Sex-specific Differences in Perceived Injury Management and Prevention in High School Student-Athletes

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BACKGROUND: Sport-related injuries are common among high school student-athletes with specific sex disparities in injury risk. Many of these injuries may be avoidable with the use of injury prevention programs (IPPs). Sex differences in injury management and return to sport are not well understood.
PURPOSE: To determine sex-specific differences in self-reported injury management and prevention strategies in high school student-athletes.
DESIGN: Cross-sectional, survey-based study.
METHODS: An anonymous 13-item electronic survey was distributed to all students in a private high school in December 2019 with responses recorded over a one-month study period. Primary outcomes were sex-specific differences in self-reported outcome measures assessing student-athlete experience during injury recovery and familiarity with IPPs. Groups were evaluated via descriptive statistics and differences between groups were compared.
RESULTS: From a total of 190 responses, 106 were included in the analysis (63F, 43M, mean age 16.7 years). Female athletes reported decreased exposure to injury prevention training (44.4% vs 69.8%, p=0.01) and practice-based utilization of IPPs (23.8% vs 55.8%, p=0.001) compared to male athletes. Overall, reported utilization of IPPs was low regardless of sex at less than 40% for all athletes. Nearly 85% of female athletes compared to 51% of male athletes felt they could benefit from IPPs (p=0.001), yet fewer than half of female athletes reported ever having training in injury prevention. There were no statistically significant differences in measures of injury management or return to sport between sexes. Females reported similar major impact of injury on life and future plans compared to male athletes.
CONCLUSIONS: Male athletes were 1.6x more likely to report injury prevention training and 2.4x more likely to report practice-based utilization of IPPs compared to female athletes. Sex-specific differences in injury management and return to sport were not identified. Better incorporation of IPPs, specifically at the high-school level, may help to address sex disparities in preventable sport-related injuries and allow student-athletes to maximize the myriad benefits of sport participation.

BACKGROUND

Subsequent to the enactment of Title IX in 1972, participation in high school athletics has increased by over 10-fold for girls compared to less than 2-fold for boys[1]. As of 2018-2019, females accounted for 43% of high school and 44% of collegiate student-athletes[1,2]. In addition, the opportunities to compete across a wide variety of sports is also growing with increasing female representation in more classically male-dominated sports, such as ice hockey and wrestling[3]. Sport-related injuries are common in both male and female high school student-athletes with an injury rate of 2.29 per 1,000 athlete exposures across nine major sports over the 2018-2019 season[4]. Among sex-comparable sports including soccer, basketball, volleyball, baseball/softball, swimming and diving, track and field, cross-country, and tennis, injury rates are higher for high school girls compared to boys with the lower extremity being the most commonly

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injured body region[4, 5]. Additionally, high school girls are more likely to suffer a severe lower extremity injury resulting in greater than three weeks of time loss or medical disqualification than boys[5]. Recognizing sex differences for specific preventable injuries along with structural, biomechanical, neuromuscular, and hormonal risk factors is imperative to mitigating injury risk [6-9].

Injury prevention programs (IPPs) are exercise-based, proactive interventions designed to decrease avoidable sport-related injuries by improving modifiable risk factors such as core stability, dynamic lower extremity alignment, eccentric strength, proprioception, balance, and neuromuscular control [10-12]. Despite demonstrated benefits related to both injury prevention and performance, IPPs are not widely utilized at the high school level and, when implemented, adherence is often suboptimal [13]. Sport-related injuries not only impact athletic performance and cardiovascular health, but impede athletes from gleaning potential benefits related to higher academic achievement, advanced educational opportunities, skilled workforce employment, and improved mental health and social interaction [14-16]. Thus, athletes, coaches, and sports medicine providers alike should prioritize injury prevention in order to maximize student-athlete potential in both sport and life.

The purpose of this study is to identify sex-specific differences in perceived management and prevention of injuries in high school student-athletes who have experienced significant sport-related injuries. Specifically, we aim to determine differences in athlete support during injury recovery, exposure to preventative exercise, and utilization of IPPs between sexes that may contribute to known sex disparities in sport.

METHODS

In December 2019, an anonymous electronic survey was developed to gauge perceptions of sport-related injury management and prevention among high school student-athletes. The survey contained 13 questions, including basic demographic information (age, gender, sport, injury, time to diagnosis, and time to recovery) and self-reported outcome measures related to the student-athlete's experience during injury recovery and exposure/access to injury prevention programs via primarily binary response format. The survey was reviewed for objectivity and clarity by the Head Athletic Trainer at a local private high school prior to distribution. Participants were recruited via email distribution of the electronic Google Forms survey link to all students in the private high school as well as through two common social media platforms. The survey link was emailed twice over the study period from December 6th, 2019 - January 8th, 2020. Informed consent was implied by completion of the survey. Retrospective analysis of the anonymous dataset was deemed exempt from institutional review board (IRB) approval.

Statistical analyses were performed with IBM *SPSS*® Statistics software platform. Independent samples t-tests were used to evaluate for sex-specific differences in demographic data between groups. Pearson's chi-squared tests were used to evaluate for sex-specific differences in categorical outcome measures for injury management and prevention between groups. P-value of less than 0.05 was considered statistically significant.

RESULTS

Overall, there were a total of 190 anonymous electronic responses collected over the one-month study period. Of these, a total of 106 responses (63F, 43M, mean age 16.7 years old) were included in this study. Responses were excluded for incompleteness (n=2), participant not of high school age (n=23), and lack of prior injury resulting in one or more months away from sport (n=59). Participant demographics and injury characteristics are presented in Table 1. The most common sports resulting in injury were soccer, lacrosse, and basketball for female athletes and ice hockey, soccer, and volleyball for male athletes. Approximately 13% of athletes reported injuries from more than one sport. The most commonly injured body region was the knee followed by the ankle for both female and male athletes. Time to diagnosis was reportedly less than 3 days for 38% of all athletes and less than 2 weeks for nearly 75% of athletes. Average time to recovery from all reported injuries was approximately 4 months. There were no significant differences in mean age, time to diagnosis, or time to recovery between sexes.

Most athletes, regardless of sex, reported that they generally felt encouraged to return to sport after injury recovery (85.7% female vs. 93.0% male; p=0.24). While there appeared to be a trend toward more female compared to male athletes reporting they had been suggested to stop playing their sport

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entirely, or retire, due to injury (39.7% vs. 25.6%, respectively), this difference was not statistically significant (p=0.13).

Table 1. Participant demographics & injury characteristics by sex

	Female	*Male*
Sex		
Total (%)	63 (59.4)	43 (40.6)
Age, years		
Mean ± SD	16.6 ± 1.1	16.9 ± 1.5
Sport (% by sex)		
Soccer	15 (20.6)	6 (11.3)
Lacrosse	12 (16.4)	5 (9.4)
Ice hockey	4 (5.5)	12 (22.6)
Volleyball	7 (9.6)	6 (11.3)
Basketball	8 (11.0)	4 (7.6)
Field hockey	7 (9.6)	1 (1.9)
Cross country	4 (5.5)	4 (7.6)
Softball/baseball	2 (2.7)	4 (7.6)
Football	0 (0.0)	5 (9.4)
Track & field	2 (2.7)	2 (3.8)
Other	12 (16.4)	4 (7.6)
Total	73 (57.9)	53 (42.1)
Injury body region (% by sex)		
Knee	19 (28.4)	10 (20.8)
Ankle & foot	16 (23.9)	9 (18.8)
Wrist & hand	9 (13.4)	8 (16.7)
Concussion	7 (10.5)	5 (10.4)
Shoulder	5 (7.5)	4 (8.3)
Leg/shin	6 (9.0)	3 (6.3)
Hip	4 (6.0)	0 (0.0)
Back	0 (0.0)	4 (8.3)
Thigh	0 (0.0)	3 (6.3)
Other	1 (1.5)	2 (4.2)
Total	67 (58.3)	48 (41.7)
Time to diagnosis (% by sex)		
Less than 3d	23 (36.5)	17 (39.5)
3d-1wk	11 (17.5)	7 (16.3)
>1wk	10 (15.8)	6 (14.0)
>2wks	18 (28.6)	11 (25.6)
Time to recovery, months		
Mean ± SD	4.1 ± 3.1	3.8 ± 2.9

Importantly, the reported major impact of injury on life or future plans was similar for both sexes (p=0.54). In terms of injury prevention programs (IPPs), there were significant sex-specific differences. While nearly 70% of male athletes reported training focused on injury prevention, only 44% of female athletes reported similar exposure (p=0.01). Similarly, female athletes were less than half as likely to report inclusion of preventative exercise as part of practice, with overall low occurrence for both sexes (23.8% female vs. 55.8% male, p=0.001). Only 24% of all athletes reported incorporation of IPPs into their high school sport programs. More female athletes felt they could benefit from inclusion of preventative training in a practice setting (84.1% female vs. 51.1% male, p=0.001).

DISCUSSION

To our knowledge, this is the first study to investigate sex-specific differences in perceived injury management and prevention among high school student-athletes. In the present study, male athletes were 1.6 times more likely to report injury prevention training and 2.4 times more likely to report inclusion of IPPs into a practice setting compared to female athletes. Fewer than half of females reported ever having training in injury prevention. Among all athletes, only 36.8% reported inclusion of preventative exercise into a practice setting, and only 24% as part of high school level sport. Within this context, our findings specifically highlight deficiencies in utilization of IPPs for high school student-athletes regardless of sex with further emphasis on the reported disparity for female compared to male athletes.

These findings are of great clinical importance given well-established epidemiologic research demonstrating high sport-related injury rates among both female and male high school athletes [5, 17], with further increased risk for lower extremity and knee injuries among female athletes [5, 18, 19]. Anterior cruciate ligament (ACL) injuries in particular are 2-4 times more common in female compared to male athletes [18, 19] with peak incidence occurring in high school years [20]. Similarly, among our study population, lower extremity injuries were most common for both sexes with knee injuries accounting for 28% of female and 21% of male injuries. Additionally, injuries were most common in cutting/pivoting sports.

Many of these injuries may be avoidable with the use of IPPs. The efficacy of IPPs has been repeatedly demonstrated in terms of improved biomechanical factors as well as translation into decreased risk for a variety of sport-related injuries,

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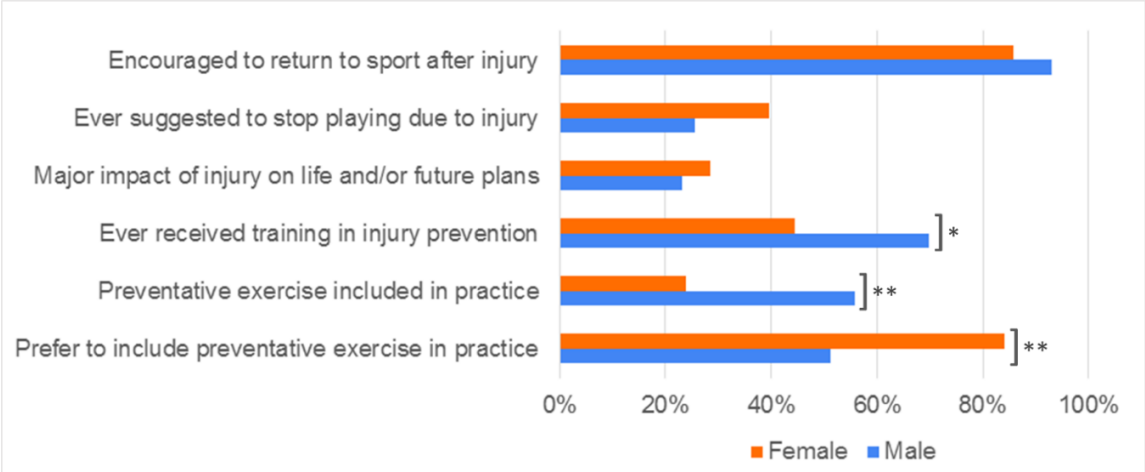

Figure 1. Self-reported outcomes for sport-related injury management and exposure to preventative exercise (*, p<0.01; **, p<0.001).

including overall injury risk as well as lower extremity, hamstring, knee, ACL, and ankle specific injury risk [10-12, 17, 21-30]. Additionally, implementation of IPPs in high school-aged athletes has been shown to result in greater biomechanical improvements compared to middle school-aged athletes [21] and greater reduction in injury risk compared to college or professional athletes [25]. This emphasizes the importance of targeting high school-aged athletes for preventive exercise, especially given peak incidence of certain injuries, including ACL injuries, during high school years [20].

Underutilization of IPPs likely stems from multiple causes. In a recent survey-based study of 440 intercollegiate female student-athletes, a vast majority (over 85%) understood that women are at higher risk for preventable ACL injuries, and nearly 90% reported they would perform injury prevention exercises daily if it would decrease their risk for ACL injury; however, only 33% noted familiarity with ACL-specific IPPs and only 15% had ever performed these types of exercises [31]. These findings indicate that a deficiency in athlete education and awareness likely contributes to underutilization of IPPs. In parallel, 84% of the female athletes in the present study felt they could benefit from incorporation of preventative exercise into a practice-based setting, yet only 44% had ever been exposed to preventative exercise and only 24% had ever practiced IPPs. While significantly fewer male athletes felt they could benefit from practice-based IPPs, possibly reflecting increased training and experience with performing these types of exercises compared to female counterparts, a majority (51%) still preferred to incorporate IPPs into practice.

Additional barriers to successful implementation of IPPs are numerous. Coaches are an integral part of IPP utilization [32], and coach-led IPPs have been demonstrated to be equal in efficacy yet superior in feasibility to IPPs with mixed leadership including coaches, trainers, physical therapists, and physicians [33]. Among high school and adolescent coaches, logistical factors (IPP complexity/inflexibility, lack of sport-specific IPP, lack of time, venue constraints, weather), athlete-related factors (player engagement, maturity level), and educational factors (lack of IPP awareness and expertise) are cited as barriers to use [13, 34-37]. Furthermore, a complex interplay of institutional and organizational influences, sport- and/or regional-specific culture, and socioeconomics has been implicated in affecting successful implementation of and adherence to IPPs [38].

Even in cases when IPPs are implemented, low adherence to these programs may limit their success [38, 39]. Among high school soccer and basketball coaches, only 21% reported IPP implementation and of those only 43% adhered to the IPP as designed [13]. Specific factors that coaches feel would increase IPP utilization and adherence include: increased access to education and training resources, sport-specific IPPs, emphasis on both injury prevention and sport performance, support from other coaches, club/organizational adoption of IPPs, ease of use (2-3 days weekly, no more than 15-20 minutes), and modifiability to increase athlete motivation (competitive elements, paired exercises, etc) [34-37]. Another potential athlete-specific factor

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related to IPP adherence is athlete sex. Interestingly, exercise fidelity, or performing the exercise correctly, has been demonstrated to be higher in adolescent female compared to male athletes [39]. Sex-specific differences in sport psychology may be of importance related to this finding as female adolescent athletes endorse higher levels of perceived injury risk with sport and lower levels of risk taking behavior compared to male athletes [40], potentially improving their adherence to IPPs. This may be another explanation for the sex disparity in preference for incorporation of IPPs into a practice setting identified in this study.

In terms of the sports medicine provider's role in enhancing coaching education and implementation of IPPs, it is imperative that the provider "speak[s] the same language as the coach" and "proposes rather than imposes" in order to optimize delivery and receptiveness of IPP information, facilitate dialogue, and allow for collaboration if needed [32]. While coaches often note preference for sport-specific IPP, the use of generalized compared to sport- or athlete-specific IPPs has not been well studied [26]. There is, however, limited evidence supporting similar improvements with a generalized compared to individualized IPP among high school and pre-high school athletes [21]. It is likely that feasibility of generalized IPPs is far greater especially at this competition level, and this knowledge may empower coaches to feel confident in adopting a generalized program rather than none at all. Additionally, while elite level athletes, coaches, and physical therapists primarily value sport performance [41], high school female athletes report the most important factor influencing willingness to perform an IPP is decreased injury risk rather than improved performance [42]. Regardless, it is important to highlight that in addition to notable reduction in injury risk, IPPs often lead to improvements in various performance metrics, including strength, explosiveness, balance, and proprioception [10]. Furthermore, it is important for all members of the sports medicine team to acknowledge the complex interplay of additional factors implicated in successful implementation of and adherence to IPPs, including institutional and organizational influences, sport- and/or regional-specific culture, and socioeconomic elements [38].

This study did not demonstrate significant sex-specific differences in outcomes related to injury management or return to play, including time to diagnosis, time to recovery, feeling of encouragement to return to sport after injury recovery, or suggestion to retire from sport due to injury. There is sparse literature investigating sex differences in injury management and return to sport in athletes. Sport-related concussion has the most robust evidence demonstrating longer time to recovery and return to sport in female compared to male athletes. This finding has been associated with many sex-specific differences including neck strength, self-reported symptomology, severity of neurologic deficit, rate of neurocognitive recovery, hormonal factors, social and behavioral norms, and more [43-45]. There is strong advocacy for further research and development of injury prevention, treatment, and return to sport protocols that consider sex differences in an effort to improve outcomes for all athletes with sport-related concussion [45].

In contrast, much remains unknown regarding potential sex disparities in treatment and recovery following musculoskeletal injuries. One study found that male athletes returned to sport at approximately twice the rate of female athletes at one year post-ACL reconstruction [46]. Sex-specific differences in objective measurements of knee function or self-reported outcome measures that may have helped to explain this finding were not reported. Also post-ACL reconstruction, sex differences in psychological factors related to recovery and return to sport have been described in high school athletes [47], suggesting that sex-specific approaches beyond rehabilitation protocols may be warranted. Further, while sex bias among clinicians has been demonstrated to affect management of other medical conditions, the potential effect that bias may have on sport-related injury and recovery is largely unknown. A single vignette-based study demonstrated racial and social class biases among Division 1 sports medicine providers regarding perception of increased pain tolerance after ACL injury in black and low socioeconomic status athletes, but bias was not demonstrated based on sex [48]. Decreased satisfaction with sports medicine care has been reported among female compared to male collegiate athletes [49], though this is not well supported and may be related to participation in lower-profile sports with decreased access to athletic trainers [50]. Much work remains to be done to better define sex differences in injury management and return to sport after musculoskeletal injury.

Finally, one-third of all athletes in the present study reported major impact of injury on their future plans and/or life goals with no difference

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between sexes. This further reinforces the fact that female athletes value sport participation as much as their male counterparts. With continually growing opportunities for female athlete sport participation in addition to known benefits beyond that of cardiovascular fitness, including psychosocial, educational, and socioeconomic benefits [14-16], young women are motivated to pursue higher levels of sport competition. As sports medicine providers, recognizing the importance of injury prevention is key in allowing young athletes—both female and male—to reach their full athletic potentials, which may in turn have life-long benefits beyond athletics.

This prospective, cross-sectional, survey-based study has multiple limitations inherent to its study design, including risk for response and recall bias. Athletes without prior injury history may have been less likely to respond, and it is possible that those athletes may have had increased exposure to IPPs. To this effect, female athletes who were excluded due to lack of significant injury more commonly reported prior injury prevention training (77% vs 44%) and incorporation of preventative exercises into practice settings (63% vs 23%) compared to female athletes included in the study population, though this finding is of limited relevance due to low sample size (n=16) and frequent incomplete survey responses. Additionally, the survey tool was initially designed in an effort to inform a journalistic endeavor with primarily binary response options. Inclusion of Likert scales would have allowed for increased granularity in responses, enhancing detection of relationships of smaller effect size and overall strength of associations. Given concern for anonymity, additional participant demographics, including ethnicity, socioeconomic status, and high school funding were not collected and may have independent influence on access to preventative exercise. Recruitment was primarily focused on students at a single private high school which limits generalizability across publicly funded schools.

CONCLUSION

This study identifies a lack of exposure to preventative exercise and IPP implementation in all high school student-athletes, while emphasizing greater deficiencies in injury prevention strategies among female compared to male athletes. Given known sex-related disparities including increased injury risk and severity for high school girls compared to boys, along with proven benefit of IPPs, these findings highlight the need for better IPP utilization. Sex-specific differences in injury management and return to sport were not identified in this study and remain largely unknown for most sport-related injuries. Future research should focus on improving injury prevention education, addressing known barriers to IPP implementation to allow for better adoption at the high school level, and investigating sex differences in injury management and return to sport with the goal of providing more equitable care and reducing preventable injury in all athletes.

Conflict of Interest Statement

The authors report no conflict of interest with the contents of this manuscript.

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REFERENCES

1. *2018-2019 High School Athletics Participation Survey [online database]*. 2019, The National Federation of State High School Associations.
2. *NCAA Sports Sponsorship and Participation Rates Database [online database]*. 2019, National Collegiate Athletic Association.
3. Tanaka, M.J., et al., *Changes in U.S. girls' participation in high school sports: implications for injury awareness.* Phys Sportsmed, 2020: p. 1-5.
4. *Summary Report National High School Sports-Related Injury Surveillance Study 2018-2019 School Year [online database]*. 2019.
5. Brant, J.A., et al., *Rates and Patterns of Lower Extremity Sports Injuries in All Gender-Comparable US High School Sports.* Orthop J Sports Med, 2019. **7**(10): p. 2325967119873059.
6. Carter, C.W., et al., *Sex-based Differences in Common Sports Injuries.* J Am Acad Orthop Surg, 2018. **26**(13): p. 447-454.
7. Lin, C.Y., et al., *Sex Differences in Common Sports Injuries.* Pm r, 2018. **10**(10): p. 1073-1082.
8. Borgstrom, H. and K.C. McInnis, *Female Athlete Hip Injuries: A Narrative Review.* Clin J Sport Med, 2020.
9. Ireland, M.L., *The female ACL: why is it more prone to injury?* Orthop Clin North Am, 2002. **33**(4): p. 637-51.
10. Barengo, N.C., et al., *The impact of the FIFA 11+ training program on injury prevention in football players:*

DOI: 10.53646/jwsm.viii.3
PUBLISHED ONLINE: SEPT 26, 2021

a systematic review. Int J Environ Res Public Health, 2014. **11**(11): p. 11986-2000.
11. Rossler, R., et al., *Exercise-based injury prevention in child and adolescent sport: a systematic review and meta-analysis.* Sports Med, 2014. **44**(12): p. 1733-48.
12. Crossley, K.M., et al., *Making football safer for women: a systematic review and meta-analysis of injury prevention programmes in 11 773 female football (soccer) players.* Br J Sports Med, 2020. **54**(18): p. 1089-1098.
13. Norcross, M.F., et al., *Factors influencing high school coaches' adoption of injury prevention programs.* J Sci Med Sport, 2016. **19**(4): p. 299-304.
14. Stevenson, B., *Beyond the Classroom: Using Title IX to Measure the Return to High School Sports.* The Review of Economics and Statistics, 2010. **92**(2): p. 284-301.
15. Briere, F.N., et al., *Prospective associations between sport participation and psychological adjustment in adolescents.* J Epidemiol Community Health, 2018. **72**(7): p. 575-581.
16. Fox, C.K., et al., *Physical activity and sports team participation: associations with academic outcomes in middle school and high school students.* J Sch Health, 2010. **80**(1): p. 31-7.
17. McGuine, T., *Sports injuries in high school athletes: a review of injury-risk and injury-prevention research.* Clin J Sport Med, 2006. **16**(6): p. 488-99.
18. Joseph, A.M., et al., *A multisport epidemiologic comparison of anterior cruciate ligament injuries in high school athletics.* J Athl Train, 2013. **48**(6): p. 810-7.
19. Gornitzky, A.L., et al., *Sport-Specific Yearly Risk and Incidence of Anterior Cruciate Ligament Tears in High School Athletes: A Systematic Review and Meta-analysis.* Am J Sports Med, 2016. **44**(10): p. 2716-2723.
20. Beck, N.A., et al., *ACL Tears in School-Aged Children and Adolescents Over 20 Years.* Pediatrics, 2017. **139**(3).
21. DiStefano, L.J., et al., *Influence of age, sex, technique, and exercise program on movement patterns after an anterior cruciate ligament injury prevention program in youth soccer players.* Am J Sports Med, 2009. **37**(3): p. 495-505.
22. Lim, B.O., et al., *Effects of sports injury prevention training on the biomechanical risk factors of anterior cruciate ligament injury in high school female basketball players.* Am J Sports Med, 2009. **37**(9): p. 1728-34.
23. McGuine, T.A. and J.S. Keene, *The effect of a balance training program on the risk of ankle sprains in high school athletes.* Am J Sports Med, 2006. **34**(7): p. 1103-11.
24. van der Horst, N., et al., *The preventive effect of the nordic hamstring exercise on hamstring injuries in amateur soccer players: a randomized controlled trial.* Am J Sports Med, 2015. **43**(6): p. 1316-23.
25. Petushek, E.J., et al., *Evidence-Based Best-Practice Guidelines for Preventing Anterior Cruciate Ligament Injuries in Young Female Athletes: A Systematic Review and Meta-analysis.* Am J Sports Med, 2019. **47**(7): p. 1744-1753.
26. Mugele, H., et al., *General versus sports-specific injury prevention programs in athletes: A systematic review on the effect on injury rates.* PLoS One, 2018. **13**(10): p. e0205635.
27. Lopes, T.J.A., et al., *The Effects of Injury Prevention Programs on the Biomechanics of Landing Tasks: A Systematic Review With Meta-analysis.* Am J Sports Med, 2018. **46**(6): p. 1492-1499.
28. Brunner, R., et al., *Effectiveness of multicomponent lower extremity injury prevention programmes in team-sport athletes: an umbrella review.* Br J Sports Med, 2019. **53**(5): p. 282-288.
29. Thompson, J.A., et al., *Biomechanical Effects of an Injury Prevention Program in Preadolescent Female Soccer Athletes.* Am J Sports Med, 2017. **45**(2): p. 294-301.
30. van Dyk, N., F.P. Behan, and R. Whiteley, *Including the Nordic hamstring exercise in injury prevention programmes halves the rate of hamstring injuries: a systematic review and meta-analysis of 8459 athletes.* Br J Sports Med, 2019. **53**(21): p. 1362-1370.
31. Tanaka, M.J., L.C. Jones, and J.M. Forman, *Awareness of Anterior Cruciate Ligament Injury-Preventive Training Programs Among Female Collegiate Athletes.* J Athl Train, 2020. **55**(4): p. 359-364.
32. Bizzini, M., A. Junge, and J. Dvorak, *Implementation of the FIFA 11+ football warm up program: how to approach and convince the Football associations to invest in prevention.* Br J Sports Med, 2013. **47**(12): p. 803-6.
33. Pfile, K.R. and B. Curioz, *Coach-led prevention programs are effective in reducing anterior cruciate ligament injury risk in female athletes: A number-needed-to-treat analysis.* Scand J Med Sci Sports, 2017. **27**(12): p. 1950-1958.
34. McGuine, T.A., et al., *Basketball coaches' utilization of ankle injury prevention strategies.* Sports Health, 2013. **5**(5): p. 410-6.
35. Mawson, R., et al., *Lower limb injury prevention programs in youth soccer: a survey of coach knowledge, usage, and barriers.* J Exp Orthop, 2018. **5**(1): p. 43.
36. Lindblom, H., S. Carlfjord, and M. Hagglund, *Adoption and use of an injury prevention exercise program in female football: A qualitative study among coaches.* Scand J Med Sci Sports, 2018. **28**(3): p. 1295-1303.
37. Donaldson, A., et al., *A concept mapping approach to identifying the barriers to implementing an evidence-based sports injury prevention programme.* Inj Prev, 2019. **25**(4): p. 244-251.
38. Owoeye, O.B.A., et al., *Advancing adherence research in sport injury prevention.* Br J Sports Med, 2018. **52**(17): p. 1078-1079.
39. Perera, N.K.P. and M. Hagglund, *We have the injury prevention exercise programme, but how well do youth follow it?* J Sci Med Sport, 2020. **23**(5): p. 463-468.
40. Kontos, A.P., *Perceived risk, risk taking, estimation of ability and injury among adolescent sport participants.* J Pediatr Psychol, 2004. **29**(6): p. 447-55.
41. Bolling, C., et al., *Letting the cat out of the bag: athletes, coaches and physiotherapists share their perspectives on*

DOI: 10.53646/jwsm.viii.3
PUBLISHED ONLINE: SEPT 26, 2021

injury prevention in elite sports. Br J Sports Med, 2020. **54**(14): p. 871-877.
42. Martinez, J.C., et al., *Female adolescent athletes' attitudes and perspectives on injury prevention programs.* J Sci Med Sport, 2017. **20**(2): p. 146-151.
43. Desai, N., et al., *Factors Affecting Recovery Trajectories in Pediatric Female Concussion.* Clin J Sport Med, 2019. **29**(5): p. 361-367.
44. Berz, K., et al., *Sex-specific differences in the severity of symptoms and recovery rate following sports-related concussion in young athletes.* Phys Sportsmed, 2013. **41**(2): p. 58-63.
45. Mollayeva, T., G. El-Khechen-Richandi, and A. Colantonio, *Sex & gender considerations in concussion research.* Concussion, 2018. **3**(1): p. CNC51.
46. Webster, K.E. and J.A. Feller, *Return to Level I Sports After Anterior Cruciate Ligament Reconstruction: Evaluation of Age, Sex, and Readiness to Return Criteria.* Orthop J Sports Med, 2018. **6**(8): p. 2325967118788045.
47. Lisee, C.M., et al., *Gender Differences in Psychological Responses to Recovery After Anterior Cruciate Ligament Reconstruction Before Return to Sport.* J Athl Train, 2020. **55**(10): p. 1098-1105.
48. Druckman, J.N., et al., *Racial bias in sport medical staff's perceptions of others' pain.* J Soc Psychol, 2018. **158**(6): p. 721-729.
49. Unruh, S., *Perceptions of athletic training services by collegiate student-athletes: a measurement of athlete satisfaction.* J Athl Train, 1998. **33**(4): p. 347-50.
50. Unruh, S., et al., *Collegiate Student-Athletes' Satisfaction With Athletic Trainers.* J Athl Train, 2005. **40**(1): p. 52-55.

DOI: 10.53646/jwsm.viii.3
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