SYSTEMATIC REVIEW & META-ANALYSIS

INJURY EPIDEMIOLOGY AND SURVEILLANCE IN BASKETBALL: A SYSTEMATIC REVIEW OF REPORTING METHODS AND META-ANALYSIS OF INJURY RATES

CRAIG BARDEN,[1] CHARLOTTE MCMASTER,[1] MATTHEW G. NEILL,[2,3,4] KIRSTEN WING,[1] KATY AHERNE,[1] MARK DE STE CROIX,[1]

[1] School of Education, Health and Science, University of Gloucestershire, Oxstalls Campus, Gloucester, GL2 9HW, UK.
[2] Sport Injury Prevention Research Centre, University of Calgary, 2500 University Drive, Calgary, Alberta, T2N 1N4, Canada.
[3] Cerebrovascular Concussion Lab, University of Calgary, 2500 University Drive, Calgary, Alberta, T2N 1N4, Canada.
[4] Human Performance Laboratory, Faculty of Kinesiology, University of Calgary, 2500 University Drive, Calgary, Alberta, T2N 1N4, Canada.

ABSTRACT

Introduction: Basketball is one of the most widely played sports worldwide, with injuries ranging from contact-related concussions to overuse tendinopathies. However, considerable methodological variation exists across injury surveillance studies, limiting the ability to directly compare findings between studies. This systematic review and meta-analysis aimed to (1) describe the reporting methods used in basketball injury surveillance research and (2) examine injury incidence rates (IIR) across different playing levels, age groups, and sexes using a range of injury definitions and exposure denominators.

Methods: Five electronic databases were searched for studies reporting basketball injury rates (PROSPERO registration: CRD42023487335). Inclusion criteria included peer-reviewed articles, written in English, describing injury rates in 5v5 training/games. Data pertaining to study demographics, reporting methods, risk of bias (modified Downs and Black checklist) and injury data were extracted. Reporting methods data was assessed descriptively. A meta-analysis was performed on pooled IIR of training and games using medical-attention (MA) and time-loss (TL) injury definitions, combined with exposure per 1000 player-hours (/1000h) or 1000 athlete-exposure (/1000AE).

Results: A total of 3,177 studies were identified, with 119 unique articles included in the review. Ten distinct injury definitions were found, with TL (55%) and MA (19%) the most common. Nine different exposure denominators were found, the most common being athlete-exposure (70%). From the meta-analysis, match IIR exceeded training incidence for all injury definitions and exposure types. A pooled TL match IIR of 6.8/1000AE (95% CI 5.0-9.5) and 24.3/1000h (95% CI 16.8-35.2) were reported, notably greater than training IIR (1.9/1000AE, 95% CI 1.4-2.4 and 2.3/1000h, 95% CI 1.4-3.9, respectively).

Conclusion: This is the first review to describe the wide range of surveillance methods adopted in basketball surveillance studies. This meta-analysis provides the most comprehensive synthesis of basketball literature, reporting pooled IIR across various contexts and settings using various exposure types and injury definitions.

ARTICLE INFO

Submitted: 12th March '26
Accepted: 8th June '26
Published: 12th June '26

Correspondence to: cbarden@glos.ac.uk

Published by Motion Publishing Group.

KEYWORDS: Basketball, Injury, Methodology, Epidemiology, Surveillance, Sport

1. INTRODUCTION

The international governing body of basketball (Fédération Internationale de Basketball; FIBA) reports that nearly 600 million people play the sport twice or more monthly[1], making it one of the most participated in sports worldwide. There are 212 national basketball federations globally overseen by FIBA[2], with two variations of the sport in the summer

Olympic games (traditional 5-v-5 and 3x3), highlighting the sport's popularity from a participation and viewership perspective.

Basketball is fast-paced and multi-directional in nature, requiring repetitive efforts to jump, accelerate, decelerate, and change direction to obtain a higher score than the opposition by scoring the ball in the opposing basketball hoop[3]. Whilst not a collision sport, there are numerous facets of contact in the game, with contact often reported as the most frequent mechanism of injury[4]. As such, the aetiology of injury is varied, ranging from overuse tendinopathies[5] to severe ligament ruptures sustained through contact and non-contact mechanisms[6], making injury prevention challenging. Evidence suggests the lower limb is consistently the most frequently injured[7, 8], with ankle injuries the most common[4, 9]. Much of the existing epidemiological literature comes from the United States, where nationwide, longitudinal surveillance projects have reported injury rates in high schools[10, 11], collegiate[12, 13] and professional[7, 14] levels of the game spanning decades. Studies have been conducted in Canadian[15], English[16] and Finnish[17] youth basketball cohorts, whilst injury rates have been described in professional Spanish[18, 19] and Australian leagues[20]. However, making comparisons between studies, populations, and playing levels is fraught with issues, given the ranges in methodologies applied throughout the literature.

Multiple injury definitions exist such as all complaint (ALL; any complaint an athletes may experience regardless of whether it requires medical assessment), medical-attention (MA; a complaint which is assessed by a medical professional irrespective of whether an athlete experiences time/exposure loss), non-time loss (NTL; a complaint which is assessed by a medical professional but does not result in any time/exposure loss) and time-loss (TL; a complaint which is assessed by a medical professional which prevents the athlete from participating in training/matches)[21, 22]. These definitions are not mutually exclusive, with a single injury possibly defined as both MA and TL injury depending on data collection methods. This is further convoluted with studies erroneously using various injury definitions interchangeably[23]. Most studies opt for a TL definition due to its ease of implementation and improved reliability in data collection, especially in non-professional settings where medical care may be limited, resulting in underreporting of NTL or MA injuries[24]. However, this approach potentially omits the burden of pathologies that may cause a player symptoms or reductions in physical capabilities but does not limit their availability for selection. Detection and management of NTL injuries are important given their potential to increase in severity and result in time-loss[25]. Furthermore, there are variations in the exposure denominator used to calculate injury incidence rates (IIR), with the most common being athlete-exposures (AE) or player-hours (h)[21]. The two are not synonymous, and it is difficult to compare rates with different denominators[26]. There appears to be a preference in North America to adopt an AE denominator, with a time denominator more widely used in Europe. As such, it is not often possible to compare injury rates from studies in different environments, with surveillance methods and collection procedures selected to suit the intended context.

Systematic reviews and meta-analyses aim to provide a complete synthesis of evidence pertaining to a topic. Previous systematic reviews and meta-analyses detailing IIR in basketball have focused on specific exposure denominators or injury definitions[27], explicit pathologies[28] and/or certain populations[29], leading to a small number of papers included in each review. A comprehensive review of the basketball injury literature is needed to aid the development of injury prevention strategies.

The first objective was to report the different definitions and reporting methods used in the basketball injury surveillance literature. The second objective of this literature review and meta-analysis was to describe the injury epidemiology of basketball across all playing levels, sex, age-groups, situations, playing-levels and identify common mechanisms and risk factors for injury.

2. MATERIALS AND METHODS

This review was conducted as per the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines and registered prospectively with PROSPERO (CRD42023487335).

2.1. Search Strategy and Study Inclusion

In consultation with a health subject librarian, five electronic databases were searched (CINAHL, Medline, PubMed, SportDiscus, Scopus), along with searching for other relevant articles through trawling bibliographies and internet searches. The search strategy (appendix A) focused upon basketball injuries in all contexts, age groups, and playing levels. No restrictions or filters were made when searching databases, with articles included from the date of database inception to the search date (search most recently updated in February 2026). Search results from each database were exported to EndNote, with duplicates automatically removed, after which the remaining titles and abstracts were exported to a bespoke Excel worksheet to allow reviewers to screen each article.

For the title and abstract screening phase, inclusion criteria included being published in a peer-reviewed journal, written in English, reporting overall and/or game and/or training injury rates (no restriction on definition) per an exposure denominator (no restriction on specific denominators), and not an intervention-based study and investigated traditional 5v5 basketball. Studies that used self-reported injury data were excluded due to issues around recall bias[30]. Exclusion criteria for the title and abstract screening phase included studies that investigated other forms of basketball (e.g., 3x3, wheelchair, referees), where basketball injury rates were pooled with other sports and could not be separated, cohorts who had sustained a previous injury, or re-injury risk (i.e., IIR post-achilles rupture). Exclusion criteria were updated prior to the full-text screening phase, where hospital-based studies were excluded due, to no exposure data reported beyond persons or years, studies that investigated a subtype of injury (i.e., non-contact knee injuries), due to the review not detailing injury subtypes, and studies that used press releases or other publicly available information to gather injury records due to concerns about the accuracy of these data sources[31]. Articles where data had been reported in a previous study were excluded to avoid duplication of results.

The title and abstract screening was split between two pairs, with each pair screening half the articles. To ensure consistency between reviewers, a guidance document was created, whilst calibration was conducted on the first 50 articles by all reviewers to identify issues and provide guidance. After this, each individual reviewer screened their articles independently on a bespoke spreadsheet, before agreement (Cohen's Kappa) with their partner was assessed by the lead author (pair 1: κ=0.73, raw agreement=0.91; pair 2: κ=0.57, raw agreement=0.80). Disagreements within pairs were resolved through discussion and reference to the guidance document. There were no articles where agreement could not be established between each pair. For articles accepted in this stage, full texts were retrieved, and then each pair worked through these articles in the same manner as the previous stage to see whether articles met the inclusion or exclusion criteria.

2.1.1. Data Extraction

Data extraction focused on four areas: study demographics, reporting methods, risk of bias, and injury data. Risk of bias was assessed using the modified Downs and Black (DB) Checklist for non-randomised studies[32]. Data was extracted into a bespoke Microsoft Excel worksheet by a single author for each area. To improve accuracy, two authors independently extracted all information for three studies to calibrate data and ensure the spreadsheet was suitable and extraction was consistent.

Demographic variables extracted included: author name, year of publication, country, continent, study period (years), sex, age group, playing age group (youth (age restricted up to under-21s or senior), playing level (amateur, professional, representative (international)), setting (school, club, university, other), and injury surveillance system (if applicable). Reporting methods variables included injury definition, exposure denominator, exposure rate, and severity classification. Injury statistics included count, injury incidence, injury severity, injury burden, situation (game, training), injury type (ligament, muscle/tendon, nerve, joint, contusion/laceration, fracture, dental, multiple), injury mechanism (contact with player/ball, other contact (floor, bleacher, basket), non-contact (identifiable mechanism), overuse (non-identifiable mechanism)), general body region (head/neck, upper-limb, lower-limb, trunk/torso), specific body locations, specific pathologies (e.g., concussion, anterior cruciate ligament (ACL) injury, ankle sprain, patella tendinopathy and achilles tendinopathy) and player position (centre, forward, guard).

2.1.2. Injury statistics for systematic review

Overall, match and/or training IIR were reported for all exposure types, injury definitions, and sub-categories (sex, playing-age, playing-level, setting, situation (match or training), injury type, mechanism, and location). Aggregated IIR and 95% confidence intervals (95% CI) were calculated manually (incidence per exposure denominator = ((injury count/ exposure count)*denominator)) if injury count and raw exposure were available due to some studies rounding IIR to the nearest whole number. If this data was not reported but an IIR was, the rate stated in the publication was used. Injury severity (days lost) was extracted for TL injuries, and where possible, multiplied by IIR to generate injury burden (days lost per a standardised denominator).

2.2. Meta-Analysis of Injury Incidence Rates

Guided by the results of the reporting methods (section 3.2), a meta-analysis was performed separately for match and training IIR, for TL and MA injury definitions, using both 1000-player hours (/1000h) and athlete-exposure (/1000AE) denominators. Data was prepared by calculating the log-transformed IIR (Log (IR)) alongside the standard error. A Der Simonian-Laird continuous random effects meta-analysis was performed in SPSS (Windows v29.0.1.0), selected due to an assumption of large variations in effect sizes. Using Log (IR) as the effect size, the pooled Log (IR) was back-transformed to provide a pooled IIR (with 95% confidence intervals). Heterogeneity was assessed using the I^2 (<25% = low, 25-75% = moderate, >75% = high) and Tau^2 statistics. Sub-group analysis was conducted by sex (male and female) and playing-age group (youth, senior, mixed), provided that four or more studies were included in the sub-group.

3. RESULTS

A total of 3,177 articles were retrieved after the initial database search, with 1,108 duplicates removed prior to any screening (Figure 1). 2,069 unique articles were screened in the title/abstract phase, with 422 articles meeting the inclusion criteria to go through to the full-text screening phase. Of these, full texts were unavailable for 30 articles, resulting in 392 articles being fully screened, of which 119 were included in the review.

3.1. Descriptive overview of studies included

Of the 119 studies included, 52.1% were published between 2011 and 2020, with 9.2% of studies published before 2001. Most studies (74.8%, n=89) reported IIR for both male and female cohorts, with 23.5% investigating injury rates in only one sex (15.1%, n=18 male; 8.4%, n=10 female), and two studies not reporting sex (1.7%). Half of the included studies investigated an adult population (49.6%, n=59), with 41.2% investigating a youth population (n=49), and the remaining a combination of age groups (9.2%, n=11). Over three-quarters of all studies assessed IIR in participants playing in North America (77.3%; United States n=87, Canada n=5), with 16.0% conducted in Europe (Spain n=7, Finland n=4, other n=8) and the remaining continents having three or less studies included in the review.

Most studies were conducted in a high-school setting (47.1%, n=56), followed by university (28.6%, n=34) and then club basketball (26.9%, n=32). Within club basketball, half of the studies reported injury rates in professional teams (n=15), youth teams (n=11), and amateur senior sides (n=6).

A total of 16 different injury surveillance systems were reported, with 46 studies (38.7%) not reporting a specific system or project. High School Reporting Information Online (HS RIO) was the most used system (29.4%, n=35), followed by the National Collegiate Athletic Association (NCAA) Injury Surveillance Project (NCAA ISP; 15.1%, n=18), which proceeded the NCAA Injury Surveillance System (NCAA ISS; 4.2%, n=5). A full demographic breakdown per study can be found in appendix B).

3.1.1. Risk of bias

The mean modified DB score was 8.4/17 (range 5-14), with studies attaining much of their score for *reporting* (mean 4.9/9; Table 1), whilst the highest percentage score was observed for *interval validity – bias* (mean

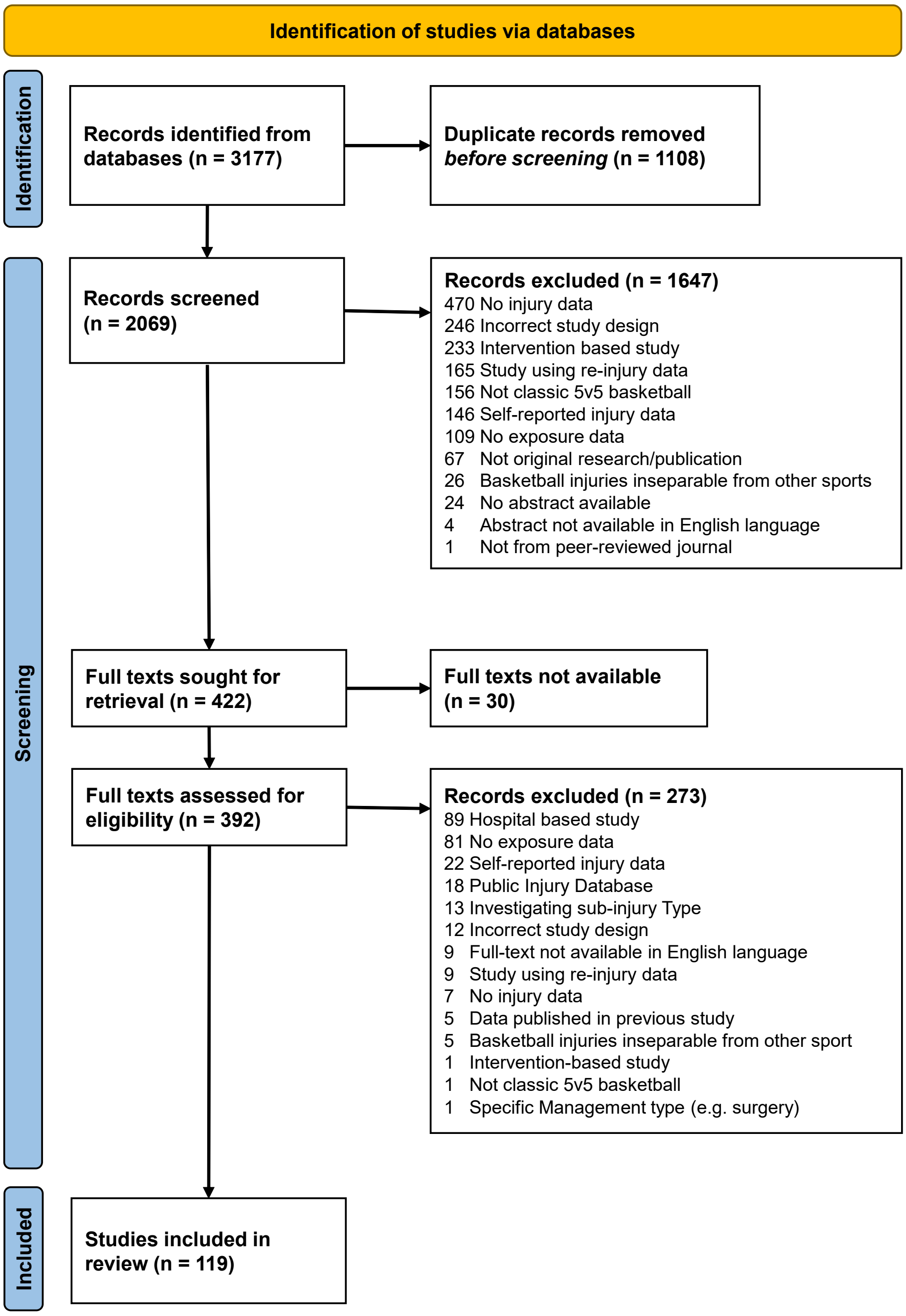

FIGURE 1. PRISMA Flow chart

TABLE 1. Mean Modified Downs and Black checklist score, broken down by dimension and publication decade

		Modified Downs and Black Checklist Dimension					
Decade of Publication	**Count (%)**	**Reporting**	**External Validity**	**Internal Validity - Bias**	**Internal Validity - Confounding**	**Power**	**Total**
1971 - 1980	1 (0.8%)	2	1	2	0	0	5.0
1981 - 1990	1 (0.8%)	3	0	3	0	0	6.0
1991 - 2000	9 (7.6%)	4.3	0.7	2.7	0.3	0.1	8.1
2001 - 2010	23 (19.3%)	4.7	0.4	3.0	0.3	0.0	8.4
2011 - 2020	62 (52.1%)	5.0	0.3	2.9	0.1	0.0	8.3
2021 - 2026	23 (19.3%)	5.1	0.3	3.0	0.2	0.0	8.6
Overall	**119**	**4.9/9**	**0.3/2**	**2.9/3**	**0.2/2**	**0.0/1**	**8.4/17**

2.9/3). Generally, DB scores increased over time, largely due to an increase in *reporting* despite a decrease in *external validity.* Modified DB score for each study is available in appendix C.

3.2. Reporting Methods

Ten distinct injury definitions were used across all studies, with nine studies not defining an injury definition (Figure 2). Most studies adopted a TL definition (54.6%, n=65), although there was a range of TL definitions used, including 24-hour (n=47), session (n=15), restricted participation (n=2), or unknown TL (n=1). The next most common definition was MA (19.3%, n=23), which may incorporate both NTL and TL injuries. TL (all) and MA injury definitions were used for the meta-analysis, given the frequency of studies using these definitions.

A total of nine different exposure denominators were found across all studies, with AE being the most adopted (69.7%, n=83), followed by player-hours (19.3%, n=23). However, within these there were multiple different denominators used. For example, AE were expressed per 1000 (n=41), 10,000 (n=30), 100,000 (n=11), and 1,000,000 (n=1) AE. There were 17 different specific denominators used across all studies, with 10 studies using multiple denominators to report injury rates. AE and player-hours were used for the meta-analysis, given the frequency of studies using these definitions.

Forty-seven (39.5%) studies reported no injury severity measures. Of those reporting severity, measures ranged from grouped severity classifications (47.1%, n=56), a specific number of days lost (10.1%, n=12), number of missed athletic exposures (1.7%, n=2), hospital attendance/surgery (1.7%, n=2), days to symptom resolution, games missed, number of treatments, hospital attendance, and medical disqualification (all 0.8% n=1). Of the studies selecting grouped severity, there were 17 different injury classifications used, the most common being ‘<7 days, 7-21 days, >21 days’ (n=13), followed by ‘<8, 8-28 days, >28 days’ (n=6). Only 12 studies reported days-lost, a metric required to calculate TL injury burden.

3.3. Descriptive Injury Statistics

Aggregated IIR, and further descriptive statistics, can be found in table 2, broken down by injury definition, situation, sex, playing-age group and setting. An interactive dashboard of injury data is available in appendix D.

3.3.1. Injury Burden

Only two studies provided the mean days-lost to calculate injury burden for matches and training. In the Great Britain Men’s national team[33], match injury burden was 675 days-lost/1000h (95% CI 234-1115; mean 7.0 days-lost), whilst training injury burden was 46.7 days-lost/1000h (95% CI 55-133; mean 8.3 days-lost). In an English high-school cohort[16], match injury burden was 671 days-lost/1000h (95% CI 377-965; mean 18 days-lost), whilst training injury burden was 62 days-lost/1000AE (95% CI 37-88; mean 26 days-lost).

3.3.2. Body Region and Diagnoses

The lower limb had the highest TL injury incidence for training and matches of all body regions across both exposure denominators (Table 3). There were variations in the second most injured body region, with upper-limb IIR being higher for games when using an AE denominator (1.8/1000AE), but head/neck injuries were more common in matches per player-hours denominator (1.6/1000h), although the number of injuries in the sample for studies using a player-hours denominator was relatively small. The ankle was the most injured body location, with overall TL match IIR for ankle sprains being 1.7/1000AE and 9.3/1000h. TL match concussion rates were 0.7/1000AE and 0.4/1000h, with only 2 concussions recorded in studies using a player-hour denominator.

3.3.3. Injury type and Mechanism

TL ligament injuries were most common across matches and training, with contusion and muscle/tendon injuries second most common, depending on the denominator (Table 3). There were variations in TL match injury mechanism, with ‘other contact’ most common using an AE denominator (1.1/1000AE) and ‘player contact’ more common using a time denominator (10.1/1000h). Similarly, ‘non-contact’ TL injuries were most common in training using an AE denominator (0.6/1000AE), whilst ‘player contact’ was most common using a training time denominator (0.9/1000h).

3.3.4. Playing Position

Data was only available for TL match injuries per AE, with no significant difference

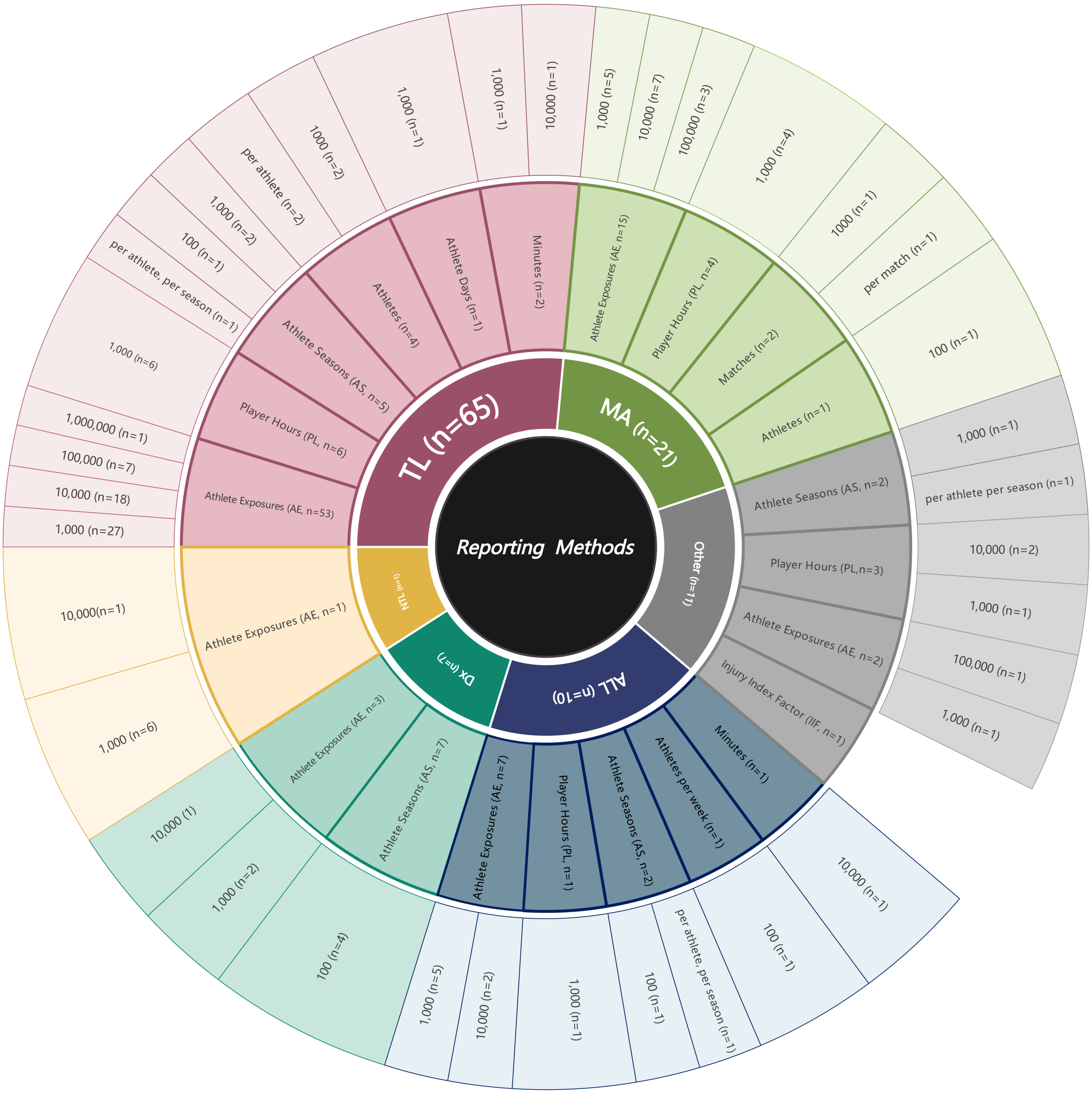

FIGURE 2. Figure demonstrating range of injury reporting methods. The inner ring represents the injury definitions, the middle ring represents the exposure type, and the outer ring represents the exposure denominator value. TL = time-loss, MA = medical attention, NTL = non-time loss, Dx = diagnosis, ALL = all complaint.

demonstrated between all three positional groups (guard: 21.3/1000AE, 95% CI 20.7-21.9; Forward: 21.7/1000AE, 95% CI 21.1-22.3; Centre: 21.0/1000AE, 95% CI 20.4-21.6).

3.4. Meta-Analysis

3.4.1. Pooled Match Injury Incidence Rates

For studies using an AE denominator, TL (all) match injury incidence ranged from 2.4-28.6/1000AE, with an overall pooled IIR of 6.8/1000AE (95% CI 5.0-9.5; Figure 3a). MA match injury incidence ranged from 9.4-66.7/1000AE, with a pooled MA match IIR of 15.0/1000AE (95% CI 12.7-17.6; Figure 3b), with high heterogeneity observed across studies ($I^2 = 0.97$).

For studies using a player-hour denominator, TL (all) match injury incidence ranged from 5.6-96.8/1000h, with an overall pooled IIR of 24.3/1000h (95% CI 16.8-35.2; Figure 4a). The pooled TL match incidence of senior basketball was notably higher than that of youth (43.4/1000h; 95% CI 33.8-55.1 and 20.1/1000h; 95% CI 13.1-30.9, respectively). Male

TABLE 2. Descriptive overview of injury count and exposure per various injury definitions and exposure denominator. Descriptive statistics for aggregated TL (all) injury incidence rates by sex, playing age, and playing level.

	1000AE						1000H					
	Match			Training			Match			Training		
Definition	**Injuries (n)**	**Exposure (AE)**	**Incidence (95% CI)**	**Injuries (n)**	**Exposure (AE)**	**Incidence (95% CI)**	**Injuries (n)**	**Exposure (h)**	**Incidence (95% CI)**	**Injuries (n)**	**Exposure (h)**	**Incidence (95% CI)**
TL (all)	15,191	2,009,747	7.6 (7.4-7.7)	10,179	4,835,637	2.1 (2.1-2.1)	4,975	119,036	41.8 (40.6-43)	873	474,594	1.8 (1.7-2)
MA	5,718	506,457	11.3 (11-11.6)	9,784	1,589,189	6.2 (6-6.3)	505	103,175	4.9 (4.5-5.3)	495	64,605	7.7 (7-8.3)
NTL	2,194	289,341	7.6 (7.3-7.9)	3,980	902,398	4.4 (4.3-4.5)	80	1,596	50.1 (39.1-61.1)	126	24,220	5.2 (4.3-6.1)
ALL	7	569	12.3 (3.2-21.4)	2	939	2.1 (0-5.1)	-	-	-	-	-	-
TL (all)	**Injuries (n)**	**Exposure (AE)**	**Incidence (95% CI)**	**Injuries (n)**	**Exposure (AE)**	**Incidence (95% CI)**	**Injuries (n)**	**Exposure (h)**	**Incidence (95% CI)**	**Injuries (n)**	**Exposure (h)**	**Incidence (95% CI)**
Male	7,849	735,072	10.7 (10.4-10.9)	3,884	1,590,631	2.4 (2.4-2.5)	4,800	108,548	44.2 (43-45.5)	609	353,064	1.7 (1.6-1.9)
Female	7,321	1,272,580	5.8 (5.6-5.9)	6,268	3,236,140	1.9 (1.9-2)	83	5,132	16.2 (12.7-19.7)	150	53,454	2.8 (2.4-3.3)
Youth	10,133	1,660,511	6.1 (6-6.2)	8,501	4,207,049	2 (2-2.1)	554	27,585	20.1 (18.4-21.8)	661	344,467	1.9 (1.8-2.1)
Senior	4,999	340,250	14.7 (14.3-15.1)	1,615	563,143	2.9 (2.7-3)	4,362	83,465	52.3 (50.7-53.8)	149	26,994	5.5 (4.6-6.4)
Mixed	59	8,986	6.6 (4.9-8.2)	63	65,445	1 (0.7-1.2)	59	7,986	7.4 (5.5-9.3)	63	103,134	0.6 (0.5-0.8)
Professional	6,205	293,026	21.2 (20.6-21.7)	-	-	-	4,386	84,132	52.1 (50.6-53.7)	164	53,740	3.1 (2.6-3.5)
University	4,964	512,461	3.5 (3.4-3.6)	6,506	1,845,225	3.5 (3.4-3.6)	-	-	-	-	-	-
High school	3,902	1,185,153	1.2 (1.2-1.3)	3,565	2,904,854	1.2 (1.2-1.3)	342	21,737	15.7 (14.1-17.4)	396	198,072	2 (1.8-2.2)
Representative	22	840	26.2 (15.2-37.1)	-	-	-	9	93	96.8 (33.5-160)	8	1,421	5.6 (1.7-9.5)
Club - Amateur	17	4,796	3.5 (1.9-5.2)	9	47,713	0.2 (0.1-0.3)	174	5,921	29.4 (25-33.8)	251	200,665	1.3 (1.1-1.4)

Note: TL = AE = athlete exposure, h = hours, n = count, CI = confidence interval, ACL = anterior cruciate ligament, AKP = anterior knee pain, CNS/PNS = central/peripheral nervous system.

TABLE 3. Descriptive statistics for aggregated TL injury incidence rates per body region, body location, injury type and injury mechanism

	1000AE						1000H					
	Match			Training			Match			Training		
Definition	**Injuries (n)**	**Exposure (AE)**	**Incidence (95% CI)**	**Injuries (n)**	**Exposure (AE)**	**Incidence (95% CI)**	**Injuries (n)**	**Exposure (h)**	**Incidence (95% CI)**	**Injuries (n)**	**Exposure (h)**	**Incidence (95% CI)**
Head/Neck	1,082	867,882	1.2 (1.2-1.3)	545	2,023,354	0.3 (0.2-0.3)	8	5,145	1.6 (0.5-2.6)	12	44,242	0.3 (0.1-0.4)
Upper-Limb	385	208,388	1.8 (1.7-2)	60	289,515	0.2 (0.2-0.3)	4	5,238	0.8 (0-1.5)	19	45,663	0.4 (0.2-0.6)
Torso	187	208,388	0.9 (0.8-1)	20	289,515	0.1 (0-0.1)	5	5,145	1 (0.1-1.8)	8	44,242	0.2 (0.1-0.3)
Lower-Limb	1,417	210,054	6.7 (6.4-7.1)	433	299,199	1.4 (1.3-1.6)	59	5,775	10.2 (7.6-12.8)	69	45,663	1.5 (1.2-1.9)
Ankle	2,297	1,368,595	1.7 (1.6-1.7)	1,544	3,002,811	0.5 (0.5-0.5)	774	82,924	9.3 (8.7-10)	5	83,858	0.1 (0-0.1)
Knee	1,437	1,253,607	1.1 (1.1-1.2)	927	2,713,296	0.3 (0.3-0.4)	314	82,831	3.8 (3.4-4.2)	4	82,437	0 (0-0.1)
Hand/Wrist	5,707	6,119,609	0.9 (0.9-1)	6,507	18,804,362	0.3 (0.3-0.4)	-	-	-	-	-	-
Eye	223	293,026	0.8 (0.7-0.9)	-	-	-	160	80,901	2 (1.7-2.3)	-	-	-
Shoulder	535	2,123,759	0.3 (0.2-0.3)	253	4,663,858	0.1 (0-0.1)	185	82,294	2.2 (1.9-2.6)	-	-	-
Foot	218	321,490	0.7 (0.6-0.8)	70	465,294	0.2 (0.1-0.2)	181	82,387	2.2 (1.9-2.5)	2	83,858	0 (0-0.1)
Lumbar	272	204,422	1.3 (1.2-1.5)	1	47,713	0 (0-0.1)	272	82,294	3.3 (2.9-3.7)	1	82,437	0 (0-0)
Concussion	2,372	3,593,358	0.7 (0.6-0.7)	1,319	8,735,671	0.2 (0.1-0.2)	2	5,238	0.4 (0.0-0.9)	0	45,663	0 (0-0)
Ankle Sprain	2,039	1,701,529	1.2 (1.1-1.3)	1,218	3,394,704	0.4 (0.3-0.4)	689	80,901	8.5 (7.9-9.2)	-	-	-
ACL	164	1,265,034	0.1 (0.1-0.1)	69	1,731,883	0 (0-0)	-	-	-	-	-	-
AKP	236	199,626	1.2 (1-1.3)	-	-	-	236	80,901	2.9 (2.5-3.3)	-	-	-
Muscle/tendon	1,605	1,473,328	1.1 (1-1.1)	1,031	3,255,793	0.3 (0.3-0.3)	851	91,366	9.3 (8.7-9.9)	15	138,448	0.1 (0.1-0.2)
Joint	85	776,562	0.1 (0.1-0.1)	98	2,151,420	0 (0-0.1)	1	5,145	0.2 (0.0-0.6)	1	44,242	0 (0-0.1)
Ligament	4,201	1,468,532	2.9 (2.8-2.9)	2,154	3,208,080	0.7 (0.6-0.7)	1,540	89,973	17.1 (16.3-18)	63	56,011	1.1 (0.8-1.4)
Fracture/bone	625	1,584,555	0.4 (0.4-0.4)	393	3,526,758	0.1 (0.1-0.1)	179	87,532	2 (1.7-2.3)	10	128,100	0.1 (0-0.1)
CNS/PNS	123	461,302	0.3 (0.2-0.3)	10	484,366	0 (0-0)	66	80,901	0.8 (0.6-1)	-	-	-
Contusion	1,690	1,354,947	1.2 (1.2-1.3)	406	2,934,167	0.1 (0.1-0.2)	912	86,046	10.6 (9.9-11.3)	14	44,242	0.3 (0.2-0.5)
Laceration	485	1,239,959	0.4 (0.4-0.4)	163	2,644,652	0.1 (0.1-0.1)	276	86,046	3.2 (2.8-3.6)	8	44,242	0.2 (0.1-0.3)
Player Contact	1,909	2,609,865	0.7 (0.7-0.8)	1,869	4,783,218	0.4 (0.4-0.4)	51	5,072	10.1 (7.3-12.8)	52	56,011	0.9 (0.7-1.2)
Ball Contact	11	119,163	0.1 (0-0.1)	29	426,447	0.1 (0-0.1)	-	-	-	-	-	-
Other Contact	902	827,770	1.1 (1-1.2)	750	2,218,205	0.3 (0.3-0.4)	4	5,145	0.8 (0-1.5)	13	44,242	0.3 (0.1-0.5)
Non-contact	947	946,504	1 (0.9-1.1)	1,627	2,645,470	0.6 (0.6-0.6)	22	5,775	3.8 (2.2-5.4)	36	45,663	0.8 (0.5-1)
Overuse	113	944,838	0.1 (0.1-0.1)	655	2,635,786	0.2 (0.2-0.3)	0	93	0 (0-0)	0	1,421	0 (0-0)

Note: TL = AE = athlete exposure, h = hours, n = count, CI = confidence interval, ACL = anterior cruciate ligament, AKP = anterior knee pain, CNS/PNS = central/peripheral nervous system.

match TL IIRs were non-significantly greater than female IIR (26.8/1000h; 95% CI 17.5-35.2 and 18.9/1000h, 95% CI 8.8-40.0, respectively). High heterogeneity was identified in all analyses. MA match injury incidence ranged from 1.2-172.0/1000h, with a pooled MA match IIR of 11.6/1000h (95% CI 7.2-18.9; Figure 4b).

3.4.2. Pooled Training Injury Incidence Rates

TL (all) training injury incidence per 1000AE ranged from 0.2-4.5/1000AE, with an overall pooled TL training injury incidence of 1.9/1000AE (95% CI 1.4-2.4; Figure 5a) and high heterogeneity (I^2 = *0.99*). Pooled training IIR were higher in senior cohorts compared to youth (3.4/1000AE; 95% CI 2.9-3.9 and 1.3/1000AE; 95% CI 1.2-1.5, respectively), whilst rates were similar between males and females (2.0/1000AE; 95% CI 1.4-2.9 and

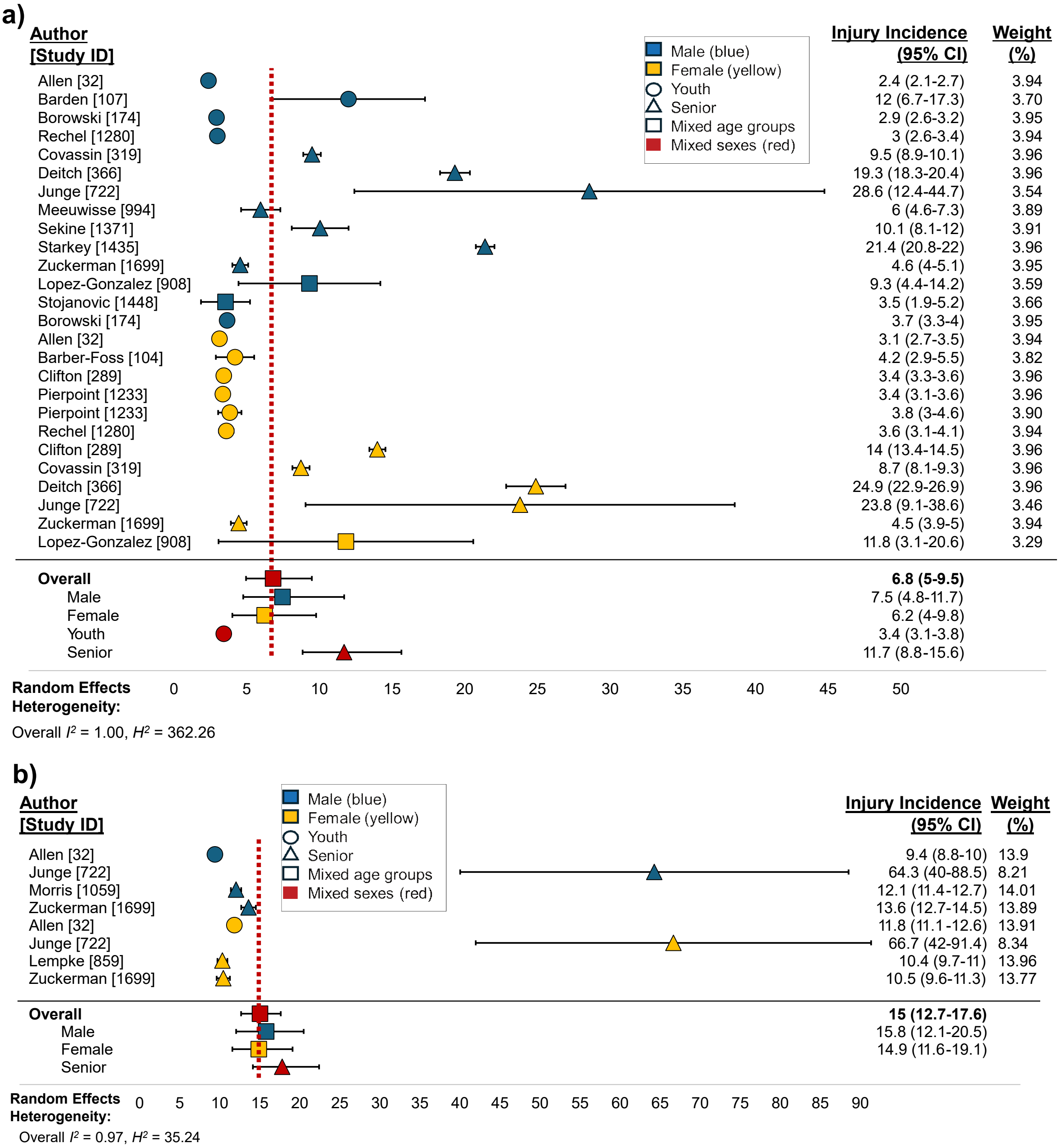

FIGURE 3. Forest plot of match injury incidence per 1000 athlete exposures (95% CI): A) TL (all) injuries; B) MA injuries.
Blue marker = male, orange marker = female, circular marker = youth, triangular marker = senior, square marker = youth and senior, red marker = male and female.

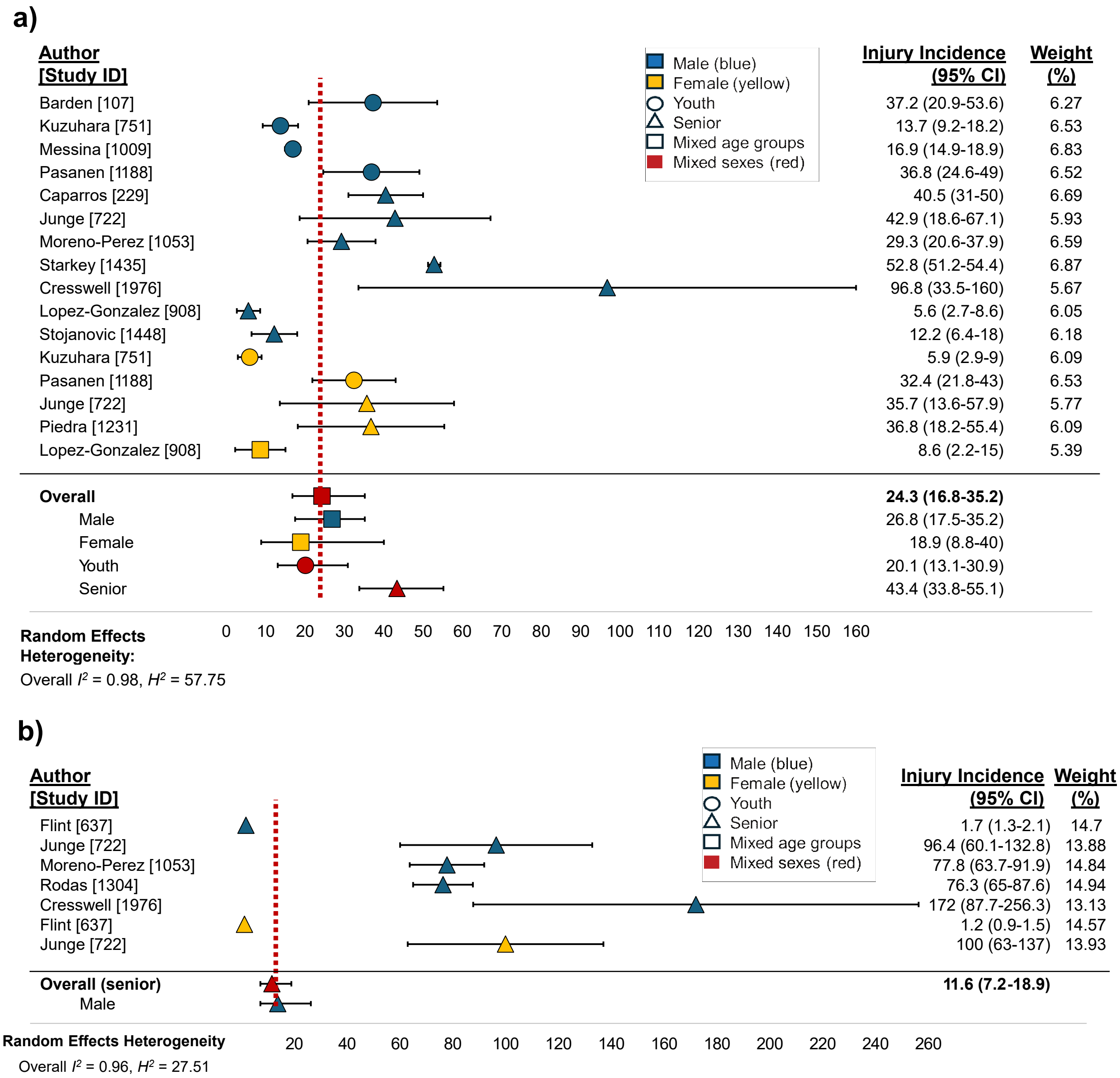

FIGURE 4. Forest plot of match injury incidence per 1000 player-hours (95% CI): A) TL (all) injuries; B) MA match injuries.
Blue marker = male, orange marker = female, circular marker = youth, triangular marker = senior, square marker = youth and senior, red marker = male and female.

1.7/1000AE; 95% CI 1.2-2.6, respectively). MA training IIR ranged from 5.3-7.0/1000AE, with an overall pooled MA training IIR of 6.2/1000AE (95% CI 5.8-6.6, Figure 5b). TL (all) training injury incidence per 1000h ranged from 0.1-24.5/1000h, with a pooled TL training injury incidence of 2.3/1000h (95% CI 1.4-3.9, Figure 6). It was not possible to conduct a meta-analysis of pooled MA training injury incidence due to only three studies being included.

4. DISCUSSION

This is the largest systematic review and meta-analysis of basketball injuries previously conducted, reporting aggregated and pooled IIR using a range of injury definitions and exposure types. It provides a synthesis of basketball injury rates, allowing for comparisons between and within different situations, sex, injury definitions, exposure denominator, playing levels, and age groups. Furthermore, it provides an overview of the range of

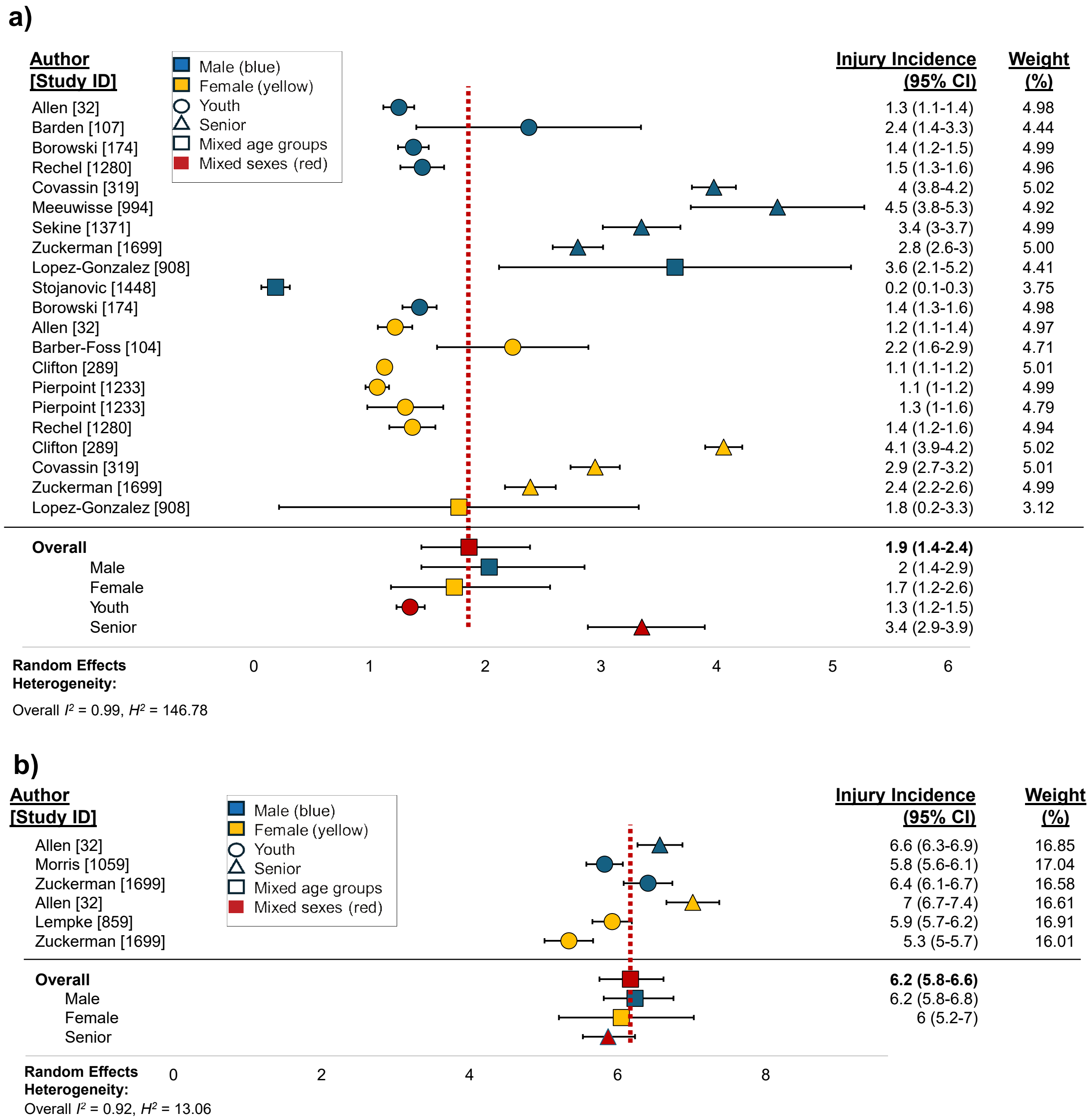

FIGURE 5. Forest plot of training injury incidence per 1000 athlete exposures (95% CI): A) TL (all) injuries; B) MA injuries.
Blue marker = male, orange marker = female, red marker = male and female, circular marker = youth, triangular marker = senior, square marker = youth and senior.

reporting methods used in basketball injury surveillance, highlighting the need to standardise methods to allow for valid comparisons between studies and contexts.

4.1. Reporting Methods

TL was the most frequently adopted injury definition, but within this definition, there were many variations used, such as missed session, 24-hour TL, or undefined TL. A TL injury definition is reported as the most reliable method to ensure all injuries meeting the criteria are captured[34]. However, this strict definition under-reports injury rates, as well as disregarding NTL injuries, which can cause an athlete discomfort and limit performance[35]. The detection and recording of MA injury definitions, inclusive of NTL and TL injuries, rely on clinical assessment and accurate reporting by a medical practitioner, requiring frequent and free access to ensure all complaints are recorded. This is often challenging in contexts where athletes do not have immediate access to medical provision and could explain the large ranges in injury incidence between studies using the same injury definition and

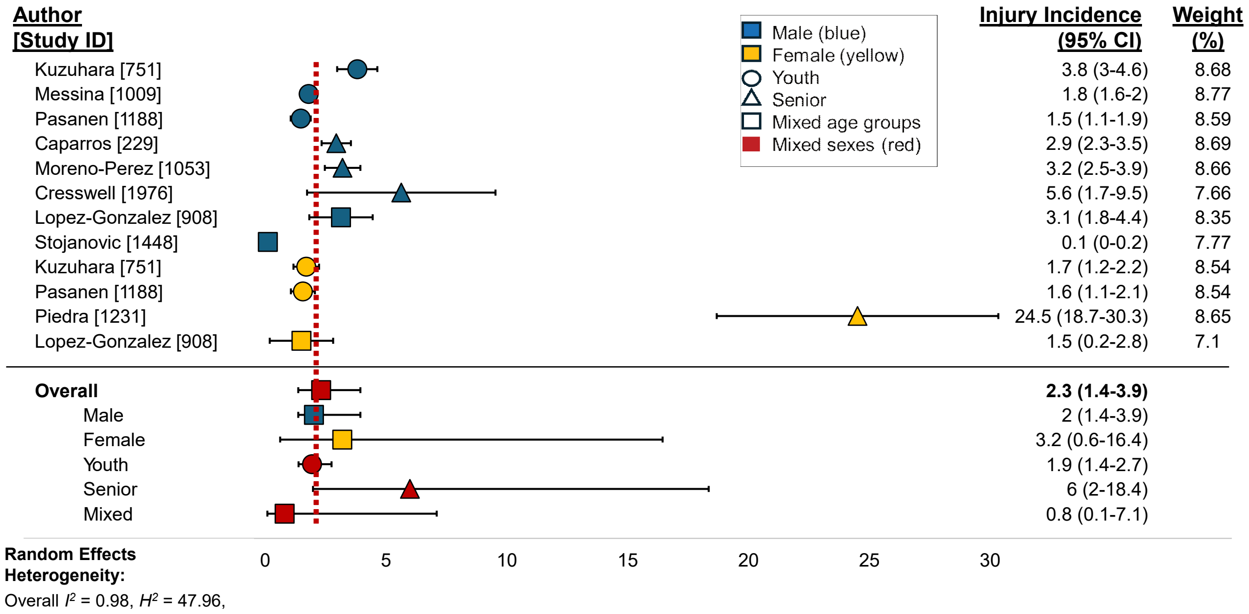

FIGURE 6. Forest plot of training TL (all) injury incidence per 1000 player-hours (95% CI) Blue marker = male, orange marker = female, red marker = male and female, circular marker = youth, triangular marker = senior, square marker = youth and senior.

exposure denominator (e.g., MA match IIR ranged between 1.2 and 172.0/1000h). Surveillance methods need to be fit for the context for which they are to be used[24], and in settings where medical professionals are not readily available to athletes, this may be simplified through adopting a time-loss injury definition rather than ambitiously recording MA injuries, which may cause an underreporting of IIR through missed injuries.

Most studies adopted an AE denominator. This method is easier to record than a time exposure, as the duration of a session is not needed, simply the number of athletes who have been exposed to training or match-play at a given time. As such, team-level exposure is often recorded as it is often less burdensome for those recording data, particularly in non-professional environments where data may be recorded by volunteers or coaches. However, an AE denominator overestimates time at risk as it assumes anyone who has entered the court has the time at risk, despite a disparity in game/training minutes[26]. It is recommended that individual-level data be recorded to allow for the examination of individual risk factors, with time-based exposures providing the most accurate estimate. However, the International Olympic Committee (IOC) consensus statement refrained from recommending a specific exposure denominator, as the reliability of data capture is essential, and thus the denominator must match the context[21].

The IOC consensus statement[21] provides a broad framework for recommended surveillance methods to provide consistency between studies and longitudinal projects. Extensions of this statement have been made to sports such as football[24], artistic gymnastics[36], competitive cycling[37], tennis[38], and snow-sports[39], whilst the statement has been used to translate specific recommendations to para sports[40] and female athletes[41]. Despite the popularity of basketball and the unique aetiology of injuries sustained, no consensus exists on the surveillance of basketball injuries. Whilst this review is evidence of the plethora of epidemiological studies conducted in basketball, it highlights the danger when comparing studies given the high heterogeneity and variation in IIR between contexts, sexes, playing-age groups and level. A basketball-specific consensus statement would facilitate consistent injury surveillance methods to increase confidence when comparing IIR between contexts and competitions worldwide.

Of the 16 surveillance systems/projects recorded, only three were referenced in four or more studies. These were HS RIO, NCAA ISP, and its predecessor, NCAA ISS, all conducted in American high school and university settings. Nearly half the studies included in the review were from these projects, yet the rules and style of play in these American settings may differ from those globally, leading to concern whether these findings are generalisable. For example, quarter length is 12 minutes in NCAA basketball, but only 10 minutes in FIBA competitions, with variations in the offensive shot clock. More time at risk would result in a greater number of injuries, but using an AE denominator underreports this risk compared to player-hours. This is shown in the data, where injury rates per 1000h are generally much greater than per 1000AE.

4.2. Injury Rates

While the pooled match TL IIR of 6.8/1000AE is low relative to other sports, the IIR varied greatly depending on sex and playing level. The TL match IIR of 52.1/1000h in professional basketball is far greater than the overall pooled IIR of 24.3/1000h, possibly due to the increase in game demands or fixture schedule[42]. The TL match IIR in professional settings is comparable to the IIR in professional football (36/1000h)[43] and ice hockey (38-86/1000h)[44], but lower than rugby (91/1000h)[45]. Match IIRs were considerably greater than training IIRs, regardless of definition or denominator, a finding consistent throughout sports injury epidemiology literature[45-47]. However, a study of NBA players found that more than half of their weekly basketball exposure was spent training, with rotational players spending more than 6 times longer training on court than playing per week[48]. Furthermore, a study of semi-professional basketball players found that external load measures, assessed using an accelerometer, were significantly greater in training than in games, both for total time and when adjusted per minute of basketball[49]. Taken together, these data suggest that, even though individual training sessions carry a lower IIR per hour, training may account for a greater absolute number of injuries simply because athletes spend more time in on court training than in competition. Thus, whilst the IIR of training injuries is low, their prevention should remain a priority, given their frequency is possibly greater than match injuries[4, 11, 19].

IIRs increased with playing age and playing level, both known risk factors for injury [50]. The match IIR of senior basketball was 2-6 times greater than youth basketball, with similar findings in professional and amateur settings. This may be reflective of a change in game length, a further reason why a time-denominator may be more appropriate than AE, but also a likely increase in game demands. A three-season study of NBA players found IIR significantly increased with game load (minutes played) and decreased with longer rest between games[42]. NBA teams play 82 games in a regular season, approximately three games a week, with players required to participate in 65 games unless injured or unavailable due to other circumstances. This is more than double the games a player in the NCAA would complete in a season, and it may be that game and training load, rather than age, is a determining factor in injury risk. To mitigate injury risk, the NBA has recently implemented a new player participation policy, which permits rest for players of a certain age, playing history and long-term injury history[51].

Studies seldom reported injury severity, with those who did opting to report grouped severity categories rather than the mean number of days lost. As such, it was not possible to calculate injury burden to compare between contexts and sports, which would have been useful given the profile of basketball injuries ranged from contusions to severe ligament ruptures. Injury prevention research often focuses on a reduction in injury incidence, but it is possible for an intervention to be effective by reducing injury severity and subsequently injury burden, without reducing the injury incidence. This is further rationale for the inclusion of injury severity within basketball surveillance projects, alongside reporting of days lost to allow for the calculation of injury burden to provide more detail to the injury risk in basketball, alongside providing further metrics for which prevention studies can be assessed.

Lower-limb injuries were most prevalent across all contexts, predominantly sustained at the ankle and knee. These locations have long been an injury prevention priority in basketball, with a significant reduction in injury rates found from those completing neuromuscular training programmes[52, 53] or using prophylactic bracing or taping [54]. New rules have also been enforced in some contexts to prevent athletes from landing on opponents' feet when jumping, a frequent mechanism of injury[55], although no evidence has been published yet regarding the effectiveness of this strategy. The IIR of complex lateral ligament sprains appear to be increasing annually in collegiate women's[13] and men's basketball[12], and further work is needed to reduce injuries to these body locations. Consideration should be given to how injury mechanisms are classified. In basketball, much contact occurs in the air, which may result in the player landing awkwardly. If they landed on their feet but pivoted on their knee, causing a serious knee injury, this would be classified as a 'non-contact' injury despite the role that aerial contact would have played in the player sustaining an injury. It may be necessary for further expansion of injury mechanism classifications, with the possible inclusion of indirect contact.

The meta-analysis found no significant difference between males and female IIRs across training, matches and different definitions/denominators, despite male IIRs appearing consistently higher. However, it may be that females are at significantly greater risk of specific pathologies, such as an ACL sprain[28] or a concussion[56].

Reported concussion IIRs were relatively low compared to collision sports such as rugby (union and league), American football and ice hockey[57, 58]. However, basketball was ranked fourth highest among NCAA sports for concussion frequency over a 5-year period[59], although approximately half of the studies investigating concussion risk included in the review were published pre-2015. Since this period, the definition of a concussion has changed, alongside changing recommendations for its detection and management[60, 61]. There has been a steady rise in the frequency of concussions and mean days missed in the NBA over the past decade[62]. As such, it may be that the concussion rates reported in this review are lower than present-day concussion rates due to improvements in detection and reporting methods. Moreover, sustaining a concussion is associated with a significantly increased subsequent musculoskeletal injury risk[63]. Thus, prevention of sport-related concussion should remain a priority given the potential for long-term consequences and subsequent re-injury following sport-related concussion[64].

4.3. Limitations

Due to the vast number of studies included and the numerous data points extracted from each study, a single author extracted data for each section. To ensure that authors were familiar with the data extraction, a calibration exercise was completed between two extractors prior to a single author extracting risk of bias and injury data independently. Studies where English text could not be found were excluded, removing 14 potential studies from the review. Only 15 studies conducted in professional environments were included in the review, and only 9 included in the meta-analysis. Many studies from the NBA or WNBA were excluded due to their dependence on publicly available injury data. Given injury risk appears to increase with playing-level, the pooled IIR may be underestimated given studies from professional leagues do not feature heavily.

There was a heavy bias of studies included from the United States, through the HS-RIO and NCAA ISS/ISP surveillance projects. These projects have good validity and reliability, requiring medical professional to collect and report data[65, 66]. However, the pooled IIR may disproportionately reflect these contexts rather than reflective of those globally. Game and training duration, style of play and scheduling will all influence IIR, as will medical support and injury reporting capabilities will also affect reported IIR. Differences here between contexts could be one of the reasons for the high heterogeneity observed across studies (I^2 frequently >0.90), limiting confidence in the pooled estimates. Sub-group heterogeneity analysis (appendix E) was conducted for sex and playing-age group, but it was not feasible to assess by geographical region or playing-level. However, contextual factors within these settings likely influence the high heterogeneity, furthering the need for a basketball-specific injury surveillance consensus statement to standardise collection methods.

A further limitation of the literature is the inconsistent reporting of injury severity, and thus the inability to calculate injury burden. Nearly 40% of studies did not report injury severity, but IIRs are not the only relevant statistic in sports injury epidemiology. An injury prevention programme could be deemed successful if reducing injury severity and burden, with IIR remaining the same. A further limitation is the predominant use of AE as a denominator, given that this may overestimate time at risk and limit the precision of IIR.

5. CONCLUSION

This study highlights the large variations in injury incidence rates across various basketball settings. However, the frailty of comparing injury rates across studies and projects is evident, given the range in methods reported in this review and the high heterogeneity found throughout. A basketball-specific consensus statement is needed to provide researchers and practitioners guidance on the best methods to record injuries, their mechanisms, definitions, and thus calculate injury rates and burden in this context. However, the synthesis of injury rates provided in this review will provide guidance for stakeholders to develop evidence-based prevention strategies specific to contexts and populations.

6. REFERENCES

1. FIBA. FIBA celebrates more than 610 million players globally on second edition of world basketball day, https://www.fiba.basketball/en/news/fiba-celebrates-more-than-610-million-players-globally-on-second-edition-of-wbd (2024, accessed 07/06/2025).
2. FIBA. Organization: What we do, https://about.fiba.basketball/en/organization/what-we-do (2025, accessed 07/06/2025).
3. Petway AJ, Freitas TT, Calleja-Gonzalez J, et al. Training load and match-play demands in basketball based on competition level: A systematic review. *PLoS One* 2020; 15: e0229212. 20200305. DOI: 10.1371/journal.pone.0229212.
4. Zuckerman SL, Wegner AM, Roos KG, et al. Injuries sustained in National Collegiate Athletic Association men's and women's basketball, 2009/2010-2014/2015. *Br J Sports Med* 2018; 52: 261-268. 20160630. DOI: 10.1136/bjsports-2016-096005.
5. Bunstine JL, Yang J, Kistamgari S, et al. Differences in Overuse Injuries in Gender-Comparable Sports: A Nationally Representative Sample of High School Athletes. *J Athl Train* 2024; 59: 962-968. DOI: 10.4085/1062-6050-0040.23.
6. Stojanovic E, Faude O, Scanlan AT, et al. Injury incidence among adolescent and senior basketball players: a prospective study in 19 teams across an entire season. *Phys Sportsmed* 2024; 52: 386-394. 20231129. DOI: 10.1080/00913847.2023.2284133.
7. Deitch JR, Starkey C, Walters SL, et al. Injury risk in professional basketball players: a comparison of Women's National Basketball Association and National Basketball Association athletes. *Am J Sports Med* 2006; 34: 1077-1083. 20060221. DOI: 10.1177/0363546505285383.
8. Kuzuhara K, Shibata M and Iguchi J. Injuries in Japanese high school basketball players during games and practices. *Journal of Physical Education and Sport* 2022; 22. DOI: 10.7752/jpes.2022.10302.
9. Kerr ZY, Nedimyer AK, Simon JE, et al. The Epidemiology of Ankle Sprains in US High School Sports, 2011-2012 to 2018-2019 Academic Years. *J Athl Train* 2022; 57: 1030-1038. DOI: 10.4085/1062-6050-0664.21.
10. Clifton DR, Hertel J, Onate JA, et al. The First Decade of Web-Based Sports Injury Surveillance: Descriptive Epidemiology of Injuries in US High School Girls' Basketball (2005-2006 Through 2013-2014) and National Collegiate Athletic Association Women's Basketball (2004-2005 Through 2013-2014). *J Athl Train* 2018; 53: 1037-1048. DOI: 10.4085/1062-6050-150-17.
11. Allen AN, Wasserman EB, Williams RM, et al. Epidemiology of Secondary School Boys' and Girls' Basketball Injuries: National Athletic Treatment, Injury and Outcomes Network. *J Athl Train* 2019; 54: 1179-1186. 20191003. DOI: 10.4085/1062-6050-330-18.
12. Morris SN, Chandran A, Lempke LB, et al. Epidemiology of Injuries in National Collegiate Athletic Association Men's Basketball: 2014-2015 Through 2018-2019. *J Athl Train* 2021; 56: 681-687. DOI: 10.4085/1062-6050-436-20.
13. Lempke LB, Chandran A, Boltz AJ, et al. Epidemiology of Injuries in National Collegiate Athletic Association Women's Basketball: 2014-2015 Through 2018-2019. *J Athl Train* 2021; 56: 674-680. DOI: 10.4085/1062-6050-466-20.
14. Herzog MM, Mack CD, Dreyer NA, et al. Ankle Sprains in the National Basketball Association, 2013-2014 Through 2016-2017. *Am J Sports Med* 2019; 47: 2651-2658. 20190807. DOI: 10.1177/0363546519864678.
15. Owoeye OBA, Ghali B, Befus K, et al. Epidemiology of all-complaint injuries in youth basketball. *Scand J Med Sci Sports* 2020; 30: 2466-2476. 20200913. DOI: 10.1111/sms.13813.
16. Barden DC and Thain DPK. Injury surveillance in English youth basketball: A 5-season cohort study to inform injury prevention strategies. *Phys Ther Sport* 2022; 58: 34-40. 20220903. DOI: 10.1016/j.ptsp.2022.08.005.

17. Pasanen K, Ekola T, Vasankari T, et al. High ankle injury rate in adolescent basketball: A 3-year prospective follow-up study. *Scand J Med Sci Sports* 2017; 27: 643-649. 20161229. DOI: 10.1111/sms.12818.
18. Caparros T, Alentorn-Geli E, Myer GD, et al. The Relationship of Practice Exposure and Injury Rate on Game Performance and Season Success in Professional Male Basketball. *J Sports Sci Med* 2016; 15: 397-402. 20160805.
19. Moreno-Perez V, Ruiz J, Vazquez-Guerrero J, et al. Training and competition injury epidemiology in professional basketball players: a prospective observational study. *Phys Sportsmed* 2023; 51: 121-128. 20211117. DOI: 10.1080/00913847.2021.2000325.
20. McKay GD, Goldie PA, Payne WR, et al. A prospective study of injuries in basketball: a total profile and comparison by gender and standard of competition. *J Sci Med Sport* 2001; 4: 196-211. DOI: 10.1016/s1440-2440(01)80030-x.
21. Bahr R, Clarsen B, Derman W, et al. International Olympic Committee consensus statement: methods for recording and reporting of epidemiological data on injury and illness in sport 2020 (including STROBE Extension for Sport Injury and Illness Surveillance (STROBE-SIIS)). *Br J Sports Med* 2020; 54: 372-389. 20200218. DOI: 10.1136/bjsports-2019-101969.
22. Clarsen B and Bahr R. Matching the choice of injury/illness definition to study setting, purpose and design: one size does not fit all! *Br J Sports Med* 2014; 48: 510-512. DOI: 10.1136/bjsports-2013-093297.
23. Rodas G, Bove T, Caparros T, et al. Ankle Sprain Versus Muscle Strain Injury in Professional Men's Basketball: A 9-Year Prospective Follow-up Study. *Orthop J Sports Med* 2019; 7: 2325967119849035. 20190621. DOI: 10.1177/2325967119849035.
24. Ekegren CL, Gabbe BJ and Finch CF. Sports Injury Surveillance Systems: A Review of Methods and Data Quality. *Sports Med* 2016; 46: 49-65. DOI: 10.1007/s40279-015-0410-z.
25. Whalan M, Lovell R and Sampson JA. Do Niggles Matter? - Increased injury risk following physical complaints in football (soccer). *Science and Medicine in Football* 2019; 4: 216-224. DOI: 10.1080/24733938.2019.1705996.
26. Stovitz SD and Shrier I. Injury rates in team sport events: tackling challenges in assessing exposure time. *Br J Sports Med* 2012; 46: 960-963. 20120425. DOI: 10.1136/bjsports-2011-090693.
27. Andreoli CV, Chiaramonti BC, Buriel E, et al. Epidemiology of sports injuries in basketball: integrative systematic review. *BMJ Open Sport Exerc Med* 2018; 4: e000468. 20181227. DOI: 10.1136/bmjsem-2018-000468.
28. Stojanovic E, Faude O, Nikic M, et al. The incidence rate of ACL injuries and ankle sprains in basketball players: A systematic review and meta-analysis. *Scand J Med Sci Sports* 2023; 33: 790-813. 20230219. DOI: 10.1111/sms.14328.
29. Lian J, Sewani F, Dayan I, et al. Systematic Review of Injuries in the Men's and Women's National Basketball Association. *Am J Sports Med* 2022; 50: 1416-1429. 20210702. DOI: 10.1177/03635465211014506.
30. Gabbe BJ, Finch CF, Bennell KL, et al. How valid is a self reported 12 month sports injury history? *Br J Sports Med* 2003; 37: 545-547. DOI: 10.1136/bjsm.37.6.545.
31. Inclan PM, Kuhn AW, Troyer SC, et al. Use of Publicly Obtained Data in Sports Medicine Research: A Systematic Review and Bibliometric Analysis. *Am J Sports Med* 2024; 52: 1367-1373. 20230612. DOI: 10.1177/03635465231177054.
32. Downs SH and Black N. The feasibility of creating a checklist for the assessment of the methodological quality both of randomised and non-randomised studies of health care interventions. *J Epidemiol Community Health* 1998; 52: 377-384. DOI: 10.1136/jech.52.6.377.
33. Cresswell T and Barden C. Injury epidemiology in international basketball: a six-season study of the Great Britain men's basketball team. *Phys Sportsmed* 2025; 53: 291-298. 20250124. DOI: 10.1080/00913847.2025.2457164.
34. Orchard J and Hoskins W. For debate: consensus injury definitions in team sports should focus on missed playing time. *Clin J Sport Med* 2007; 17: 192-196. DOI: 10.1097/JSM.0b013e3180547527.
35. Brenner JS, Watson A, Council On Sports M, et al. Overuse Injuries, Overtraining, and Burnout in Young Athletes. *Pediatrics* 2024; 153. DOI: 10.1542/peds.2023-065129.
36. Casey E, Patel TS, Almedia JF, et al. Artistic gymnastics-specific extension of the IOC 2020 consensus statement: methods for recording and reporting of epidemiological data on injury and illness in sport. *BMJ Open Sport Exerc Med* 2024; 10: e002040. 20241001. DOI: 10.1136/bmjsem-2024-002040.
37. Clarsen B, Pluim BM, Moreno-Perez V, et al. Methods for epidemiological studies in competitive cycling: an extension of the IOC consensus statement on methods for recording and reporting of epidemiological data on injury and illness in sport 2020. *Br J Sports Med* 2021; 55: 1262-1269. 20210512. DOI: 10.1136/bjsports-2020-103906.

38. Verhagen E, Clarsen B, Capel-Davies J, et al. Tennis-specific extension of the International Olympic Committee consensus statement: methods for recording and reporting of epidemiological data on injury and illness in sport 2020. *Br J Sports Med* 2021; 55: 9-13. 20201020. DOI: 10.1136/bjsports-2020-102360.
39. Sporri J, McGawley K, Alhammoud M, et al. Snow sports-specific extension of the IOC consensus statement: methods for recording and reporting epidemiological data on injury and illness in sports. *Br J Sports Med* 2024; 59: 8-23. 20241223. DOI: 10.1136/bjsports-2024-108720.
40. Derman W, Badenhorst M, Blauwet C, et al. Para sport translation of the IOC consensus on recording and reporting of data for injury and illness in sport. *Br J Sports Med* 2021; 55: 1068-1076. 20210414. DOI: 10.1136/bjsports-2020-103464.
41. Moore IS, Crossley KM, Bo K, et al. Female athlete health domains: a supplement to the International Olympic Committee consensus statement on methods for recording and reporting epidemiological data on injury and illness in sport. *Br J Sports Med* 2023; 57: 1164-1174. 20230622. DOI: 10.1136/bjsports-2022-106620.
42. Lewis M. It's a Hard-Knock Life: Game Load, Fatigue, and Injury Risk in the National Basketball Association. *J Athl Train* 2018; 53: 503-509. 20180517. DOI: 10.4085/1062-6050-243-17.
43. Lopez-Valenciano A, Ruiz-Perez I, Garcia-Gomez A, et al. Epidemiology of injuries in professional football: a systematic review and meta-analysis. *Br J Sports Med* 2020; 54: 711-718. 20190606. DOI: 10.1136/bjsports-2018-099577.
44. Cattaneo M, Ramponi C and Thorborg K. What is the Injury Incidence and Profile in Professional Male Ice Hockey? A Systematic Review. *Int J Sports Phys Ther* 2024; 19: 1398-1409. 20240102. DOI: 10.26603/001c.90591.
45. Williams S, Robertson C, Starling L, et al. Injuries in Elite Men's Rugby Union: An Updated (2012-2020) Meta-Analysis of 11,620 Match and Training Injuries. *Sports Med* 2022; 52: 1127-1140. 20211202. DOI: 10.1007/s40279-021-01603-w.
46. Robles-Palazon FJ, Lopez-Valenciano A, De Ste Croix M, et al. Epidemiology of injuries in male and female youth football players: A systematic review and meta-analysis. *J Sport Health Sci* 2022; 11: 681-695. 20211023. DOI: 10.1016/j.jshs.2021.10.002.
47. Hootman JM, Dick R and Agel J. Epidemiology of collegiate injuries for 15 sports: summary and recommendations for injury prevention initiatives. *J Athl Train* 2007; 42: 311-319.
48. Russell JL, McLean BD, Impellizzeri FM, et al. Measuring Physical Demands in Basketball: An Explorative Systematic Review of Practices. *Sports Med* 2021; 51: 81-112. DOI: 10.1007/s40279-020-01375-9.
49. Fox JL, Stanton R and Scanlan AT. A Comparison of Training and Competition Demands in Semiprofessional Male Basketball Players. *Res Q Exerc Sport* 2018; 89: 103-111. 20180115. DOI: 10.1080/02701367.2017.1410693.
50. Meeuwisse WH, Tyreman H, Hagel B, et al. A dynamic model of etiology in sport injury: the recursive nature of risk and causation. *Clin J Sport Med* 2007; 17: 215-219. DOI: 10.1097/JSM.0b013e3180592a48.
51. NBA. Player Participation Policy, https://www.nba.com/news/nba-board-of-governors-approves-new-player-participation-policy (2023, accessed 08/07/2025).
52. Riva D, Bianchi R, Rocca F, et al. Proprioceptive Training and Injury Prevention in a Professional Men's Basketball Team: A Six-Year Prospective Study. *J Strength Cond Res* 2016; 30: 461-475. DOI: 10.1519/JSC.0000000000001097.
53. Davis AC, Emptage NP, Pounds D, et al. The Effectiveness of Neuromuscular Warmups for Lower Extremity Injury Prevention in Basketball: A Systematic Review. *Sports Med Open* 2021; 7: 67. 20210916. DOI: 10.1186/s40798-021-00355-1.
54. Taylor JB, Ford KR, Nguyen AD, et al. Prevention of Lower Extremity Injuries in Basketball: A Systematic Review and Meta-Analysis. *Sports Health* 2015; 7: 392-398. 20150626. DOI: 10.1177/1941738115593441.
55. Achenbach L, Klein C, Luig P, et al. Collision with opponents-but not foul play-dominates injury mechanism in professional men's basketball. *BMC Sports Sci Med Rehabil* 2021; 13: 94. 20210819. DOI: 10.1186/s13102-021-00322-z.
56. Covassin T, Swanik CB and Sachs ML. Epidemiological considerations of concussions among intercollegiate athletes. *Appl Neuropsychol* 2003; 10: 12-22. DOI: 10.1207/S15324826AN1001_3.
57. Ingram V, Fielding M, Dunne LAM, et al. The Incidence of Sports-Related Concussion in Children and Adolescents: A Systematic Review and Meta-Analysis. *Sports Med Open* 2025; 11: 36. 20250411. DOI: 10.1186/s40798-025-00834-9.

58. Matias-Soto J, Infante-Cano M, Garcia-Munoz C, et al. Concussion Incidence by Type of Sport: Differences by Sex, Age Groups, Type of Session, and Level of Play An Overview of Systematic Reviews With Meta-analysis. *J Orthop Sports Phys Ther* 2024; 54: 702-710. DOI: 10.2519/jospt.2024.12677.
59. Chandran A, Boltz AJ, Morris SN, et al. Epidemiology of Concussions in National Collegiate Athletic Association (NCAA) Sports: 2014/15-2018/19. *Am J Sports Med* 2022; 50: 526-536. 20211213. DOI: 10.1177/03635465211060340.
60. Aubry M, Cantu R, Dvorak J, et al. Summary and agreement statement of the First International Conference on Concussion in Sport, Vienna 2001. Recommendations for the improvement of safety and health of athletes who may suffer concussive injuries. *Br J Sports Med* 2002; 36: 6-10. DOI: 10.1136/bjsm.36.1.6.
61. Patricios JS, Schneider KJ, Dvorak J, et al. Consensus statement on concussion in sport: the 6th International Conference on Concussion in Sport-Amsterdam, October 2022. *Br J Sports Med* 2023; 57: 695-711. DOI: 10.1136/bjsports-2023-106898.
62. Patel BH, Okoroha KR, Jildeh TR, et al. Concussions in the National Basketball Association: Analysis of Incidence, Return to Play, and Performance From 1999 to 2018. *Orthop J Sports Med* 2019; 7: 2325967119854199. 20190627. DOI: 10.1177/2325967119854199.
63. McPherson AL, Nagai T, Webster KE, et al. Musculoskeletal Injury Risk After Sport-Related Concussion: A Systematic Review and Meta-analysis. *Am J Sports Med* 2019; 47: 1754-1762. 20180803. DOI: 10.1177/0363546518785901.
64. Manley G, Gardner AJ, Schneider KJ, et al. A systematic review of potential long-term effects of sport-related concussion. *Br J Sports Med* 2017; 51: 969-977. 20170428. DOI: 10.1136/bjsports-2017-097791.
65. Kerr ZY, Comstock RD, Dompier TP, et al. The First Decade of Web-Based Sports Injury Surveillance (2004-2005 Through 2013-2014): Methods of the National Collegiate Athletic Association Injury Surveillance Program and High School Reporting Information Online. *J Athl Train* 2018; 53: 729-737. 20180823. DOI: 10.4085/1062-6050-143-17.
66. Kucera KL, Marshall SW, Bell DR, et al. Validity of soccer injury data from the National Collegiate Athletic Association's Injury Surveillance System. *J Athl Train* 2011; 46: 489-499. DOI: 10.4085/1062-6050-46.5.489.

FUNDING: No funding was received to conduct this research.

COMPETING INTERESTS: CB is the Editor-in-Chief of the *Journal of Injury & Illness Prevention in Sport*. The manuscript was handled by a separate editor and reviewed independently.

ETHICAL REQUIREMENTS: N/A

ACKNOWLEDGEMENTS: N/A

AUTHOR CONTRIBUTIONS: CB conceived the idea and devised the methodology with MDSC. CB, CM, MGN, KW, and KA completed title and/or full-text screening. MGN completed the risk of bias assessment, and CB completed reporting methods and injury data extraction. CB wrote the manuscript with input and approval from all co-authors. All authors have read and approved the final version of the manuscript.

SUPPLEMENTARY FILE LINKS:

APPENDIX A - Search Strategy

APPENDIX B - Demographic Information

APPENDIX C - DB Scores by Article ID

APPENDIX D - Injury Statistics Dashboard

APPENDIX E - Forest Plot Outputs