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Sex Differences in Injury, Stoppage and Concussion Rates in Amateur and Olympic-Style Boxing: A Systematic Review and Meta-Analysis

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Contents

Section	Page
Abstract	3
Key Points	3
Background	4
Methods	4
Results	6
Discussion	10
Conclusions	12
List of abbreviations	12
Declarations	12
References	13
Additional files	14

Item	Title	Page
Fig. 1	PRISMA 2020 flow diagram	6
Fig. 2	Boxing injury data in the included cohorts	7
Fig. 3	Headguard rules and data availability by Games	8
Fig. 4	Risk-of-bias judgements (ROBINS-E)	8
Fig. 5	Forest plot, injury risk ratios	9
Fig. 6	Evidence map by outcome and cohort	10
Table 1	Characteristics of the included studies	7
Table 2	Risk of bias (ROBINS-E)	8
Table 3	Injury data and meta-analysis	9
Table 4	Summary of findings (GRADE)	11

Sex Differences in Injury, Stoppage and Concussion Rates in Amateur and Olympic-Style Boxing: A Systematic Review and Meta-Analysis

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Abstract

Background: Women have boxed at the Olympic Games since 2012; since 2013 elite men have competed without headguards while women have kept them. Sex differences in injury, stoppage and concussion rates in amateur and Olympic-style boxing have not been systematically reviewed. The review question was: in amateur and Olympic-style boxers, do injury incidence, stoppage rates and concussion rates differ between women and men?

Methods: PubMed/MEDLINE and Consensus were searched on 29 September 2026 (English-language reports, no date limit), with backward citation searching. Eligible studies reported at least one outcome (injury, stoppage, diagnosed concussion, laceration, fracture, other craniofacial or regional injury, or acute neurocognitive change) for women and men from the same amateur or Olympic-style boxing population with sex-specific denominators; outcomes were kept separate. Screening and extraction were single-reviewer with verification. Risk of bias was assessed with ROBINS-E and certainty with GRADE. Risk ratios (women versus men) were pooled with a restricted maximum likelihood random-effects model with Hartung-Knapp adjustment.

Results: From 416 unique database records and 36 citation-search records, four studies were eligible, all International Olympic Committee injury-surveillance cohorts (Olympic Games 2012, 2016 and 2020; Youth Olympic Games 2018). Sex-specific boxing data were available from the published text of two. At London 2012, where both sexes wore headguards, 7 of 36 women (19.4%) and 18 of 247 men (7.3%) sustained a medical-attention injury (risk ratio 2.67, 95% CI 1.20 to 5.94). At Tokyo 2020, where men boxed without headguards and women with them, the reported risk ratio was 0.43 (0.24 to 0.75). The pooled estimate (risk ratio 1.05) was not interpretable (I^2 = 92%; Hartung-Knapp 95% CI 0.00 to >1000). No eligible study reported stoppages, diagnosed concussion, lacerations, fractures or neurocognitive change by sex. Certainty of evidence was very low.

Conclusions: The direction of the sex difference in injury reversed once protective-equipment rules diverged by sex, and no sex-stratified evidence exists for stoppages or concussion. Regulators cannot assume equal or unequal risk by sex. Sex-stratified surveillance with exposure denominators, recording stoppage and concussion by sex, is a prerequisite for evidence-based sex-specific rules.

Registration: Not registered.

Key Points

- In the only Olympic Games at which women and men boxed under the same headguard rule (London 2012), the proportion of boxers injured was higher in women; after headguards were removed from men's boxing, the direction reversed.
- No published study reports head-blow stoppages, diagnosed concussion, lacerations, fractures or acute neurocognitive change for women and men drawn from the same amateur boxing population.
- Sex-stratified injury surveillance with exposure denominators, adopted by federations and athletic commissions, is a prerequisite for sex-specific rules on protective equipment and medical stoppage.

Keywords: Boxing; Women; Sex differences; Injury surveillance; Concussion; Stoppage; Headguard; Olympic Games; Systematic review; Meta-analysis

Background

Women's boxing has been an Olympic event since the London 2012 Games, where women competed in three of the ten weight categories available to men [1]. In the same period the governing body of amateur boxing changed its rules on protective equipment: the International Boxing Association (AIBA) removed headguards from elite men's competition from 2013, and its Open Boxing Competition Rules effective from 1 February 2015 stated that headguards were not allowed in elite men's competitions while remaining mandatory for all other categories, including elite women [2, 3]. Men therefore boxed without headguards at the 2016 Olympic Games while women wore them [3, 4], and the same practice was reported for the Tokyo 2020 Games [5]. Rules have continued to change, and a 2025 opinion article refers to a recent prohibition of headguards by the International Boxing Association [6]; the Association of Ringside Physicians has recommended that, in the absence of data on sex differences, headguard policies be standardised for men and women [7].

Sex-specific evidence is central to these decisions, yet it is thin. Systematic reviews have addressed boxing injury epidemiology, in one case with a separate pooled estimate for female boxers [8], and protective headgear, but none has synthesised within-study comparisons of women and men [8–12]. Across sports, female athletes have been reported to have higher concussion rates than male athletes in sex-comparable sports [13, 14], whereas male team-sport athletes sustain more injuries overall [15]; female athletes are under-represented in the research that informs concussion consensus statements [16–18]. Whether these patterns hold in boxing, a sport in which the head is a scoring target and in which equipment rules now differ by sex, is unknown.

For athletic commissions and federations, three questions arise whenever a rule is written separately for women and men: whether injury rates differ, whether bouts are stopped for head blows at different rates, and whether concussion is diagnosed at different rates. This review therefore asked: in amateur and Olympic-style boxers, do injury incidence, stoppage rates and concussion rates differ between women and men? The population was amateur and Olympic-style boxers of any age or level; the exposure was female sex and the comparator male sex within the same study; the outcomes were injury incidence, stoppage rates (head-blow and other), diagnosed concussion, laceration, fracture, other craniofacial injury, regional injury and acute neurocognitive change, each analysed separately; eligible designs were cohort, surveillance, competition-record and cross-sectional studies and trials reporting sex-stratified data.

Methods

Design, reporting and registration

The review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement [19]; the completed checklist and abstract checklist are provided as Additional file 5. The review was not registered and no protocol was published; the eligibility criteria, outcomes and analysis plan were fixed in a working outline before the searches were run and are reproduced in Additional file 1.

Eligibility criteria

Population: amateur and Olympic-style boxers of any age and competition level (youth, novice, national, collegiate, military-academy and elite international competition), in sanctioned competition or, as a separate stratum, in training or sparring. Professional boxers were excluded, as were other combat sports unless boxing was reported separately. Exposure and comparator: female sex versus male sex, with both sexes drawn from the same study population, setting and surveillance method; single-sex studies were ineligible. Outcomes: (1) injury incidence as defined by the source study; (2) stoppage attributed to head blows (referee stops contest-head, knockout or equivalent); (3) clinician-diagnosed concussion or traumatic brain injury; and, as secondary endpoints, other stoppage categories, laceration, fracture, other craniofacial injury, non-head injury by region and acute neurocognitive change measured with a validated instrument. Each endpoint was analysed separately; stoppage was not treated as a surrogate for diagnosed concussion, and biomechanical head-impact measures were excluded. Eligible studies had to report a sex-specific denominator (athletes, bouts, rounds, athlete-exposures or minutes) or an outcome that was itself a proportion of such a denominator; distributions of injuries among injured patients without a population denominator were ineligible. Designs: prospective or retrospective cohort, surveillance, competition-record and cross-sectional studies, and randomised trials if sex-stratified. Reports: peer-reviewed English-language reports of any publication date; conference abstracts, case reports without denominators and reviews were excluded, reviews being used for citation searching.

Information sources and search strategy

PubMed/MEDLINE [20] and the academic search engine Consensus [21] were searched on 29 September 2026 with no date limit and an English-language limit. Because the PubMed interface used accepts at most 20 Boolean operators per query, the strategy combined a boxing block ('Boxing'[MeSH Terms] OR boxing, boxer or boxers in title or abstract) with three outcome blocks run separately: (a) injury terms (Wounds and Injuries, Athletic Injuries and Facial Injuries as MeSH terms; injury, injuries, laceration, lacerations, fracture, fractures) with a sex block (Female as a MeSH term; female, women, sex or gender in title or abstract); (b) concussion terms (Brain Concussion, Brain Injuries, Traumatic and Craniocerebral Trauma as

MeSH terms; concussion, concussions, traumatic brain injury, neurocognitive, cognitive) with the sex block; and (c) stoppage terms (stoppage, stoppages, referee stopped contest, knockout, knockouts, technical knockout, medical stoppage, bout outcome, bout outcomes) without the sex block, because bout-record studies do not necessarily name sex in the abstract. Consensus was queried with five free-text searches, each returning the 20 top-ranked records. The full strings, filters, dates and record counts are given in Additional file 1. Backward citation searching was performed on the reference lists of relevant reviews and primary studies (31 sources sought; 12 reference lists obtained) and is reported as identification via other methods. No other database, registry or grey-literature source was searched.

Selection process

Records were deduplicated by PubMed identifier and digital object identifier. Titles and abstracts were screened against the criteria, and full texts of retained records were sought through PubMed Central, the publisher, open repositories located through the Unpaywall and OpenAlex services and full-text excerpts indexed by Consensus. Screening was single-reviewer, and every decision was verified by the author. When a full text could not be obtained, the record was classified as not retrieved; where the published record (abstract, indexing terms or partially visible text) established that the population, design or outcome could not meet the criteria, the reason was recorded and the report is listed with that reason in Additional file 2, separately from reports that remained potentially eligible.

Data collection process and data items

The following items were extracted into a structured workbook (Additional file 3): citation, digital object identifier, PubMed identifier, country and event, competition level, sex, age, design, sample size, exposure and comparator definitions, outcome definition, exposure denominator, event counts by sex, effect estimates with 95% confidence intervals, adjustment variables, funding, headguard rule and bout format by sex at the time of the study, and the location (table, figure or section) of every number. Numbers were taken only from text, tables or figures actually read; values available only in supplementary files that could not be obtained are marked as not yet extracted, and no value was estimated or read from a graph.

Potential effect modifiers and reasons for heterogeneity

The following were specified in advance as potential effect modifiers: age group (youth versus adult), competition level, setting (competition versus training or sparring), study design, risk of bias, the headguard rule applying to each sex during the study period, bout format and rule-change periods. Headguard status was recorded per study from the rules in force because the rules have differed by sex since 2013 [2, 3].

Study risk of bias, reporting bias and certainty assessment

Risk of bias was assessed at the outcome level with the ROBINS-E tool for non-randomised studies of exposures [22], treating sex as the exposure and the proportion of boxers injured as the outcome, across the domains of confounding, exposure measurement, participant selection, post-exposure interventions, missing data, outcome measurement and selective reporting. Reporting bias was assessed by examining whether sex-stratified results were reported for boxing in the main text, in supplementary files or not at all; funnel plots and Egger's test were not used because fewer than ten studies contributed to any analysis. Certainty of evidence was rated with the GRADE approach [23], starting at low for observational designs.

Effect measures and synthesis methods

The effect measure for proportions was the risk ratio (women versus men), with the odds ratio planned as a sensitivity analysis; for exposure-adjusted rates the incidence rate ratio; and for continuous neurocognitive measures the standardised mean difference (Hedges' g). Log risk ratios and their variances were computed from counts, with a continuity correction of 0.5 applied only when a zero cell was present, or derived from a reported ratio and confidence interval. Studies were pooled only when at least two shared a comparable exposure, comparator and outcome definition; otherwise results were synthesised narratively following the Synthesis Without Meta-analysis guidance [24]. Pooling used a random-effects model with restricted maximum likelihood estimation of the between-study variance and the Hartung-Knapp adjustment [25], reporting the pooled estimate, its 95% confidence interval, the 95% prediction interval (estimable with three or more studies), tau-squared, I-squared, Cochran's Q and the number of studies and participants. Subgroup analyses by the pre-specified modifiers and sensitivity analyses (leave-one-out, low risk of bias only, risk ratio versus odds ratio, exclusion of derived values and a normal-distribution confidence interval without the Hartung-Knapp adjustment) were planned. The model was implemented in Python (version 3) rather than in the R environment specified in the analysis plan, and was validated against the published output of the metafor package [26] for a reference dataset (identical pooled estimate, between-study variance, I-squared and Q); the dataset, the Python script and an equivalent metafor script are provided as Additional file 4. Duplicate cohorts were identified so that each population entered an analysis once.

Results

Study selection

The database searches returned 597 records (PubMed/MEDLINE 497; Consensus 100), of which 181 were duplicates, leaving 416 unique records. After title and abstract screening, 357 were excluded and 59 reports were sought in full. Twenty-six full texts were assessed and 23 were excluded with reasons; 33 reports could not be obtained in full, of which 30 were shown by the published record to be ineligible (most often emergency-department registry studies without a competition level or a sex-specific denominator, studies of professional boxers, or studies without an outcome by sex) and three remained potentially eligible (an accepted manuscript of a three-Games combat-sport analysis [4], a sparring study with neurocognitive testing in 30 women and 30 men [27], and a retrospective series of post-bout examinations [28]). Citation searching of 12 reference lists identified 36 further records, of which 17 were sought, six assessed and one included; eight remained not retrieved. Four studies were included (Fig. 1). Full texts excluded after assessment included a five-year surveillance study of the Great Britain squad, which was male only [29], a Victorian cohort of amateur and professional boxers with three female amateurs and no result by sex [30] and a German questionnaire cohort of 44 competitive boxers, 42 of them male, without results by sex [31]. All reports not retrieved and all excluded full texts are listed with reasons in Additional file 2.

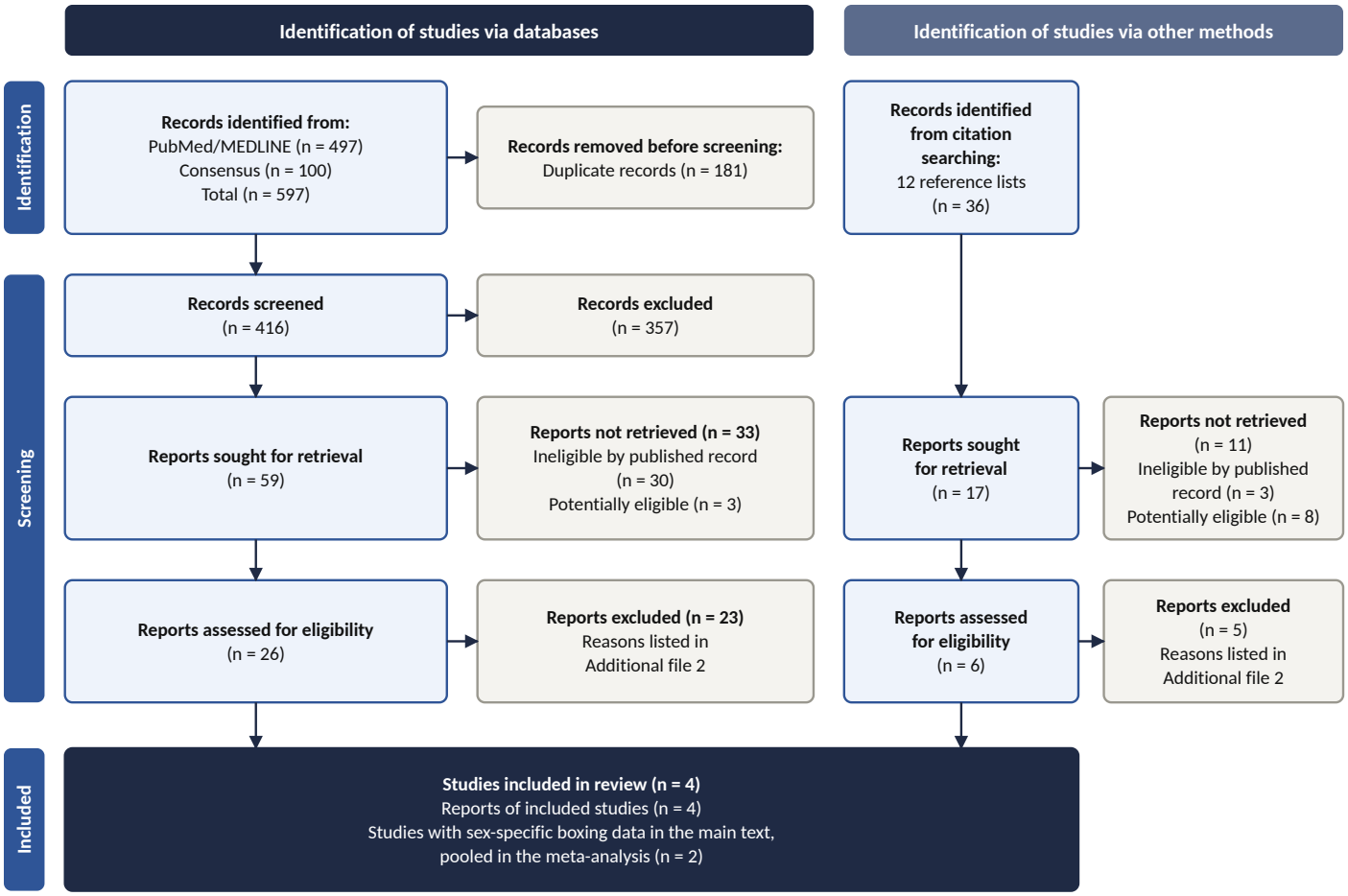


Fig. 1 PRISMA 2020 flow diagram of study identification, screening and inclusion. Identification via databases (PubMed/MEDLINE and Consensus, searched 29 September 2026) and via citation searching of reference lists. Reports not retrieved are divided into those shown by the published record to be ineligible and those that remained potentially eligible. Record-level exclusions and reasons are listed in Additional file 2.

Study characteristics

All four included studies were prospective injury and illness surveillance cohorts conducted by the International Olympic Committee during a Games period, using the same medical-attention injury definition and daily reporting by National Olympic Committee medical teams and organising-committee medical staff [32, 33]: the London 2012 Olympic Games [34], the Rio de Janeiro 2016 Olympic Games [35], the Tokyo 2020 Olympic Games held in 2021 [36] and the Buenos Aires 2018 Youth Olympic Games [37] (Table 1). Injuries were defined as new or recurring conditions incurred in competition or training during the Games that received medical attention, irrespective of time loss, and the denominator was the number of registered athletes per sport and sex. Boxing was among the sports with the highest injury incidence in three cohorts: 30.1 (95% CI 23.7 to 36.4) injuries per 100

athletes in 2016 [35], 27.1 (21.1 to 33.1) in 2020 [36] and 32.9 (20.5 to 45.4) at the Youth Olympic Games [37]; at London 2012, 25 of 283 boxers (8.8%, computed from the sex-specific table) were injured [34] (Fig. 2a). The Beijing 2008 cohort [38], in which boxing was contested by men only, and the pooled three-Games analysis of combat sports [4], which overlaps the 2012 and 2016 cohorts, were not eligible. Sex-specific boxing data are reported in the main text of the 2012 report (Table 2 of that paper) and as a risk ratio in the main text of the 2020 report; for the 2016 and 2018 cohorts they are held in online appendices (appendix 4 of the 2016 report; appendices 2 and 9 of the 2018 report) that could not be obtained for this version of the review. The headguard rule differed by study: both sexes wore headguards in 2012 and, under the youth rules, in 2018, whereas men boxed without headguards and women with them in 2016 and 2020 [3, 4] (Fig. 3).

Table 1 Characteristics of the included studies

Study	Event and dates	Design and injury definition	Athletes (all sports)	Boxing injury incidence (both sexes)	Sex-specific boxing data	Headguard rule by sex
Engebretsen 2013 [34]	London 2012 Olympic Games, 27 July to 12 August 2012	Prospective IOC surveillance; medical-attention injury in competition or training during the Games	10568 (4676 women; 5892 men)	Not reported as a rate in the main text; 25 injured boxers of 283	Main text (Table 2): women 7/36 (19.4%); men 18/247 (7.3%)	Concordant (both with headguards)
Soligard 2017 [35]	Rio de Janeiro 2016 Olympic Games, 5 to 21 August 2016	Prospective IOC surveillance; same definition	11274 (5089 women; 6185 men)	30.1 (95% CI 23.7 to 36.4) per 100 athletes	Online appendix 4 (not yet obtained)	Discordant (men without; women with)
Soligard 2022 [36]	Tokyo 2020 Olympic Games, 23 July to 8 August 2021	Prospective IOC surveillance; same definition	11315 (5423 women; 5892 men)	27.1 (95% CI 21.1 to 33.1) per 100 athletes	Main text: RR 0.43 (95% CI 0.24 to 0.75); counts in online appendix 1 (not yet obtained)	Discordant (men without; women with)
Steffen 2019 [37]	Buenos Aires 2018 Youth Olympic Games, 6 to 18 October 2018	Prospective IOC surveillance; same definition; athletes born 2000–2001	3984 (1983 women; 2003 men, as reported)	32.9 (95% CI 20.5 to 45.4) per 100 athletes	Online appendices 2 and 9 (not yet obtained)	Concordant (youth rules; both with headguards)

IOC, International Olympic Committee; RR, risk ratio (women versus men). Injury definition: new or recurring musculoskeletal complaint, concussion or other medical condition incurred in competition or training during the Games period and receiving medical attention, regardless of absence from sport. Headguard rule taken from the AIBA Open Boxing Competition Rules effective 1 February 2015 (Rule 20.1) and from the three-Games combat-sport analysis; the 2018 youth rule and the 2020 rule are to be verified against the rules in force at those events.

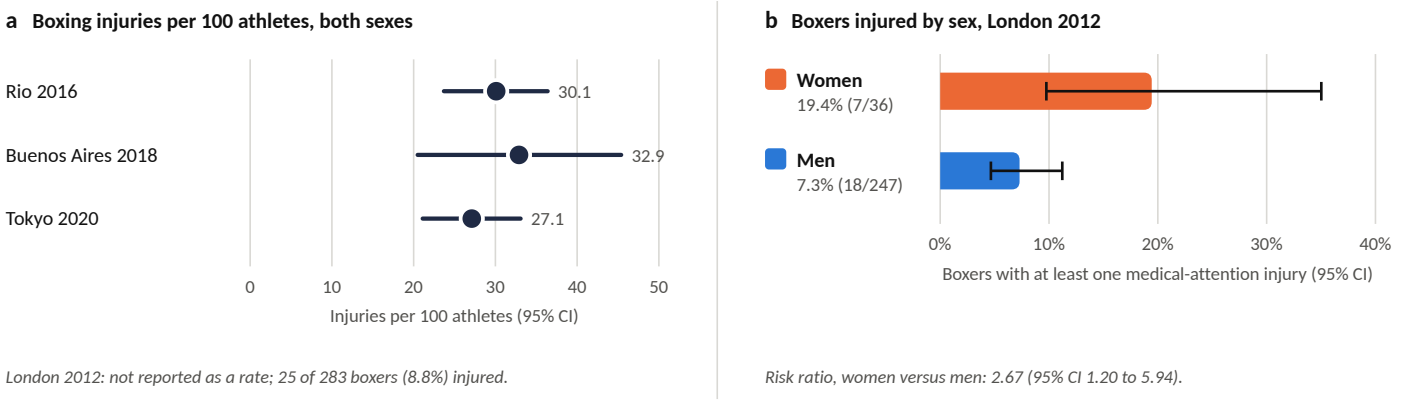


Fig. 2 Boxing injury data in the included cohorts. **a** Boxing injuries per 100 athletes, both sexes, with 95% confidence intervals as reported for Rio 2016, Buenos Aires 2018 and Tokyo 2020 [35–37]; the London 2012 report gives counts rather than a rate [34]. **b** Proportion of boxers with at least one medical-attention injury by sex at London 2012, the only Games with a concordant headguard rule and sex-specific counts in the main text [34]. Error bars in **b** are Wilson 95% confidence intervals computed for this figure from the reported counts.

Risk of bias in studies

For the sex comparison, the 2016 and 2020 cohorts were judged at high risk of bias because sex was confounded with protective equipment: the same surveillance programme reported a three-fold higher injury rate in male boxers after the removal of headguards [4]. The 2012 and 2018 cohorts were judged to have some concerns, because bouts per athlete were not reported by sex and the per-athlete proportion does not account for exposure, because completeness of reporting by National Olympic Committees varied, and because 27 injuries across all sports in 2012 lacked a recorded sex. Exposure measurement (sex from the athlete database), participant selection (all registered athletes) and selective reporting (sex-specific results reported for every sport) were judged at low risk in all four studies (Table 2; Fig. 4; Additional file 3).

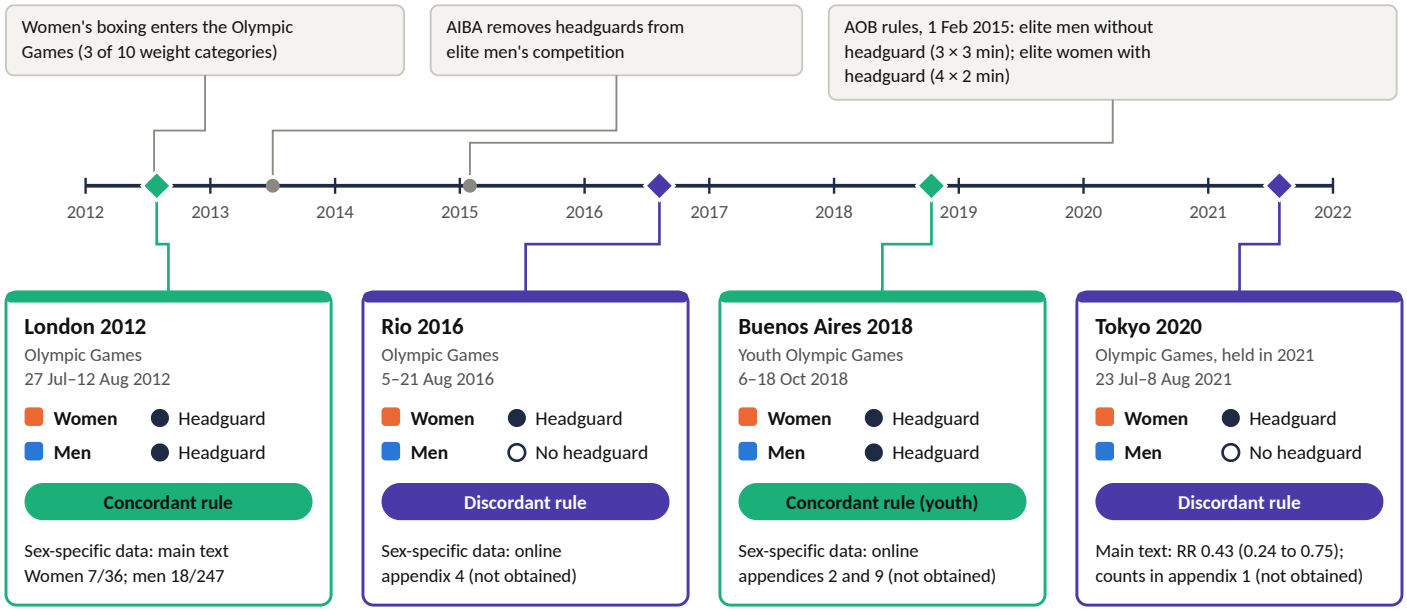


Fig. 3 Headguard rules by sex and availability of sex-specific boxing data at each included Games. Rule changes from the sources cited in the Background [1–3]. Concordant, both sexes wore headguards; discordant, men boxed without headguards and women with them. The 2018 youth rule and the 2020 rule are to be verified against the rules in force at those events (Table 1).

Table 2 Risk of bias (ROBINS-E) for the comparison of women with men

Study	Confounding	Exposure measurement	Participant selection	Post-exposure interventions	Missing data	Outcome measurement	Selective reporting	Overall
Engebretsen 2013	− Some concerns	+ Low	+ Low	+ Low	− Some concerns	− Some concerns	+ Low	− **Some concerns**
Soligard 2017	× High	+ Low	+ Low	+ Low	− Some concerns	− Some concerns	+ Low	× **High**
Soligard 2022	× High	+ Low	+ Low	+ Low	− Some concerns	− Some concerns	+ Low	× **High**
Steffen 2019	− Some concerns	+ Low	+ Low	+ Low	− Some concerns	− Some concerns	+ Low	− **Some concerns**

Confounding was rated high where the headguard rule differed by sex during the event and some concerns where exposure (bouts or minutes) per athlete was not reported by sex. Missing data reflects variable completeness of daily reporting by National Olympic Committees. Outcome measurement reflects a medical-attention definition applied by many reporting teams. Rationale for each judgement is given in Additional file 3.

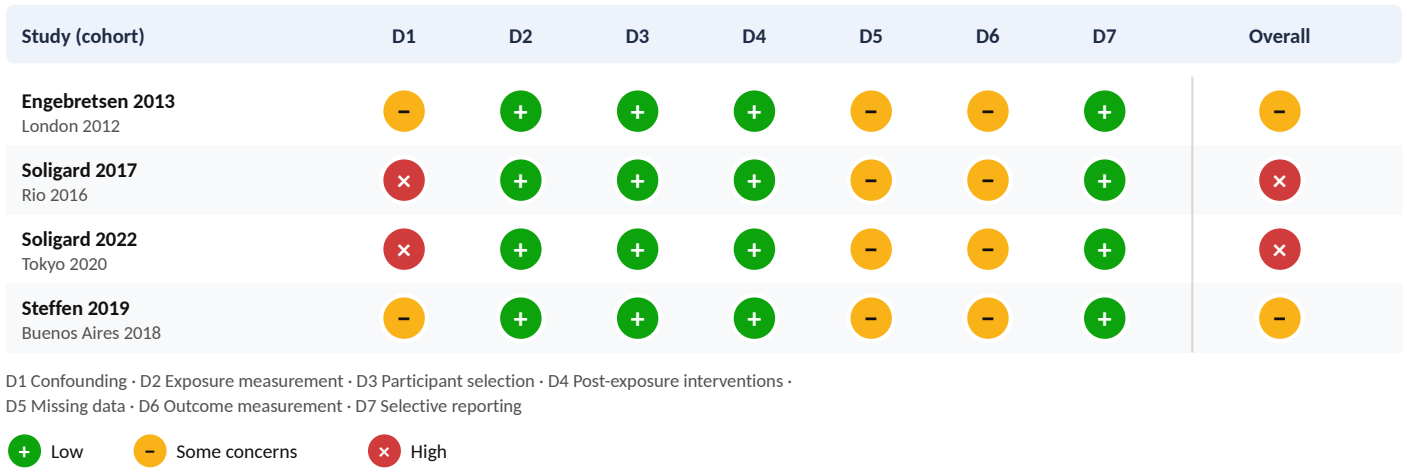


Fig. 4 Risk-of-bias judgements (ROBINS-E) for the comparison of women with men, by domain and overall. Judgements as in Table 2; rationale in Additional file 3.

Injury incidence: results of individual studies and synthesis

At London 2012, 7 of 36 female boxers (19.4%) and 18 of 247 male boxers (7.3%) sustained at least one medical-attention injury, a risk ratio of 2.67 (95% CI 1.20 to 5.94); no woman and one man had an injury with an estimated absence of more than seven days [34] (Fig. 2b; Table 3). At Tokyo 2020, female boxers were at lower risk of injury than male boxers (risk ratio 0.43, 95% CI 0.24 to 0.75), the sex-specific counts being reported in the online appendix [36]. For Rio 2016 and the 2018 Youth Olympic Games the sex-specific boxing counts and risk ratios are held in the online appendices not yet obtained.

Pooling the two available estimates gave a risk ratio of 1.05 with a Hartung-Knapp 95% confidence interval from 0.00 to more than 1000 (one degree of freedom), a normal-distribution interval of 0.17 to 6.26, τ^2 of 1.54, I^2 of 92.5% and Cochran's Q of 13.27 (one degree of freedom, P = 0.0003) (Fig. 5). The pooled estimate is therefore not interpretable; the two Games differed in direction, not merely in magnitude. In the pre-specified subgroup analysis by headguard rule, the Games with a concordant rule (2012) showed a higher proportion of injured women, and the Games with a discordant rule (2020) showed a lower proportion, each subgroup containing a single study. The prediction interval could not be estimated with two studies, and the leave-one-out, low-risk-of-bias-only and odds-ratio sensitivity analyses were not informative with two studies; the normal-distribution sensitivity interval is reported above. Exposure-adjusted incidence rate ratios by sex could not be extracted because minutes of exposure and bouts by sex are not reported in the Games reports; the three-Games combat-sport analysis, which used minutes of exposure, reported no overall difference in injury rate between female and male combat-sport athletes and presented the boxing-specific comparison only in a figure that could not be obtained [4].

Table 3 Injury data and random-effects meta-analysis, women versus men

Study (Games)	Headguard rule	Women injured/n (%)	Men injured/n (%)	RR (95% CI)	log RR (SE)	Weight (%)
Engebretsen 2013 [34] (London 2012)	Concordant	7/36 (19.4)	18/247 (7.3)	2.67 (1.20 to 5.94)	0.981 (0.408)	48.8
Soligard 2022 [36] (Tokyo 2020)	Discordant	Online appendix 1 (not obtained)	Online appendix 1 (not obtained)	0.43 (0.24 to 0.75)	−0.844 (0.291)[a]	51.2
Soligard 2017 [35] (Rio 2016)	Discordant	Online appendix 4 (not obtained)	Online appendix 4 (not obtained)	Not available	–	–
Steffen 2019 [37] (Buenos Aires 2018)	Concordant (youth)	Online appendices 2 and 9 (not obtained)	Online appendices 2 and 9 (not obtained)	Not available	–	–
Pooled, random effects (REML, Hartung-Knapp), 2 studies				**1.05 (0.00 to >1000)**	0.046 (0.912)	100

Heterogeneity: τ^2 = 1.54; I^2 = 92.5%; Cochran's Q = 13.27 (df = 1), P = 0.0003. Normal-distribution 95% CI (sensitivity analysis) 0.17 to 6.26. The prediction interval is not estimable with two studies. Weights are random-effects weights. [a] Standard error derived from the reported 95% confidence interval. RR, risk ratio (women versus men); SE, standard error; REML, restricted maximum likelihood.

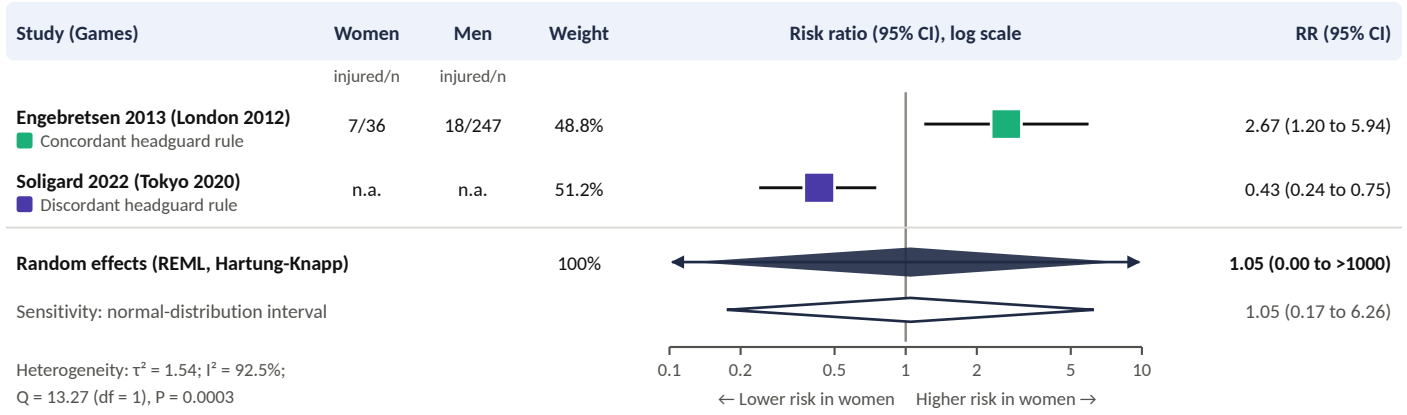


Fig. 5 Forest plot of injury risk ratios, women versus men, in Olympic-style boxing. Risk ratio for at least one medical-attention injury during the Games period, women versus men, with 95% confidence intervals, on a logarithmic axis. Squares are proportional to random-effects weights. The pooled estimate uses restricted maximum likelihood estimation of the between-study variance with the Hartung-Knapp adjustment; with two studies the adjusted interval exceeds the axis range and is not interpretable. Headguard rule: concordant, both sexes wore headguards; discordant, men boxed without headguards and women with them.

Stoppage, concussion and other outcomes

No eligible study reported head-blow stoppages, other stoppage categories, diagnosed concussion, lacerations, fractures, other craniofacial injuries, regional injuries or acute neurocognitive change for women and men from the same amateur boxing population (Fig. 6). The largest bout-record study, covering 29357 amateur bouts from 1952 to 2011, reported knockout and referee-stops-contest rates without any breakdown by sex [39], and the AIBA headguard study compared men's competitions [2]. In the Games cohorts, concussion, fracture and laceration counts for boxing are reported without sex: seven of the twelve concussions recorded across all sports at Rio 2016 occurred in boxing [35], and at Tokyo 2020 five of the twenty acute fractures and three of the six skin lesions or lacerations with an estimated absence of more than seven days occurred in boxing [36]. A prospective sparring study of 30 female and 30 male amateur boxers reported no significant difference in neurocognitive scores between the sexes in its abstract; its full text could not be obtained and the sex-specific scores were not extracted [27]. Women-only surveillance reports provide injury rates without a male comparator from the same population and were therefore ineligible: 43.98 injuries per 1000 athlete-bouts and no concussions at an elite women's national championship in India [40], and a six-year report on female boxing in Italy [41].

Outcome (women versus men)	London 2012 Olympic Games	Rio 2016 Olympic Games	Buenos Aires 2018 Youth Olympic Games	Tokyo 2020 Olympic Games
Injury incidence	Counts	Appendix	Appendix	Ratio only
Head-blow stoppage (RSC-H, knockout)	None	None	None	None
Other stoppage categories	None	None	None	None
Diagnosed concussion or TBI	None	No sex split	None	None
Laceration	None	None	None	No sex split
Fracture	None	None	None	No sex split
Other craniofacial injury	None	None	None	None
Regional (non-head) injury	None	None	None	None
Acute neurocognitive change	None	None	None	None

Counts by sex, main text · Ratio by sex, main text · By sex, in appendix not obtained · Boxing count without sex split · No sex-stratified data

Cells marked "No sex split" are the boxing counts cited in the text (Rio 2016: 7 of 12 Games-wide concussions; Tokyo 2020: 5 of 20 acute fractures and 3 of 6 skin lesions or lacerations with absence of more than seven days). TBI, traumatic brain injury; RSC-H, referee stops contest because of head blows.

Fig. 6 Evidence map of sex-stratified data for each outcome in the four included cohorts. Shading shows where data comparing women and men were found: counts in the main text, a ratio in the main text, data held in online appendices not obtained, boxing counts reported without a sex split, or no sex-stratified data.

Reporting bias and certainty of evidence

Sex-stratified results for boxing were reported in every Games cohort, but in three of four they were placed in supplementary files rather than the main text, and in none were bouts or minutes of exposure reported by sex. Applying GRADE, the certainty of evidence for a sex difference in injury incidence was very low, downgraded for serious risk of bias (confounding by equipment rules and unmeasured exposure), very serious inconsistency (reversal of direction between Games) and very serious imprecision (seven injured women in the 2012 cohort and two studies in the synthesis). For stoppage, concussion and the secondary endpoints there was no evidence to rate (Table 4).

Discussion

Principal findings

Four surveillance cohorts, all from the Olympic or Youth Olympic Games, provide the only published within-study comparisons of injury between female and male amateur boxers, and their results are not consistent. When both sexes boxed under the same headguard rule at London 2012, women were about two and a half times as likely as men to be recorded with an injury, although the estimate rests on seven injured women. When the rule diverged, at Tokyo 2020, women were less than half as likely as men to be injured. The pooled estimate is uninformative, and the pre-specified subgroup analysis by headguard rule, although based on one study per subgroup, identifies the most plausible explanation for the reversal: the removal of headguards from men's boxing was followed by a three-fold increase in the injury rate of male boxers in the same surveillance programme

[4] and by an increase in cuts in AIBA tournaments [2, 42], so that after 2013 the comparison of women with men is largely a comparison of headguarded with unguarded boxers. For stoppages, diagnosed concussion and every secondary endpoint, no sex-stratified evidence from a common population exists.

Table 4 Summary of findings and certainty of evidence (GRADE)

Outcome (women versus men)	Studies with data	Findings	Certainty
Injury incidence (proportion of boxers with a medical-attention injury)	2 of 4 included cohorts (London 2012: 283 boxers; Tokyo 2020: reported RR); 2 cohorts pending appendix data	RR 2.67 (1.20 to 5.94) in 2012 (concordant headguard rule); RR 0.43 (0.24 to 0.75) in 2020 (discordant rule); pooled RR 1.05, not interpretable (I^2 92.5%)	Very low (serious risk of bias; very serious inconsistency; very serious imprecision)
Head-blow stoppage (RSC-H, knockout)	None	No within-study sex comparison published	No evidence
Diagnosed concussion or traumatic brain injury	None	Concussion counts for boxing reported without sex (7 of 12 Games-wide concussions in boxing in 2016)	No evidence
Other stoppage categories; laceration; fracture; other craniofacial injury; regional injury	None	Injury-type counts for boxing reported without sex	No evidence
Acute neurocognitive change after bouts or sparring	1 potentially eligible study (30 women, 30 men); full text not obtained	Abstract reports no significant difference between sexes; values not extracted	Not assessable

RR, risk ratio; RSC-H, referee stops contest because of head blows; I^2, I-squared. Certainty started at low for observational designs and was downgraded as indicated.

Comparison with previous reviews

Previous meta-analyses of amateur boxing injury epidemiology reported pooled competition incidence rates of 54.7 injuries per 1000 athlete-exposures and 6.8 per 1000 minutes of exposure [9] and characterised injury types across amateur and professional boxing [8], but neither compared women and men within studies; a review of Olympic combat-sport surveillance likewise did not stratify by sex [10]. The three-Games analysis found no overall sex difference in exposure-adjusted injury rates across boxing, judo, taekwondo and wrestling [4], and a meta-analysis of Games surveillance across all sports found similar injury incidence in female and male athletes [43]. In Olympic-style karate, the only striking sport with a sex comparison in a systematic review, injury rates did not differ by sex (rate ratio 1.09, 95% CI 0.88 to 1.36) [44], although a later tournament study found a higher risk in senior men than senior women [45]. Across sports, higher concussion rates in female athletes have been reported in sex-comparable sports [13, 14], and the head-impact literature in boxing and mixed martial arts, based on small numbers of women, reports fewer impacts in women but similar impact magnitudes [46]. The present review adds that in boxing the sex comparison cannot be separated from the equipment rule after 2013 and that the concussion question has never been examined with sex-stratified data in an amateur population.

Proposed mechanisms

Several mechanisms are proposed, none of which the included studies can test. First, headguards reduce lacerations [2, 7], so a rule that removes them from one sex raises that sex's recorded injury proportion under a medical-attention definition that counts cuts. Second, exposure per athlete may differ by sex: the Olympic programme offered women fewer weight categories than men [1], and bout formats have differed, the 2015 rules prescribing three rounds of three minutes for elite men and four rounds of two minutes for elite women [3]; the Games reports use athletes rather than bouts or minutes as the denominator, so any such difference is absorbed into the comparison. Third, injury reporting and medical attention-seeking may differ by sex, as has been suggested for concussion in other sports [17]. Fourth, the small number of women at each Games (36 in 2012) makes the sex-specific proportion sensitive to a handful of events. These explanations are not mutually exclusive, and only surveillance that records equipment, bouts, minutes and sex for every athlete can distinguish them.

Generalisability

The evidence concerns elite boxers during a Games period. It does not extend to sparring or training, to novice or youth competition outside the Youth Olympic Games, to national or regional tournaments, or to the professional ranks, where a Nevada study reported lower injury and knockout rates in women than in men [47]. The included cohorts used a medical-attention definition, so the findings do not describe time-loss injury, and they do not describe stoppage or concussion at all.

Implications for regulation

For injury incidence, the evidence does not support a claim that women are at lower, or at higher, risk than men in Olympic-style boxing; the only like-for-like comparison points towards a higher recorded injury proportion in women, with very low certainty. Commissions and federations that regulate women's and men's boxing differently should therefore document the rationale for each difference and record the data needed to evaluate it. For

head-blow stoppages, no sex-stratified evidence exists, so stoppage thresholds and referee and ringside-physician practice cannot presently be justified as sex-specific on injury grounds; commissions can address this directly by recording bout outcomes by sex in their own event records. For concussion, the absence of sex-stratified diagnosis data in amateur boxing contrasts with the wider sports literature reporting higher concussion rates in female athletes [13, 14], and argues for post-bout medical examination protocols that record diagnosed concussion by sex. For protective equipment, the ringside physicians' recommendation to standardise headguard policy across sexes until data exist [7] is consistent with the present findings: sex-discordant rules make the sex question unanswerable.

Research priorities

Priorities are: publication of sex-stratified boxing data with bouts and minutes of exposure from the existing Games surveillance datasets; prospective surveillance at World Championships and continental championships that records sex, equipment, bout format, stoppage type and diagnosed concussion for every bout; secondary analyses of national bout-record databases by sex; and neurocognitive studies powered to compare women and men after sparring and competition. Commissions hold event records that could contribute to several of these priorities at little cost.

Limitations

This review has limitations. Only two sources were searched, PubMed/MEDLINE and Consensus, so reports indexed only in Embase, SPORTDiscus or regional databases may have been missed; citation searching partly mitigated this and identified the 2012 cohort. Screening was performed by a single reviewer with verification, so screening errors cannot be excluded. The review was not registered. Thirty-three database reports and eleven citation-search reports could not be obtained in full; 33 of these were classified from the published record as ineligible by design or population, a procedure that risks misclassification and is disclosed record by record in Additional file 2, and 11 remained potentially eligible, including the three-Games combat-sport analysis whose boxing-specific sex comparison is presented only in a figure. The sex-specific data of two included cohorts are held in supplementary files that could not be obtained for this version, so the synthesis rests on two Games, one of them a reported ratio without counts, and heterogeneity between them was extreme. The Games reports use athletes rather than exposure as the denominator, the comparisons are unadjusted, and the numbers of women are small. Analyses were run in a Python implementation validated against metafor rather than in R itself. Finally, the evidence is observational and cannot establish causation for any of the proposed mechanisms.

Conclusions

In amateur and Olympic-style boxing, the published evidence on sex differences consists of four Olympic and Youth Olympic surveillance cohorts. Where women and men boxed under the same headguard rule, a higher proportion of women than men was recorded with an injury; where the rule differed by sex, the direction reversed. The certainty of this evidence is very low, and there is no sex-stratified evidence at all on head-blow stoppages, diagnosed concussion, lacerations, fractures or acute neurocognitive change. For policy, the state of the evidence does not justify sex-specific rules on injury grounds in either direction, and it argues for recording equipment, exposure, stoppage and concussion by sex in every sanctioned event. For research, the immediate need is the release and analysis of sex-stratified exposure data that already exist within Games surveillance, followed by prospective surveillance of championships and national bout records designed to compare women and men.

List of abbreviations

AIBA International Boxing Association (Association Internationale de Boxe Amateur)
AOB AIBA Open Boxing
CI confidence interval
GRADE Grading of Recommendations, Assessment, Development and Evaluation
IBA International Boxing Association
IOC International Olympic Committee
MeSH Medical Subject Headings
PRISMA Preferred Reporting Items for Systematic Reviews and Meta-Analyses
REML restricted maximum likelihood
ROBINS-E Risk Of Bias In Non-randomised Studies – of Exposures
RR risk ratio
RSC referee stops contest
SWiM Synthesis Without Meta-analysis

Declarations

Ethics approval and consent to participate

Not applicable. The review analysed published aggregate data only.

Consent for publication

Not applicable.

Availability of data and materials

The datasets supporting the conclusions of this article are included within the article and its additional files (search log, screening log with every record-level decision, extraction and risk-of-bias workbook, analysis dataset and scripts).

Competing interests

Casey C. Sears is Commissioner of the Alabama Athletic Commission and chairs its Medical Oversight Committee, Amateur Boxing Committee and Rules and Procedures Committee, regulatory roles that include the approval of rules for amateur and professional combat sports in Alabama, and operates Sears Publishing Company. CCS declares no financial competing interests.

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Authors' contributions

CCS conceived the review, defined the question and criteria, directed and verified the searches, screening and data extraction, interpreted the analyses and wrote the manuscript. The author read and approved the final manuscript.

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Authors' information

CCS is a nationally registered paramedic, a Fellow of the Academy of Wilderness Medicine, a former boxer, a licensed combat-sports referee and judge, and a member of the Alabama Boxing Hall of Fame.

References

1. Tjønndal A. 'I don't think they realise how good we are': Innovation, inclusion and exclusion in women's Olympic boxing. Int Rev Sociol Sport. 2019;54(2):131–150. https://doi.org/10.1177/1012690217715642.
2. Loosemore MP, Butler CF, Khadri A, McDonagh D, Patel VA, Bailes JE. Use of head guards in AIBA boxing tournaments - a cross-sectional observational study. Clin J Sport Med. 2017;27(1):86–88.
3. International Boxing Association. AIBA Open Boxing (AOB) Competition Rules, effective as of February 1, 2015. https://www.iba.sport/wp-content/uploads/2015/02/AOB-Competition-Rules-2015-09-11.pdf. Accessed 29 Sep 2026.
4. Lystad RP, Alevras A, Rudy I, Soligard T, Engebretsen L. Injury incidence, severity and profile in Olympic combat sports: a comparative analysis of 7712 athlete exposures from three consecutive Olympic Games. Br J Sports Med. 2021;55(19):1077–1083.
5. Esomnofu A. AIBA drops headgear for male amateur boxers; female fighters still wear them. Global Sport Matters, Arizona State University. 2019. https://live-global-sport-matter.ws.asu.edu/health/2019/08/27/aiba-drops-headgear-male-amateur-boxers-female-fighters-wear-them/. Accessed 29 Sep 2026.
6. Le K, Marchant JN, Le KDR. The case for protective headguards in amateur boxing and implications for international policy on headguard bans. Sports Med Open. 2025;11(1):54.
7. deWeber K, Parlee L, Nguyen A, Lenihan MW, Goedecke L. Headguard use in combat sports: position statement of the Association of Ringside Physicians. Phys Sportsmed. 2024;52(3):229–238.
8. Mao Y, Zhao D, Li J, Fu W. Incidence rates and pathology types of boxing-specific injuries: a systematic review and meta-analysis of epidemiology studies in the 21st century. Orthop J Sports Med. 2023;11(3):23259671221127669.
9. Alevras AJ, Fuller JT, Mitchell R, Lystad RP. Epidemiology of injuries in amateur boxing: a systematic review and meta-analysis. J Sci Med Sport. 2022;25(12):995–1001.
10. Bromley SJ, Drew MK, Talpey S, McIntosh AS, Finch CF. A systematic review of prospective epidemiological research into injury and illness in Olympic combat sport. Br J Sports Med. 2018;52(1):8–16.
11. Tjønndal A, Haudenhuyse R, de Geus B, Buyse L. Concussions, cuts and cracked bones: a systematic literature review on protective headgear and head injury prevention in Olympic boxing. Eur J Sport Sci. 2022;22(3):447–459.
12. Donnelly RR, Ugbolue UC, Gao Y, Gu Y, Dutheil F, Baker JS. A systematic review and meta-analysis investigating head trauma in boxing. Clin J Sport Med. 2023;33(6):658–674.
13. Van Pelt KL, Puetz T, Swallow J, Lapointe AP, Broglio SP. Data-driven risk classification of concussion rates: a systematic review and meta-analysis. Sports Med. 2021;51(6):1227–1244.
14. Hardaker NJ, Hume PA, Sims ST. Differences in injury profiles between female and male athletes across the participant classification framework: a systematic review and meta-analysis. Sports Med. 2024;54(6):1595–1665.
15. Zech A, Hollander K, Junge A, Steib S, Groll A, Heiner J, et al. Sex differences in injury rates in team-sport athletes: a systematic review and meta-regression analysis. J Sport Health Sci. 2022;11(1):104–114.
16. D'Lauro C, Jones ER, Swope LM, Anderson MN, Broglio S, Schmidt JD. Under-representation of female athletes in research informing influential concussion consensus and position statements: an evidence review and synthesis. Br J Sports Med. 2022; https://doi.org/10.1136/bjsports-2021-105045.
17. McGroarty NK, Brown SM, Mulcahey MK. Sport-related concussion in female athletes: a systematic review. Orthop J Sports Med. 2020;8(7):2325967120932306.
18. Fahr J, Kraff O, Deuschl C, Dodel R. Concussion in female athletes of contact sports: a scoping review. Orthop J Sports Med. 2024;12(10):23259671241276447.
19. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 2021;372:n71.
20. National Library of Medicine. PubMed. https://pubmed.ncbi.nlm.nih.gov. Accessed 29 Sep 2026.

21. Consensus. Consensus academic search engine. https://consensus.app. Accessed 29 Sep 2026.
22. Higgins JPT, Morgan RL, Rooney AA, Taylor KW, Thayer KA, Silva RA, et al. A tool to assess risk of bias in non-randomized follow-up studies of exposure effects (ROBINS-E). Environ Int. 2024;186:108602.
23. Guyatt GH, Oxman AD, Vist GE, Kunz R, Falck-Ytter Y, Alonso-Coello P, et al. GRADE: an emerging consensus on rating quality of evidence and strength of recommendations. BMJ. 2008;336(7650):924–6.
24. Campbell M, McKenzie JE, Sowden A, Katikireddi SV, Brennan SE, Ellis S, et al. Synthesis without meta-analysis (SWiM) in systematic reviews: reporting guideline. BMJ. 2020;368:l6890.
25. IntHout J, Ioannidis JP, Borm GF. The Hartung-Knapp-Sidik-Jonkman method for random effects meta-analysis is straightforward and considerably outperforms the standard DerSimonian-Laird method. BMC Med Res Methodol. 2014;14:25.
26. Viechtbauer W. Conducting meta-analyses in R with the metafor package. J Stat Softw. 2010;36(3):1–48. https://doi.org/10.18637/jss.v036.i03.
27. Stojsih S, Boitano M, Wilhelm M, Bir C. A prospective study of punch biomechanics and cognitive function for amateur boxers. Br J Sports Med. 2010;44(10):725–30.
28. Karpman S, Reid P, Phillips L, Qin Z, Gross DP. Combative sports injuries: an Edmonton retrospective. Clin J Sport Med. 2016;26(4):332–4.
29. Loosemore M, Lightfoot J, Palmer-Green D, Gatt I, Bilzon J, Beardsley C. Boxing injury epidemiology in the Great Britain team: a 5-year surveillance study of medically diagnosed injury incidence and outcome. Br J Sports Med. 2015;49(17):1100–7.
30. Zazryn T, Cameron P, McCrory P. A prospective cohort study of injury in amateur and professional boxing. Br J Sports Med. 2006;40(8):670–4.
31. Siewe J, Rudat J, Zarghooni K, Sobottke R, Eysel P, Herren C, et al. Injuries in competitive boxing. A prospective study. Int J Sports Med. 2015;36(3):249–53.
32. Junge A, Engebretsen L, Alonso JM, Renström P, Mountjoy M, Aubry M, et al. Injury surveillance in multi-sport events: the International Olympic Committee approach. Br J Sports Med. 2008;42(6):413–21.
33. Bahr R, Clarsen B, Derman W, Dvorak J, Emery CA, Finch CF, 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(7):372–389.
34. Engebretsen L, Soligard T, Steffen K, Alonso JM, Aubry M, Budgett R, et al. Sports injuries and illnesses during the London Summer Olympic Games 2012. Br J Sports Med. 2013;47(7):407–14.
35. Soligard T, Steffen K, Palmer D, Alonso JM, Bahr R, Lopes AD, et al. Sports injury and illness incidence in the Rio de Janeiro 2016 Olympic Summer Games: a prospective study of 11274 athletes from 207 countries. Br J Sports Med. 2017;51(17):1265–1271.
36. Soligard T, Palmer D, Steffen K, Lopes AD, Grek N, Onishi K, et al. New sports, COVID-19 and the heat: sports injuries and illnesses in the Tokyo 2020 Summer Olympics. Br J Sports Med. 2022; https://doi.org/10.1136/bjsports-2022-106155.
37. Steffen K, Soligard T, Mountjoy M, Dallo I, Gessara AM, Giuria H, et al. How do the new Olympic sports compare with the traditional Olympic sports? Injury and illness at the 2018 Youth Olympic Summer Games in Buenos Aires, Argentina. Br J Sports Med. 2020;54(3):168–175.
38. Junge A, Engebretsen L, Mountjoy ML, Alonso JM, Renström PA, Aubry MJ, et al. Sports injuries during the Summer Olympic Games 2008. Am J Sports Med. 2009;37(11):2165–72.
39. Bianco M, Loosemore M, Daniele G, Palmieri V, Faina M, Zeppilli P. Amateur boxing in the last 59 years. Impact of rules changes on the type of verdicts recorded and implications on boxers' health. Br J Sports Med. 2013;47(7):452–7.
40. Dande J, Mallick A, Patil AA, Kalra SS. Injury surveillance during elite women's national boxing championship in India. Med J Armed Forces India. 2023;79(3):262–266.
41. Bianco M, Sanna N, Bucari S, Fabiano C, Palmieri V, Zeppilli P. Female boxing in Italy: 2002–2007 report. Br J Sports Med. 2011;45(7):563–70.
42. Davis P, Waldock R, Connorton A, Driver S, Anderson S. Comparison of amateur boxing before and after the 2013 rules change and the impact on boxers' safety. Br J Sports Med. 2018;52(11):741–746.
43. Torvaldsson K, Fagher K, Derman W, Engebretsen L, Lindblom H, Lopes AD, et al. Injury and illness epidemiology in elite athletes during the Olympic, Youth Olympic and Paralympic Games: a systematic review and meta-analysis. Br J Sports Med. 2025;59(18):1302–1314.
44. Lystad RP, Augustovičová D, Harris G, Beskin K, Arriaza R. Epidemiology of injuries in Olympic-style karate competitions: systematic review and meta-analysis. Br J Sports Med. 2020;54(16):976–983.
45. Rosso C, Arnold RF, Daci A, Grezda K. Incidence rate of injury and injury sites in European and Swiss karate competitions: a prospective epidemiological study of 2404 fights. BMJ Open Sport Exerc Med. 2023;9(3):e001719.
46. Jansen AE, McGrath M, Samorezov S, Johnston J, Bartsch A, Alberts J. Characterizing head impact exposure in men and women during boxing and mixed martial arts. Orthop J Sports Med. 2021;9(12):23259671211059815.
47. Bledsoe GH, Li G, Levy F. Injury risk in professional boxing. South Med J. 2005;98(10):994–8.

Additional files

Additional file 1 (.xlsx). Search log. Databases, exact query strings, filters, dates, record counts and deduplication totals; the pre-search working outline with the eligibility criteria and analysis plan.

Additional file 2 (.xlsx). Screening log. Every record screened at title and abstract with its decision and reason; every report sought with its retrieval route, full-text decision, reason and the basis of record-level decisions; citation-search sources and candidates.

Additional file 3 (.xlsx). Extraction and risk-of-bias workbook. Extracted data with the location of every value, ROBINS-E judgements with rationale, GRADE ratings and the outcome map.

Additional file 4 (.zip). Analysis dataset and scripts. analysis_data.csv, meta_tools.py, run_analysis.py, run_analysis.R (metafor), results.json, results_table.csv and figure files.

Additional file 5 (.docx). PRISMA 2020 checklists. PRISMA 2020 checklist and PRISMA 2020 for Abstracts checklist with manuscript locations.

An LLM or AI model was used to assist in the production of the article. For more information contact editor@searspublishing.net.

Reference DOI links

Crossref DOI links for the cited works whose entries in the reference list above do not print a DOI. Numbers match the reference list.

2. Loosemore MP et al. Clin J Sport Med 2017. https://doi.org/10.1097/JSM.0000000000000322
4. Lystad RP et al. Br J Sports Med 2021. https://doi.org/10.1136/bjsports-2020-102958
6. Le K et al. Sports Med Open 2025. https://doi.org/10.1186/s40798-025-00871-4
7. deWeber K et al. Phys Sportsmed 2024. https://doi.org/10.1080/00913847.2023.2242415
8. Mao Y et al. Orthop J Sports Med 2023. https://doi.org/10.1177/23259671221127669
9. Alevras AJ et al. J Sci Med Sport 2022. https://doi.org/10.1016/j.jsams.2022.09.165
10. Bromley SJ et al. Br J Sports Med 2018. https://doi.org/10.1136/bjsports-2016-097313
11. Tjønndal A et al. Eur J Sport Sci 2022. https://doi.org/10.1080/17461391.2021.1872711
12. Donnelly RR et al. Clin J Sport Med 2023. https://doi.org/10.1097/JSM.0000000000001195
13. Van Pelt KL et al. Sports Med 2021. https://doi.org/10.1007/s40279-021-01428-7
14. Hardaker NJ et al. Sports Med 2024. https://doi.org/10.1007/s40279-024-02010-7
15. Zech A et al. J Sport Health Sci 2022. https://doi.org/10.1016/j.jshs.2021.04.003
17. McGroarty NK et al. Orthop J Sports Med 2020. https://doi.org/10.1177/2325967120932306
18. Fahr J et al. Orthop J Sports Med 2024. https://doi.org/10.1177/23259671241276447
19. Page MJ et al. BMJ 2021. https://doi.org/10.1136/bmj.n71
22. Higgins JPT et al. Environ Int 2024. https://doi.org/10.1016/j.envint.2024.108602
23. Guyatt GH et al. BMJ 2008. https://doi.org/10.1136/bmj.39489.470347.AD
24. Campbell M et al. BMJ 2020. https://doi.org/10.1136/bmj.l6890
25. IntHout J et al. BMC Med Res Methodol 2014. https://doi.org/10.1186/1471-2288-14-25
27. Stojsih S et al. Br J Sports Med 2010. https://doi.org/10.1136/bjsm.2008.052845
28. Karpman S et al. Clin J Sport Med 2016. https://doi.org/10.1097/JSM.0000000000000235
29. Loosemore M et al. Br J Sports Med 2015. https://doi.org/10.1136/bjsports-2015-094755
30. Zazryn T et al. Br J Sports Med 2006. https://doi.org/10.1136/bjsm.2006.025924
31. Siewe J et al. Int J Sports Med 2015. https://doi.org/10.1055/s-0034-1387764
32. Junge A et al. Br J Sports Med 2008. https://doi.org/10.1136/bjsm.2008.046631
33. Bahr R et al. Br J Sports Med 2020. https://doi.org/10.1136/bjsports-2019-101969
35. Soligard T et al. Br J Sports Med 2017. https://doi.org/10.1136/bjsports-2017-097956
37. Steffen K et al. Br J Sports Med 2020. https://doi.org/10.1136/bjsports-2019-101040
38. Junge A et al. Am J Sports Med 2009. https://doi.org/10.1177/0363546509339357
39. Bianco M et al. Br J Sports Med 2013. https://doi.org/10.1136/bjsports-2012-091771
40. Dande J et al. Med J Armed Forces India 2023. https://doi.org/10.1016/j.mjafi.2021.03.016
41. Bianco M et al. Br J Sports Med 2011. https://doi.org/10.1136/bjsm.2009.061135
42. Davis P et al. Br J Sports Med 2018. https://doi.org/10.1136/bjsports-2017-097667
43. Torvaldsson K et al. Br J Sports Med 2025. https://doi.org/10.1136/bjsports-2025-109980
44. Lystad RP et al. Br J Sports Med 2020. https://doi.org/10.1136/bjsports-2020-101990
45. Rosso C et al. BMJ Open Sport Exerc Med 2023. https://doi.org/10.1136/bmjsem-2023-001719
46. Jansen AE et al. Orthop J Sports Med 2021. https://doi.org/10.1177/23259671211059815
47. Bledsoe GH et al. South Med J 2005. https://doi.org/10.1097/01.smj.0000182498.19288.e2