Journal of Athletic Training 2016;51(4):317–320
doi: 10.4085/1062-6050-51.4.13

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High School Rowing Injuries: National Athletic Treatment, Injury and Outcomes Network (NATION)

Christine M. Baugh, MPH*; Zachary Y. Kerr, PhD, MPH†

*Harvard University Interfaculty Initiative in Health Policy, Cambridge, MA; †Datalys Center for Sports Injury Research and Prevention, Inc, Indianapolis, IN

Context: Data on high school (HS) rowing injuries are lacking.

Objective: To describe the epidemiology of HS boys' and girls' rowing injuries during the 2011–2012 through 2013–2014 academic years.

Design: Descriptive epidemiology study.

Setting: Injury and exposure data from 8 and 11 boys' and girls' rowing programs providing 13 and 17 team-seasons of data, respectively.

Patients or Other Participants: High school boys' and girls' varsity rowing student-athletes.

Intervention(s): High school rowing data from the National Athletic Treatment, Injury and Outcomes Network.

Main Outcome Measure(s): Injury rates and rate ratios were reported with 95% confidence intervals (CIs).

Results: In HS boys' and girls' rowing, 59 and 190 injuries were reported, respectively, for rates of 2.39/1000 athlete-exposures (95% CI = 1.78, 3.00) and 8.60/1000 athlete-exposures (95% CI = 7.38, 9.82). The girls' rowing injury rate was 3.60 times that of boys' (95% CI = 2.69, 4.82).

Conclusions: These findings suggest a higher injury rate among HS female rowers than HS male rowers. Additional research exploring reasons for the sex difference is warranted.

Key Words: sport injuries, injury surveillance, crew

Key Points

- The injury rate in high school rowing was higher among females than among males.
- Most injuries in high school rowing resulted in time loss of less than 24 hours.
- Additional surveillance of high school rowing is necessary to effectively develop and implement prevention strategies to reduce the risk of injury in this population.

Data on injuries in nonelite high school (HS) rowers are lacking. The existing rowing injury epidemiology literature comprises mostly reports from the collegiate, senior, and masters levels.[1–5] High school rowers may differ in physical maturity and sport-related experience. Reports of rowing injuries in HS-aged athletes are currently limited to elite junior rowers competing internationally[6] or specific injuries such as low back pain (LBP).[7,8] Rowing has a small but growing HS-aged population in the United States, with nearly 7000 HS athletes competing during the 2013–2014 school year.[9] More epidemiologic research on rowing injuries is needed in nonelite athletes at both the HS level and more broadly.[1]

In rowers, the most common injury is LBP.[1–3] Previous authors[4–6] estimated that LBP accounted for approximately one-third of rowing injuries. Other common rowing injuries are rib fractures, intercostal muscle strains, shoulder pain, patellofemoral pain, iliotibial band friction syndrome, and dermatologic problems such as blisters and track bite.[5] These injuries have been documented more substantially in elite rowers at the collegiate and masters levels of competition. In junior elite (HS-aged) rowers, more than three-quarters of injuries were from overuse and affected the lower back, knee, and wrist/forearm.[10] In a report from the 2012 Summer Olympics,[4] both the number of injuries and the duration of time lost to injury were less in rowing than in many other sports. The extent to which these injury patterns translate to the nonelite HS level is unclear. We describe the epidemiology of rowing-related injuries in a population of girls' and boys' nonelite HS athletes.

METHODS

The methods of the National Athletic Treatment, Injury and Outcomes Network (NATION) have been previously described.[11] This surveillance research was deemed exempt by the Western Institutional Review Board (Puyallup, WA). The study population consisted of HS boys' and girls' rowing student-athletes at the varsity level (ie, the principal team representing an HS in a sport).

The NATION used a convenience sample of high school varsity teams from 27 sports with certified athletic trainers (ATs) reporting injury data.[11] The number of programs providing data varied by sport and year. Athletic trainers worked with the participating teams and attended school-sanctioned practices and competitions during the 2011–2012 through 2013–2014 academic years. Eight boys' rowing programs provided 13 team-seasons of data. Eleven girls' rowing programs provided 17 team-seasons of data.

Injury and athlete-exposure (AE) data were collected through the electronic health record application used by the team medical staff throughout the academic year.[11] All varsity-level practice and competition events and team

Table 1. Injury Counts and Rates per 1000 Athlete-Exposures With 95% Confidence Intervals in High School Boys' and Girls' Rowing, 2011–2012 Through 2013–2014

	Boys			Girls		
Event Type	No. of Injuries	No. of Athlete-Exposures	Rate (95% Confidence Interval)	No. of Injuries	No. of Athlete-Exposures	Rate (95% Confidence Interval)
Competition	15	3576	4.20 (2.07, 6.32)	31	3434	9.03 (5.85, 12.20)
Practice	44	21 105	2.08 (1.47, 2.70)	159	18 663	8.52 (7.20, 9.84)
Overall	59	24 681	2.39 (1.78, 3.00)	190	22 097	8.60 (7.38, 9.82)

conditioning sessions were included in the NATION datasets. Individual weight-lifting and conditioning sessions were excluded. A *reportable injury* was one that resulted from participation in a school-sanctioned practice or competition and required attention from an AT or physician. All injuries were included, regardless of time loss. We provided no study-specific criteria, thereby relying on the training and expertise of participating ATs to adequately diagnoses injuries and injury mechanisms. A *reportable AE* was defined as 1 student-athlete participating in 1 school-sanctioned practice or competition. Only athletes with actual playing time in a competition were included in competition exposures.

From the electronic health record application, common data elements, including injury and exposure information, were stripped of any identifiers and personally identifiable information.[11] This common data element standard allowed ATs to document injuries as they normally would in their daily clinical practice, as opposed to reporting injuries separately for injury-surveillance purposes. All electronic health record applications successfully completed a data-validation process before certification. Exported data passed through an automated verification process that conducted a series of consistency checks. Data were reviewed and flagged for invalid values. The AT and data quality-assurance staff were then notified and worked together to resolve the concern. Data that passed the verification process were then placed into the aggregate datasets that were analyzed.

Rates were calculated per 1000 AEs overall and by event type. Injury proportions were also calculated by body part, diagnosis, and mechanism. Mechanism was categorized as contact (including with other athletes and equipment) or noncontact/overuse. Sex-specific rates and injury proportions were compared with rate ratios (RRs) and injury proportion ratios (IPRs), respectively. All RRs and IPRs with 95% confidence intervals (CIs) that did not include 1.00 were deemed significant. Data were analyzed using SAS-Enterprise Guide software (version 4.3; SAS Institute, Cary, NC).

RESULTS

In HS boys' and girls' rowing, 59 and 190 injuries were reported, respectively (Table 1), for rates of 2.39/1000 AEs (95% CI = 1.78, 3.00) and 8.60/1000 AEs (95% CI = 7.38, 9.82). The overall rate in girls was 3.60 times that of boys (95% CI = 2.69, 4.82). Competition rates were higher than practice rates in boys (RR = 2.01, 95% CI = 1.12, 3.62) but not in girls (RR = 1.06, 95% CI = 0.72, 1.56).

Commonly injured body parts were the hand/wrist (boys: 22.0%, n = 13; girls: 17.4%, n = 33), knee (boys: 16.9%, n = 10; girls: 18.4%, n = 35), and lower back (boys: 10.2%, n = 6; girls: 12.6%, n = 24; Table 2). In addition, abrasions, contusions, and strains comprised the largest proportion of injuries (boys: 66.1%, n = 39; girls: 59.5%, n = 113). No differences existed in the injury distributions by body part or diagnosis in boys' and girls' rowing.

Most boys' rowing injuries were due to contact (66.1%, n = 39), particularly with other athletes (23.7%, n = 14), the boat (11.9%, n = 7), the oars (11.9%, n = 7), and the rigger (11.9%, n = 7). The proportion of injuries due to contact in boys' rowing (66.1%, n = 39) was larger than that in girls' rowing (32.1%, n = 61; IPR = 2.06; 95% CI = 1.56, 2.71). Most girls' rowing injuries were due to noncontact/overuse (43.7%, n = 83). The proportion of injuries due to noncontact/overuse in girls' rowing (43.7%, n = 83) was larger than that in boys' rowing (18.6%, n = 11; IPR = 2.34; 95% CI = 1.34, 4.09).

Of all contact injuries, most affected the hand/wrist (boys: 23.1%, n = 9; girls: 34.4%, n = 21) or knee (boys: 20.5%, n = 8; girls: 24.6%, n = 15) and were abrasions (boys: 35.9%, n = 14; girls: 32.8%, n = 20) or contusions (boys: 25.6%, n = 10; girls: 47.5%, n = 29). Of all noncontact/overuse injuries, most occurred to the lower back (boys: 18.2%, n = 2; girls: 14.5%, n = 12) or ankle

Table 2. Injury Counts by Body Part and Diagnosis in High School Boys' and Girls' Rowing, 2011–2012 Through 2013–2014, No. (%)[a]

Body Part or Diagnosis	Boys	Girls
Body part		
Head/face/neck	2 (3.4)	7 (3.7)
Shoulder	2 (3.4)	12 (6.3)
Arm/elbow	3 (5.1)	7 (3.7)
Hand/wrist	13 (22.0)	33 (17.4)
Abdomen	0 (0.0)	4 (2.1)
Upper back	2 (3.4)	6 (3.2)
Lower back	6 (10.2)	24 (12.6)
Hip/groin	3 (5.1)	9 (4.7)
Thigh/upper leg	7 (11.9)	16 (8.4)
Knee	10 (16.9)	35 (18.4)
Lower leg	5 (8.5)	10 (5.3)
Ankle	6 (10.2)	16 (8.4)
Foot	0 (0.0)	11 (5.8)
Diagnosis		
Abrasion	14 (23.7)	32 (16.8)
Concussion	0 (0.0)	3 (1.6)
Contusion	10 (16.9)	39 (20.5)
Laceration	5 (8.5)	12 (6.3)
Sprain	5 (8.5)	19 (10.0)
Strain	15 (25.4)	42 (22.1)
Other[b]	10 (16.9)	43 (22.6)
Total	59 (100.0)	190 (100.0)

[a] Percentages were rounded.

[b] Includes diagnoses specified only by body part injured (ie, *other knee injury*).

(boys: 18.2%, n = 2; girls: 13.3%, n = 11) and were sprains (boys: 18.2%, n = 2; girls: 18.1%, n = 15) or strains (boys: 81.8%, n = 9; girls: 31.3%, n = 26).

No boys' rowing injuries resulted in time loss of at least 24 hours. In girls' rowing, 4 injuries (3 concussions and 1 unspecified knee injury) resulted in time loss of at least 24 hours. One injury (in girls' rowing) was recurrent.

DISCUSSION

This is the first study, to our knowledge, to characterize the frequency and distribution of injuries among nonelite girls' and boys' HS rowing. Our findings were similar to those of previous researchers[1–6,10] studying other competition levels in regard to body parts injured, such as the wrist/hand, knee, and lower back. Overuse injuries were less common than in earlier reports, perhaps because of the nonelite level of competition, as training load is a demonstrated risk factor for overuse injury in rowers.[2] However, our study did not capture training load, warranting additional research comparing such data across competition levels.

Nearly all injuries observed in this population resulted in time loss under 24 hours. With traditional definitions of injury surveillance, these injuries would not have been reported. Characterizing these non–time-loss injuries is critical, as these injuries, although often minor (eg, contusions and abrasions), may cause athletes pain and may, in some cases, be preventable. This finding parallels previous research[4] from the 2012 Summer Olympics, which showed that most rowing injuries did not result in substantial time loss.

The injury rate for girls was higher than that for boys, which concurs with previous research[10] on elite junior rowers. Although authors[5] who found sex differences in rowing injury rates suggested that females were more prone to specific injuries because of anatomical and hormonal differences, there is no established reason for these differences. More of the injuries sustained by female rowers in this study were characterized as overuse. Monitoring training volume and improving technique may reduce overuse injuries in this population.

Boys had a larger proportion of contact injuries than girls did. Rowing is not a contact or collision sport, so 1 potential source of these injuries is accidental contact with equipment or other athletes. This occurs especially in inexperienced rowers, particularly when putting the boat into and removing the boat from the water. According to Smoljanovic et al,[10] injuries from a single traumatic event were more common in less experienced elite junior rowers. However, our study lacks information on experience before the study period. Future surveillance researchers would benefit from obtaining data on athlete experience to better identify the association with injury risk.

Although extremity injuries comprised large proportions of injuries, we also found cases of LBP, similar to previous investigators.[1–3,6] Higher training volume and a history of injury have been associated with greater back pain in rowers.[1,2,12] Furthermore, poor technique on the water and on the ergometer (often due to inexperience) may play an additional role in injury,[1] particularly in this nonelite HS rower population. Therapeutic interventions[8] have successfully reduced the frequency and severity of LBP in adolescent rowers. Improving technique and appropriately tailoring training volume and progression may help reduce back injury in nonelite rowers.

Limitations

Our data originate from a small convenience sample of HSs and may not generalize to HS rowing more broadly. Many injuries were also classified as *other*, highlighting the need for more injury detail in future data collection. Preexisting risk factors and student-athlete demographics (eg, age, height, weight) were also not examined. We observed a relatively low injury count overall, which restricted our ability to stratify results by event type.

CONCLUSIONS

Our findings suggest that the majority of injuries sustained in HS rowers result in minor time loss. The injuries frequently sustained in HS rowing mirrored those common at other levels of competition; frequent injuries affected the knee, hand/wrist, and lower back. Additionally, the injury rate in girls' rowing exceeded that in boy's rowing, warranting the need for future research. Additional surveillance of HS rowers examining larger samples, more defined injury details, and preexisting risk factors will help to build upon our findings. Understanding injuries in nonelite HS rowing is important to effectively implement prevention strategies to reduce the risk of injury in this population.

ACKNOWLEDGMENTS

This study would not have been possible without the assistance of the many HS ATs who participated in the program.

FINANCIAL DISCLOSURES

This project was funded by the National Athletic Trainers' Association Research & Education Foundation and the Central Indiana Corporate Partnership Foundation in cooperation with BioCrossroads. The content of this report is solely the responsibility of the authors and does not necessarily reflect the views of the National Athletic Trainers' Association Research & Education Foundation, Central Indiana Corporate Partnership Foundation, or BioCrossroads.

Christine Baugh's doctoral education was supported by the National Institute of Mental Health of the National Institutes of Health under award number T32MH019733. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

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Address correspondence to Zachary Y. Kerr, PhD, MPH, Datalys Center for Sports Injury Research and Prevention, Inc, 401 West Michigan Street, Suite 500, Indianapolis, IN 46202. Address e-mail to zkerr@datalyscenter.org.