Evaluating ACL Injury Risk by Sex, Sport, and Competition Level: A Systematic Review and Meta-Analysis

Luke Terrian BS[1], Jon Novosel BS[1], Dana Norman MS[2], Alicia Montalvo PhD[3], Erich Petushek PhD[2]

[1]Michigan State University College of Human Medicine, [2]Michigan[2] Technological University Department of Biological Sciences, [3]Arizona State University College of Health Solutions

College of Human Medicine
MICHIGAN STATE UNIVERSITY

Introduction

Despite the effectiveness of preventative neuromuscular training programs for reducing ACL injuries, ACL injury rates remain high.

- Possible lack of implementation of training programs or lack of targeted implementation of preventative efforts

Identifying high risk cohorts may aid in effective preventative measures

- Certain demographics are associated with increased risk
- Gaps exist in injury risk data for specific groups of athletes

There is a need for easily understandable data on injury risk

- The common convention for quantifying risk is athlete exposures
  - Difficult metric to understand for practitioners and the public

Objectives

- Primary objective: Estimate the risk of primary ACL injury across sport, competition level, and sex using an easily applicable metric of injuries per athlete-year.
- Secondary objective: Address the variability in reported injury rates and identify cohorts with little available injury incidence data

Methods

PRISMA guidelines followed

- Literature searches of electronic databases were performed in April 2021 and March 2022 with a final update in March 2025.

Inclusion and exclusion criteria

- Inclusion criteria: English language, organized sport population, total number of primary ACL injuries reported.
- Exclusion criteria: Secondary injuries were not differentiated, total population not identified, no mention of ACL injuries, multi-sport athletes, no differentiation of sex, recreational or youth sports, no ACL injuries noted.

Data Extraction

- Number of ACL injuries, competition level, sport type, and study period were extracted. Injury rate per season was calculated.

Data Analysis

- Primary outcome was ACL injury rate. We used software environment R for univariate subgroup and meta-analysis techniques

Results

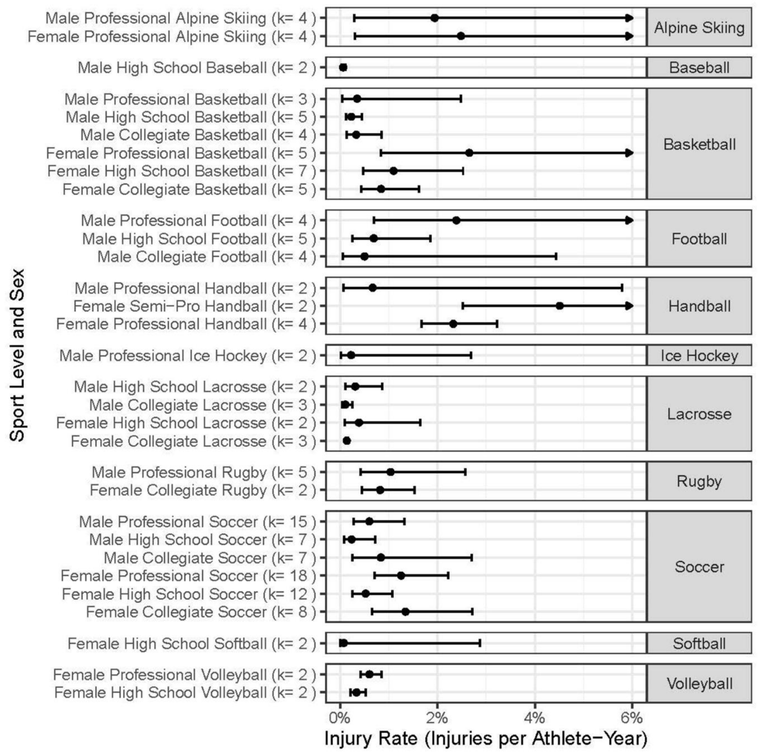

Fig. 1: Forest plot for the combined injury risk of anterior cruciate ligament injury in male and female sports, across each level. Error bars represent the 95% confidence intervals (CI's).

Number of ACL Injuries

Sport	Sex	Level: High School	Level: Collegiate	Level: Professional
Alpine Skiing	Male	11	NA	158
	Female	4	NA	183
Australian Rules Football	Female	NA	NA	11
Ballet	Male	NA	NA	1
	Female	NA	NA	2
Basketball	Male	45	350	50
	Female	171	1121	40
Dance	Male	NA	NA	1
	Female	NA	NA	8
Field Hockey	Female	4	1	NA
Floorball	Male	0	NA	NA
	Female	8	NA	3
Football	Male	388	386	820
Handball	Male	NA	NA	73
	Female	12	11	71
Ice Hockey	Male	NA	17	86
	Female	NA	5	NA
Lacrosse	Male	29	187	NA
	Female	38	165	NA
Netball	Female	NA	NA	4
Rugby	Male	16	3	33
	Female	NA	27	NA
Soccer	Male	855	2037	1643
	Female	493	1065	302
Softball / Baseball	Male	11	2	NA
	Female	22	12	NA
Volleyball	Female	20	1	37
Wrestling	Male	27	NA	NA

Legend
# of ACL Injuries
Lowest
Medium
Highest

Fig 2: Heat Map denoting number of ACL injuries across Sport, Sex and Level. The cells listed with NA (Not Applicable) indicate that there were no studies found based on the specified demographic.

Conclusions

- There is high variability in results with limited data available for ACL injury rate differences between sexes in various sports and levels
- Female athletes demonstrated higher risk of ACL injury compared to male athletes, but it is unclear if this is true for all sports and levels
- The highest risk of ACL injury was observed in professional and semi-professional sports.
  - The highest risk sports were:
    - Female semi-pro handball (IR=0.045/athlete-year)
    - Female professional basketball (IR=0.027/athlete-year)
    - Female professional alpine skiing (IR=0.025/athlete-year)
- Due to sparsity of data, investigators and practitioners should be cautious about overgeneralizing between-sex and between-sport differences to the athletes they work with
  - While keeping general trends in mind, they should consider specific sport and individual athlete factors when developing strategies for ACL injury prevention
- Future research should focus on collecting ACL injury data from a wider array of sports and levels
- More complete coverage of sports & levels will provide a better understanding of injury rates to decide what groups need more resources allocated for injury prevention training
- Efforts should be made to create databases like the National Football League Surveillance Database and International Olympic Committee Injury Surveillance System across more sports & levels

References

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2. Barenius B, Ponzer S, Shalabi A, Bujak R, Norlén L, Eriksson K. Increased risk of osteoarthritis after anterior cruciate ligament reconstruction: a 14-year follow-up study of a randomized controlled trial. Am J Sports Med. May 2014;42(5):1049-57.

*Complete reference list is available upon request