate in more than 1 type or use more than 1 rod set up. Fifth, diagnoses were self-recalled by participants and not cross-validated by medical records. Last, we may have had limited numbers and power to detect meaningful differences. Future studies should continue to elucidate patterns and trends of upper extremity pain through both clinical and biomechanical studies. Optimizing the efficiency of fly-casting through technique or equipment would theoretically reduce the strain and injury to the upper extremity.

CONCLUSION

No aspects of recreational fly-fishing were associated with long-term upper extremity disability, and only a little over a third of fly-fishers in this study reported having transient pain/soreness immediately after fishing, lasting for less than a day or only between 1 day and 1 week. For participants who saw a medical provider for pain, elbow and rotator cuff tendinitis were the most common diagnoses made. Recreational fly-fishers should cast overhand, and if elliptical or sidearm casting is necessary, intermittent overhead casting may reduce the risk of upper extremity pain. Although further study is needed, holding the rod with a neutral grip (thumb on top), as opposed to one where the hand is fully pronated (finger on top), may also help reduce the rate of upper extremity pain and soreness. Last, recreational fly-fishers should be mindful of their casting technique and frequency when using weighted line or added weight (split-shot, weighted heads, etc), as this has been shown to cause an increased prevalence of upper extremity pain/soreness as well.

SUPPLEMENTAL MATERIAL

The survey for this article is available at <http://journals.sagepub.com/doi/suppl/10.1177/2325967120959303>

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APPENDIX

TABLE A1

State or Country of Residence of the 162 Fly-Fishers Included in This Study

State or Country	No. (%)
Alaska	2 (1.2)
Arizona	2 (1.2)
California	9 (5.6)
Colorado	11 (6.8)
Connecticut	4 (2.5)
Delaware	1 (0.6)
Florida	1 (0.6)
Idaho	3 (1.9)
Indiana	1 (0.6)
Iowa	1 (0.6)
Kansas	2 (1.2)
Kentucky	2 (1.2)
Maine	1 (0.6)
Maryland	4 (2.5)
Massachusetts	7 (4.3)
Michigan	4 (2.5)
Minnesota	2 (1.2)
Missouri	3 (1.9)
Montana	4 (2.5)
Nebraska	1 (0.6)
New Hampshire	3 (1.9)
New Jersey	12 (7.4)
New York	9 (5.6)
North Carolina	13 (8.0)
Ohio	3 (1.9)
Oklahoma	3 (1.9)
Oregon	2 (1.2)
Pennsylvania	9 (5.6)
South Carolina	3 (1.9)
Tennessee	8 (4.9)
Texas	6 (3.7)
Utah	1 (0.6)
Vermont	1 (0.6)
Virginia	6 (3.7)
Washington	3 (1.9)
West Virginia	1 (0.6)
Wisconsin	2 (1.2)
Wyoming	2 (1.2)
Canada	5 (3.1)
Other	5 (3.1)

TABLE A2

Orthopaedic Histories of the 162 Fly-Fishers Included in This Study^a

Previous Upper Extremity Orthopaedic Injuries (n)	Diagnoses for Acute Pain After Fly-Fishing (n)
Rotator cuff tendinitis (30)	Elbow tendinitis (6)
Elbow tendinitis (18)	Rotator cuff tendinitis (6)
Shoulder subluxation/dislocation (13)	Carpal tunnel syndrome (5)
Shoulder unspecified (12)	Shoulder arthritis (4)
Carpal tunnel syndrome (6)	Shoulder unspecified (4)
Clavicle fracture (5)	Acromioclavicular joint arthritis (2)
Shoulder fracture (5)	Biceps rupture/tendinitis (2)
Unspecified (5)	Trigger finger (2)
Forearm fracture (4)	Wrist/hand arthritis (2)
Hand arthritis (3)	Wrist/hand unspecified (2)
Hand fracture (3)	Shoulder bursitis (1)
Elbow unspecified (3)	Shoulder impingement (1)
Shoulder bursitis (3)	Shoulder labral tear (1)
Shoulder labral tear (3)	Shoulder polio sequelae (1)
Trigger finger (3)	TFCC ligament tear (1)
Wrist tendinitis (3)	Wrist/hand contracture (1)
Acromioclavicular joint arthritis (2)	Wrist/hand tendinitis (1)
Biceps rupture/tendinitis (2)	
Frozen shoulder (2)	
Hand unspecified (2)	
Shoulder arthritis (2)	
Wrist arthritis (2)	
Wrist fracture (2)	
Wrist unspecified (2)	
Acromioclavicular joint separation (1)	
Arm fracture (1)	
Cubital tunnel syndrome (1)	
Elbow bursitis (1)	
Elbow fracture (1)	
Finger dislocation (1)	
Forearm unspecified (1)	
Hand tenosynovitis (1)	
Pronator teres syndrome (1)	
Shoulder polio sequelae (1)	
TFCC tear (1)	
Wrist dislocation (1)	
Wrist ligament injury (1)	

^aTFCC, triangular fibrocartilage complex.