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REVIEW

EPIDEMIOLOGY OF MUSCULOSKELETAL INJURIES IN FEMALE WRESTLING

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ABSTRACT

Background: Wrestling is among the world's oldest combat sports and is associated with a substantial burden of musculoskeletal injury. However, epidemiological syntheses in wrestling have historically been dominated by male cohorts, and the injury profile in women's wrestling remains less clearly defined. Therefore, the aim of this review was to synthesize the available evidence on the incidence, anatomical distribution, severity, and type of musculoskeletal injuries in female wrestlers.

Material and methods: PubMed, Scopus, Web of Science and SPORTDiscus with full text databases were screened for relevant articles. Ten studies were included in the qualitative synthesis of our review.

Results: Ten studies were included. Reported injury incidence ranged from 4.29 injuries per 1000 training hours to 16.8 injuries per 1000 athlete-exposures, depending on the exposure denominator used. Across studies, upper-extremity and lower-extremity injuries represented the largest proportion of reported injuries, followed by trunk and head/neck/face injuries. Within extremity injuries, shoulder and upper arm injuries represented the largest share. Notably, while upper-extremity injuries predominated in youth cohorts, lower-extremity injuries accounted for the greatest proportion of injuries in elite athletes. Most injuries were classified as mild, and joint and muscle injuries were among the most frequently reported injury categories.

Conclusions: This review provides an updated synthesis of musculoskeletal injury epidemiology in female wrestling, highlighting age- and level-specific injury patterns relevant for prevention planning. Nevertheless, interpretation must remain cautious due to substantial between-study heterogeneity in injury definitions, exposure denominators, injury categorization, and clinical ascertainment. Standardized surveillance methods and reporting practices are needed to enable robust comparisons and evidence-based prevention strategies.

KEYWORDS

Epidemiology, female, injury, prevention, wrestling

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INTRODUCTION

Physical activity is one of the most common leisure-time activities in modern society[1]. In addition to its important role in social interactions[2], it also has a major impact on the general health[3]. Sport is a specific type of physical activity and is defined as an institutionalized, rule-governed contest of human physical skill[4]. For the general population, sports represent an important context for recreation and entertainment, either through active or passive engagement[5]. Furthermore, children and adolescents are often encouraged to participate in sports, to form friendships, aid in upbringing and improve pro-social behavior[6]. These benefits of sports participation are accompanied by certain risks, including sport-related injuries. In fact, the incidence of injuries appears to be higher in certain athletic populations compared with the general population[7]. Generally, among the highest rates of injuries are reported in combat sports[8].

Wrestling is a combat sport characterized by intense physical confrontation between two contenders, with the goal of achieving superiority over the opponent through control, grappling, throwing, and par terre techniques. It is considered a highly dynamic sport, characterized by sudden explosive attacks and counterattacks[9]. During defensive actions, high muscle forces are experienced alongside substantial frontal- and transverse-plane motion at the knee and ankle[10]. In addition, several injury mechanisms are intrinsically linked to sport-specific positions and maneuvers (e.g., takedown and defensive takedown positions), in which leverage, twisting, and uncontrolled falls may place extreme loads on the shoulder complex, elbow, and cervical spine. These high-velocity, high-load actions expose the musculoskeletal system to substantial strain, likely increasing the risk of both acute traumatic injury and cumulative microtrauma. High injury rates in wrestling have been consistently reported in epidemiological studies.

Thomas and Zamanpour synthesized competition and database evidence and reported a weighted average injury rate of 16.3 injuries/1000 athletic encounters (AEs) across competition studies, with substantially higher weighted rates in database-derived reports (69.5/1000 AEs), underscoring the burden of injury and the influence of surveillance methodology[11]. Importantly, comparisons across studies remain challenging because definitions of reportable injury, exposure, and severity vary considerably between surveillance systems and clinical settings[11]. Nevertheless, several robust trends are consistently observed: injury incidence is typically higher in competition than in practice, and injury location and severity differ by age and competition level[12]. For example, clinical summaries indicate that the shoulder is commonly injured in high school wrestlers (reported in the range of 18–24% of injuries), whereas among collegiate wrestlers the knee is frequently the leading injury site (approximately one quarter of injuries), with knee injuries also representing a major contributor to prolonged time loss and surgical treatment. Complementing these findings, NCAA surveillance focusing on upper extremity injury has reported an incidence of 21.59 shoulder and elbow injuries per 10,000 AEs, with a markedly higher risk during competition (approximately four-fold) and a greater likelihood of injury later in the match (2.5-fold), implicating fatigue and match dynamics as clinically relevant risk modifiers[13].

The majority of available epidemiological studies and review articles focus primarily on male wrestling[11]. Historically, wrestling has been framed as a male sport, and women's participation and visibility have developed more recently in formal competition structures: females were included in the World Championships in 1987, and women's freestyle wrestling entered the Olympic program in 2004[11].

In parallel with the growth in female participation[14], there is an increasing need for sex-specific evidence to inform coaching, medical coverage, and prevention strategies. Although the technical and physiological demands of wrestling may be comparable between sexes, biological differences can plausibly shape injury risk and injury patterns. For instance, sex-related differences in neuromuscular control, force production, movement strategies, joint laxity, and upper-extremity stabilization demands during grappling and takedown maneuvers may influence injury distribution and tissue-specific injury risk[15,16]. Notably, international competition surveillance including women's wrestling suggests meaningful style-related differences in injury location, with extremity injuries occurring proportionally more often in women's wrestling than in Greco-Roman or men's freestyle, emphasizing the need to better characterize the musculoskeletal injury profile in female athletes[17] and recent evidence also indicates a substantial burden of severe spinal injuries in elite female wrestlers[18].

To date, relatively few epidemiological studies have quantified musculoskeletal injury incidence and patterns in female wrestlers. Considering the steep rise in female participation and plausible sex-specific determinants of injury risk, a focused synthesis of the literature is warranted. Therefore, the aim of our study was to review the literature on musculoskeletal injury epidemiology in female wrestling. Our findings may provide an evidence base for clinicians and researchers to support the development of targeted prevention strategies and improved medical planning in female wrestling.

MATERIALS AND METHODS

This study is a qualitative literature review of epidemiological studies on musculoskeletal injuries in female wrestling. The review was conceptually framed using the Population Exposure Outcome (PEO) model. The population of interest included female wrestlers of all age categories and competitive levels.

Exposure was defined as participation in wrestling training

and/or competition, while outcomes included injury incidence, anatomical distribution, severity, and type of musculoskeletal injuries.

Search strategy

We screened the scientific databases PubMed, Scopus, Web of Science and SPORTDiscus with full text using the following search term: (female OR women OR woman) AND wrestl* AND (injur* OR pain OR disorder* OR traum*) AND (epidemiology OR incidence OR prevalence OR rate OR occurr*). In Scopus, the search was limited to titles, abstracts, and keywords due to the large number of irrelevant records identified during preliminary searches. The search strategy was not restricted by language of publication. All records retrieved through the database searches were screened for relevance based on title and abstract, followed by full-text assessment according to the predefined eligibility criteria. The screening process was conducted independently by two authors. The review was conducted and reported in accordance with the PRISMA 2020 guidelines. The search included studies published from database inception until December 2025.

Eligibility criteria

We included epidemiological studies that reported the occurrence of injuries in female wrestling. Specifically, the included studies should have reported at least one measure of injury rate or proportion exclusively for female wrestling, regardless of their competitive level, category or age. The included outcome measures were incidence of injuries, proportion of injuries, injury severity and type of injury. Studies reporting incidence for injuries of a specific body part were also considered to be included in the review. On the other hand, studies reporting the proportion of specific injuries for a single body part were not included. Studies focusing on a specific severity category were considered eligible if they provided epidemiologically relevant data on musculoskeletal injuries in female wrestlers.

Data extraction and analysis

The records retrieved during screening were exported to the Zotero reference manager. Upon completion of the screening process, the characteristics of the included studies were extracted to an Excel spreadsheet. These include, but were not limited to, the authors, studied population, definition of incidence and/or severity, reported distribution of injuries, incidence, severity and type of injuries. Analyses included only studies that reported the required data clearly. The pooled characteristics and results of the included studies were presented descriptively in the Qualitative analysis portion of the Results.

A meta-analysis was not performed due to substantial methodological heterogeneity across the included studies. Specifically, studies differed in injury definitions, exposure denominators (e.g., athlete exposures, matches, training hours), populations (youth vs. elite athletes), clinical settings, and injury classification systems. Consequently, quantitative pooling of results was deemed inappropriate, and findings were synthesized descriptively.

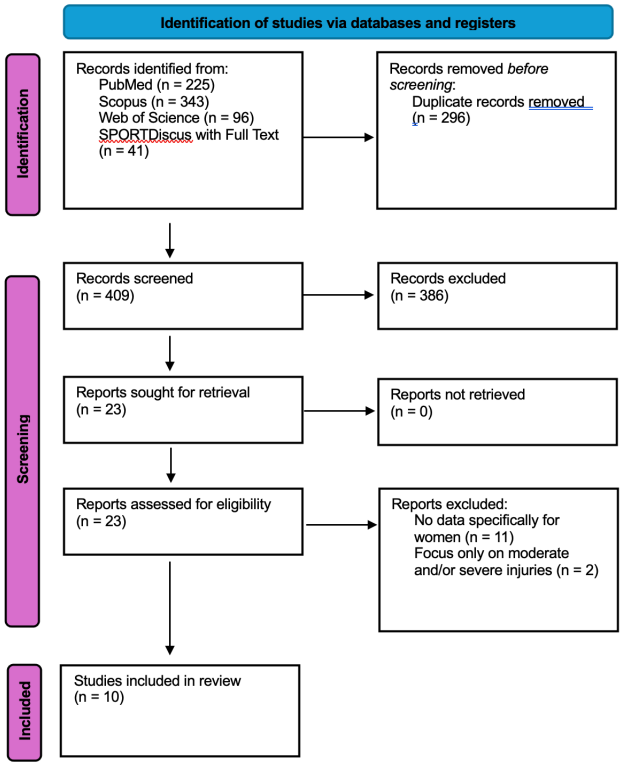


Figure 1. *Flow chart.*

Risk of bias and certainty of evidence

The methodological quality of the included studies was assessed using the Joanna Briggs Institute (JBI) Critical Appraisal Checklist for Prevalence Studies[19]. The checklist evaluates key domains including sample frame appropriateness, participant selection, exposure measurement, outcome measurement, statistical analysis, and response rate adequacy. Two reviewers assessed studies independently; disagreements were resolved by discussion. The overall risk of bias was classified as low, moderate, or high based on the number and relevance of unmet criteria. No studies were excluded based on risk of bias assessment alone; instead, methodological quality was considered during interpretation of findings.

The review protocol was not registered in PROSPERO, as the study was conducted as a qualitative epidemiological synthesis without quantitative pooling. Nevertheless, the methodological approach and eligibility criteria were defined a priori. The review protocol was registered retrospectively on the Open Science Framework (OSF; registration available upon publication due to embargo; OSF project ID: 7uebh).

RESULTS

Altogether, our search term yielded 705 publications. After duplicate removal, 409 publications were screened by title and abstract. The full text of 23 publications was screened

and assessed for eligibility. Finally, 10 studies were included in the qualitative synthesis. Study identification, screening, eligibility assessment, and inclusion are summarized in accordance with the PRISMA 2020 guidelines and presented in *Figure 1*.

Ten studies were included in our review, of which eight were competition- or sample-based studies and two were analyses of emergency department databases. The former consisted of three prospective epidemiological studies[20-22], one retrospective study[23], two descriptive cross-sectional studies[24,26], one retrospective cross-sectional study[18], and one retrospective Olympic surveillance study[25] *(Table 1)*. Overall, 1781 female wrestlers were included in the eight sample-based studies. Four studies included elite athletes[18,20,21,23], one study included predominantly youth athletes competing in national championship settings[24] and three studies included athletes competing in Olympic or national championship settings[22,24,25]. Three studies explicitly reported adult-only samples[18,20,21]. With regard to the clinical setting, two studies analysed injuries during Olympic Games competitions[22,25], two studies from a South Korea National Training Center[20,21], one from the Turkish National Championships[26], one from the Taiwanese National Wrestling Sport Championship[23], and one from Korean elite female wrestling cohorts[18].

The overall risk of bias across the included studies ranged from low to high. Two studies demonstrated a low risk of bias, primarily due to prospective designs and standardized injury surveillance. Most studies were classified as having a moderate risk of bias, mainly due to heterogeneous injury definitions, limited exposure standardization, or reliance on descriptive analyses. One study was assessed as having a high risk of bias due to retrospective self-reported data and limited methodological

Authors	Study type	Setting	Age	Level	Number of participants	Injury definition	Definition of incidence	Incidence
Shadgan et al.[22]	Prospective epidemiological study	Beijing Olympic Games	NA	Elite	66	Any new MSK injury, receiving medical attention regardless of time loss	NA	NA
Park et al.[21]	Prospective epidemiological study	South Korea National Training Center	>18	Elite	75	Any acute or chronic MSK injury	Injuries per 1000 training hours	4.29 injuries/1000 training hours
					Lightweight: NA			4.75 injuries/1000 training hours
					Heavyweight: NA			3.83 injuries/1000 training hours
Kim and Park[20]	Prospective epidemiological study	South Korea National Training Center	>18	Elite	100	Any MSK injury	Injuries per 1000 AE	16.8 injuries/1000 AE
					50 Lightweight			18.3 injuries/1000 AE
					50 Heavyweight			15.3 injuries/1000 AE
Shadgan et al.[25]	Descriptive cross-sectional study	Rio de Janeiro and Tokyo Olympic Games	NA	Elite	Rio Olympics: 112	Any injury requiring medical attention, regardless of time loss	Injuries per 100 athletes	4.5 injuries/100 athletes
					Tokyo Olympics: 96			6.3 injuries/100 athletes
Khera et al.[28]	Retrospective study	NEISS database 2014-2023	5-18	Youth/High School	NA	Any injury	/	/
Can et al.[24]	Descriptive cross-sectional study	Turkish National Championships	>U-15	National championship	1165	Any injury	Injuries per 1000 matches	4.9 injuries/1000 matches
Hoge et al.[27]	Retrospective study	NEISS database 2005-2019	14-18	/	NA	Any injury	/	/
Lin et al.[23]	Questionnaire-based retrospective study	Taiwanese National Wrestling Sport Championship	16-18	National championship	22	Any injury	/	/
Song et al.[18]	Retrospective cross-sectional study	Korean national team selection competition	24.5±2.8	Elite	54	Severe spinal injury causing >3 weeks time loss	/	46.3% prevalence of severe spinal injuries
Köse et al.[26]	Questionnaire-based retrospective study	Turkish National Championship	Youth to senior	National championship	152	Self-reported injuries	/	/

Table 1. *Characteristics of the included studies.*

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detail (*Table 2*). Two studies defined reportable injuries regardless of time loss[22,25]. The other studies did not refer to absence from training or competition as an injury definition criterion. Injury incidence was reported using different exposure denominators and therefore cannot be directly compared or summarized as a single pooled estimate. Specifically, incidence was reported as injuries per 1000 training hours[21], per 1000 matches[24], per 100

Study	Sample frame	Sampling methods	Injury definition	Outcome measurement	Statistical analysis	Overall RoB
Shadgan et al.[22]	Yes	Yes	Yes	Yes	No	Moderate
Park et al.[21]	Yes	Yes	Yes	Yes	Yes	Low
Kim and Park[20]	Yes	Yes	Yes	Yes	Yes	Low
Shadgan et al.[25]	Yes	Yes	Yes	Yes	No	Moderate
Can et al.[24]	Yes	Yes	Partial	Yes	Yes	Moderate
Khera et al.[28]	Partial	No	Yes	Partial	Yes	Moderate
Hoge et al.[27]	Partial	No	Yes	Partial	Yes	Moderate
Lin et al.[23]	Yes	No	Partial	Yes	No	High
Song et al.[18]	Yes	Partial	Yes	Yes	Yes	Moderate
Köse et al.[26]	Partial	No	Partial	Partial	Yes	High

Table 2. *Risk of bias (RoB) assessment of included studies using the JBI checklist adapted summary.*

Authors, year	Sample size	Upper extremity (%)	Lower extremity (%)	Head, face and neck (%)	Trunk (%)	Shoulder and upper arm (%)	Elbow and lower arm (%)	Wrist, hand, fingers (%)	Hip groin and thigh (%)	Knee (%)	Lower leg, ankle and foot (%)
Shadgan et al.[22]	66	20.0 (1)	/	80.0 (4)	/	/	/	20.0 (1)	/	/	/
Park et al.[21]	75	28.1 (126)	39.3 (176)	9.6 (43)	23.0 (103)	12.3 (55)	5.0 (22)	10.9 (49)	7.8 (35)	11.1 (50)	20.3 (91)
	LW	29.4 (73)	37.9 (94)	9.3 (23)	23.4 (58)	11.7 (29)	6.1 (15)	11.6 (29)	8.9 (22)	10.5 (26)	18.5 (46)
	HW	26.5 (53)	41.0 (82)	10.0 (20)	22.5 (45)	13.0 (26)	3.5 (7)	10.0 (20)	6.5 (13)	12.0 (24)	22.5 (45)
Kim and Park[20]	100	25.7 (86)	37.7 (126)	12.6 (42)	24.0 (80)	/	/	/	/	/	/
Shadgan et al.[25]	Rio: 112	20.0 (1)	20.0 (1)	60.0 (3)	0.0 (0)	/	/	/	/	/	/
	Tokyo: 96	16.6% (1)	16.6% (1)	50.0% (3)	16.6% (1)	/	/	/	/	/	/
Khera et al.[28]	NA	40.3 (295)	21.7 (159)	24.5 (179)	13.5 (99)	16.1 (118)	15.0 (110)	9.2 (67)	/	12.7 (93)	9.0 (66)
	5-11 years	57.0 (45)	16.5 (13)	21.5 (17)	5.1 (4)	10.1 (8)	24.1 (19)	22.8 (18)	/	8.9 (7)	7.6 (6)
	11-18 years	42.3 (250)	24.7 (146)	27.4 (162)	5.6 (33)	18.6 (110)	15.4 (91)	8.3 (49)	/	14.6 (86)	10.2 (60)
Can et al.[24]	1165	41.6 (57)	19.7 (27)	23.3 (32)	15.3 (21)	18.9 (26)	14.6 (20)	8.0 (11)	5.1 (7)	8.0 (11)	6.6 (9)
Hoge et al.[27]	NA	40.9	21.9	18.5	14.0	16.7	12.2	12.0	/	10.4	11.5
Lin et al.[23]	22	39.8 (35)	36.4 (32)	10.2 (9)	13.6 (12)	5.6 (5)	9.0 (8)	24.9 (22)	4.5 (4)	12.5 (11)	19.2 (17)
Köse et al.[26]	152	32.6	43.7	8.0	3.2	12.5	18.2	14.4	/	24.1	19.6

Table 3. *Relative proportion of injuries per body part.*

Abbreviations: LW, lightweight; HW, heavyweight.

Note: The absolute number of injuries was reported in brackets. Absolute injury counts were not available in all included studies. Values are presented descriptively due to heterogeneity in injury definitions and reporting methods across studies.

athletes[25], and per 1000 athlete-exposures[20]. Reported values ranged from 4.29 injuries/1000 training hours to 16.8 injuries/1000 athlete-exposures, depending on the denominator used. Given the heterogeneity in exposure definitions, incidence values are presented descriptively and should not be interpreted as directly comparable. None of the included studies reported standardized injury incidence estimates stratified by specific body parts. Although standardized incidence estimates for specific body parts were not available, descriptive epidemiological data from national championship cohorts suggest that upper and lower extremity injuries represent the largest proportion of reported injuries in female wrestlers[26] *(Table 3)*. Five of the included studies defined and reported the injury severity in female wrestlers[18,20-22,25]. Four studies included elite or high-level female wrestlers and classified injuries using either qualitative or time-loss-based severity definitions[20-22,25]. Two studies used qualitative injury severity classifications based on the need for medical attention and competition discontinuation[22,25], whereas two studies used time-loss–based severity classifications according to recovery or treatment duration[20,21]. Although one study referred to days of treatment and the other to days of recovery, these measures were interpreted as comparable indicators of time loss. Across the four studies using categorical severity classifications, most reported injuries were classified as mild. Interestingly, three studies reported a higher proportion of severe injuries than moderate injuries. Additionally, Song et al.[18] specifically investigated severe spinal injuries in elite female wrestlers and reported that 46.3% of athletes had experienced severe spinal injuries, most commonly involving the lumbosacral region *(Table 4)*.

Eight of the included studies reported injury characteristics, including anatomical distribution and injury type[20–28]. Joint injuries were the most common musculoskeletal injury category in two studies[20,27], whereas muscle injuries predominated in one study[24]. Tendon injuries were specifically reported in one study[23]. In two studies[27,28] muscle and joint injuries (strain/sprain) were combined into a single category and represented the most frequently reported injury group. Across the included studies, extremity injuries represented the largest proportion of reported musculoskeletal injuries in female wrestlers, although the relative distribution between upper and lower extremities differed according to age category and competition level[20–26] *(Table 5)*.

Certainty of evidence (GRADE)

Using the GRADE approach, the overall certainty of evidence for all key outcomes ranged from low to very low. The certainty was primarily downgraded due to the observational nature of the included studies, substantial methodological heterogeneity, and imprecision related to small sample sizes and inconsistent exposure definitions. A detailed summary of findings is presented in *Table 6*.

Authors, year	Categories	Severity definition	Proportion (%)	Upper extremity (%)	Lower extremity (%)	Head, face and neck (%)	Trunk (%)
Shadgan et al.[22]	Mild	Fully treated on the mat.	100 (5)	/	/	/	/
	Moderate	Treated primarily on the mat but needing more attention after the competition.	0 (0)	/	/	/	/
	Severe	Required the athletes to discontinue the match and be transferred to the hospital.	0 (0)	/	/	/	/
Park et al.[21]	Mild	1–3 days of treatment	60.7 (272)	69.0 (87)	61.4 (108)	58.1 (25)	50.5 (52)
	Moderate	4–7 days of treatment	18.3 (82)	18.3 (23)	17.0 (30)	27.9 (12)	16.5 (17)
	Severe	≥8 days of treatment	21.0 (94)	12.7 (16)	21.6 (38)	14.0 (6)	33.0 (34)
Kim and Park[20]	Mild	1–3 days of recovery	65.9 (220)	72.1 (62)	69.8 (88)	57.1 (24)	57.5 (46)
	Moderate	4–7 days of recovery	15.6 (52)	15.1 (13)	15.9 (20)	28.6 (12)	8.8 (7)
	Severe	≥8 days of recovery	18.6 (62)	12.8 (11)	14.3 (18)	14.3 (6)	33.8 (27)
Shadgan et al.[25]	Mild	Fully treated on the mat.	/	/	/	54.5 (6)	9.1 (1)
	Moderate	Treated primarily on the mat but needing more attention after the competition.	/	/	/	/	/
	Severe	Required the athletes to discontinue the match and be transferred to the hospital.	/	18.2 (2)	18.2 (2)	/	/
Song et al.[18]	Severe	>3 weeks time loss	46.3 (25)	/	/	20.0 cervical spine injuries	72.0 lumbosacral disc injuries

Table 4. *Severity of injuries.*

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Authors	Overuse injury	Muscle injury (%)	Joint injury (%)	Bone injury (%)	Tendon injury (%)	Other injuries (%)
Shadgan et al.[22]	/	/	20.0 (1)	/	/	80.0 (4)
Kim and Park[20]	/	35.0 (117)	56.9 (190)	0.6 (2)	7.5 (25)	/
Shadgan et al.[25]	/	18.2 (2)	27.3 (3)	/	/	54.6 (6)
Khera et al.[28]	/	34.8 (292) [a]	34.8 (292)[a]	14.7 (124)	/	48.6 (409)
Can et al.[24]	/	52.6 (72)	15.3% (21)	/	0.7 (1)	31.4 (43)
Hoge et al.[27]	/	52.6[a]	52.6% [a]	10.6	/	36.6
Lin et al.[23]	15.2 (14)	/	/	1.0 (1)	13.0 (12)	70.6 (65)

Table 5. *Injury type.*

Outcome	N of studies	Study design	Key limitations	Consistency	Directness	Precision	Overall certainty
Injury incidence	4	Observational	Heterogeneous injury and exposure definitions	Inconsistent	Direct	Imprecise	Low
Anatomical distribution of injuries	9	Observational	Variable injury classification systems and heterogeneous injury definitions	Generally consistent	Direct	Imprecise	Low
Injury severity	5	Observational	Non-standardized severity definitions and retrospective self-reporting	Inconsistent	Direct	Imprecise	Very low
Type of injured structure	7	Observational	Mixed injury categorization and reporting	Generally consistent	Direct	Imprecise	Low

Table 6. *Summary of findings (GRADE).*

DISCUSSION

We aimed to review and summarise the literature on the epidemiology of musculoskeletal injuries in female wrestling. The results of the included studies indicate a relatively high incidence of injuries, ranging from 4.29 injuries per 1000 training hours to 16.8 injuries per 1000 athlete-exposures, depending on the exposure definition used. Notably, we observed a key difference in the proportion of injuries per body part between youth and elite athletes. Specifically, while elite athletes show a higher proportion of lower extremity injuries, upper extremity injuries are most common among youth athletes. Although only half of the included studies reported injury severity, it appears that most reported injuries across the included studies were classified as mild.

Our findings are somewhat comparable to those of a systematic review published by Thomas et al.[11]. That review included only one study with data on female wrestlers[23], and therefore it may serve as a rough comparison between genders. They concluded that the average incidence of injuries was 16.3 injuries per 1,000 athletic encounters when summarising competition-based studies. Thomas et al. also reported substantially higher injury rates in database-derived studies, highlighting the important influence of surveillance methodology and clinical setting on epidemiological estimates[11]. In our review, reported injury incidence ranged from 4.29 injuries per 1000 training hours to 16.8 injuries per 1000 athlete-exposures, which is lower compared to their findings. Nevertheless, our summarised findings should not be directly compared with those of Thomas et al. due to heterogeneous definitions of injury incidence[11]. One study from our review[20] calculated the incidence of injuries per 1,000 athlete exposures and found a similar incidence (16.8 injuries per 1,000 athlete exposures) to the average incidence reported by Thomas et al.[11]. Importantly, an athlete exposure/encounter may consist of a few hours of training, hence the difference in incidence of injuries between studies should be interpreted with caution. An additional source of heterogeneity in our review was the clinical setting of the included studies in our review (training centre, national championships, emergency department databases, Olympic games). Findings from studies with direct comparisons between genders are inconsistent, with some studies reporting a higher injury incidence in males[22,25], while the others found a similar incidence[17] or even a higher incidence in females[20].

In terms of the reported distribution of injuries per body part, our findings were similar to Thomas et al.[11]. It appears that extremity injuries predominate in both male and female wrestling populations, although the relative distribution between upper and lower extremity injuries may differ according to age, level, and surveillance setting. Our findings suggest that upper extremity injuries may

represent a relatively greater proportion of injuries in female wrestlers compared with patterns previously reported in predominantly male cohorts (24% and 26% from Thomas et al.[11]). Our findings regarding the predominance of extremity injuries are also supported by descriptive data from Turkish female wrestling cohorts[26]. Several factors may potentially contribute to these findings. In general female athletes display a higher level of joint laxity[29] which could in some cases be related to hypermobility and multidirectional instability of the shoulder joint[30]. This may partially contribute to a higher occurrence of injuries in the shoulder joint either during grappling in the end range positions or during falling after an opponents take-down. This is further supported by the fact that joint injuries appeared to be the most common in our review. Another possible explanation is tied to the higher proportion of head and neck injuries in males reported by Thomas et al.[11]. This is consistent with the findings of a recent systematic review, which showed a higher incidence of traumatic brain injuries in males compared to females[31]. Male wrestlers experience a 30% higher count of head acceleration events during matches, which could explain the higher proportion of head and neck injuries compared to females[32]. In summary, although there may be some subtle differences in the reported distribution of injuries per body part between genders, the general injury profile seems to be comparable.

An important finding of our study is the difference in injury profiles between elite and youth female wrestlers. Notably, elite female wrestlers showed a higher proportion of lower extremity injuries, whereas youth wrestlers consistently showed a higher proportion of upper extremity injuries, particularly shoulder injuries. Differences in upper- and lower-extremity strength development during athletic development may partially influence injury distribution patterns between youth and elite wrestlers. However, direct evidence supporting this mechanism in female wrestling populations remains limited, and the observed differences are likely multifactorial. Lastly, the observed differences may also partially reflect differences in clinical setting, competition level, or regional training practices across the included studies.

Interpretation of the present findings should consider the overall certainty of evidence, which ranged from low to very low according to the GRADE approach. This primarily reflects the observational design of the included studies, substantial heterogeneity in injury definitions and exposure metrics, and imprecision related to sample size and outcome reporting. Consequently, while consistent patterns in injury distribution and severity were observed, the reported estimates should be interpreted as descriptive rather than definitive.

The findings suggest that most reported injuries were mild, while severe injuries were reported more frequently than moderate injuries in several included studies. This observation may partly reflect limitations in the operational definitions used to classify injury severity. Park et al. and Kim and Park defined injuries as moderate in case 4-7 days of treatment is needed[20,21]. It is plausible that this short range of treatment days results in an overestimated proportion of severe injuries. Future epidemiological studies should consider adopting a different strategy for the classification of injury severity.

The risk of bias assessment further contextualizes these findings. Although several studies demonstrated low risk of bias due to prospective designs and standardized injury surveillance, most were classified as having moderate risk of bias. Common limitations included non-standardized exposure denominators, limited statistical reporting, and reliance on competition-based or emergency department data, which may not fully capture the overall injury burden in female wrestling.

Our findings may offer some important implications for injury prevention programs. Based on these results, the findings suggest that the main component of female wrestling injury prevention programs should aim at decreasing the likelihood of joint and muscle injuries, with a particular focus on the extremities. In addition, these strategies should be specifically constructed in order to include trunk and neck loading, as injuries to these regions are still fairly common. Resistance training is likely to represent a key component of injury prevention strategies in female wrestling, given its established role in enhancing both performance and musculoskeletal resilience. Particular emphasis may be warranted for upper-extremity neuromuscular control and shoulder stabilization in female wrestlers due to the relatively high proportion of extremity injuries reported across studies. Multicomponent injury prevention programs should also include neuromuscular and stabilization exercises. Since the highest reported distribution of injuries was found for the shoulder and upper arm, targeted upper-extremity neuromuscular exercises may be considered as part of multicomponent injury prevention strategies. Considering the increased probability for joint laxity and hypermobility in female athletes, it is important that neuromuscular drills for the upper extremity are not limited to open kinetic chain movements. Closed kinetic chain exercises are widely advocated as a key component of exercise-based interventions for shoulder instability, as they are well tolerated due to increased joint compressive forces and enhanced muscle coactivation, which may contribute to improved shoulder stability[34,35]. Such exercises may be considered as part of multicomponent injury prevention strategies in female wrestling. Progressive increases in exercise complexity, instability, and movement variability may further enhance neuromuscular demands. Currently, only limited evidence is available regarding the effectiveness of exercise-based injury prevention interventions in wrestling. Bayati et al. reported that an injury prevention warm-up program (Wrestling+) reduced injury incidence by 58%[36]. The wrestling + injury prevention program consists of several

drills, containing both elements of neuromuscular control and muscle performance. Based on the similar injury profile between male and female wrestlers, it may be recommended that female wrestlers implement a similar warm-up strategy with the aim of decreasing the likelihood of injuries. Currently, evidence regarding injury prevention interventions specifically in female wrestling remains limited.

Finally, several limitations of this review should be acknowledged. A major limitation is the methodological heterogeneity of the included studies. For example, the categorisation of injury location and type varied substantially across studies, which influenced how injuries could be clustered and summarised in our qualitative analysis. In addition, most studies did not incorporate time loss (days of absence) into the injury definition. This may have led to an overestimation of injury frequency by including very low-grade complaints. The definition and reporting of injury incidence were also highly heterogeneous, a well-recognised limitation in sports injury epidemiology that limits comparisons across studies. Only a limited number of studies included larger samples of elite adult athletes. Consequently, the generalisability of findings to elite-level female wrestlers remains limited.

CONCLUSIONS

This review provides an updated synthesis of musculoskeletal injury epidemiology in female wrestling, offering clinically relevant insights into age- and competition-level–specific injury patterns. Injuries predominantly affect the extremities, with a clear age- and level-specific pattern: upper extremity injuries are more common in youth athletes, whereas lower extremity injuries predominate in elite wrestlers. These interpretations should be considered hypothesis-generating and warrant confirmation in prospective, sex-specific injury surveillance studies. Most reported injuries were classified as mild and primarily involved joints and muscles, suggesting a considerable burden of potentially preventable conditions.

These findings offer a clinically relevant framework for injury prevention and medical planning that should be tailored to age category and competitive level. However, the current evidence base is constrained by substantial methodological heterogeneity, inconsistent injury definitions, and a predominance of data derived from youth populations, limiting generalisability to elite female wrestlers. Future research should prioritise standardized injury definitions, exposure metrics, and severity classifications to improve comparability and enable higher-certainty epidemiological evidence to support effective injury prevention strategies in female wrestling.

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